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COVER NOTE

From:	Secretary-General of the European Commission, signed by Mr Jordi AYET PUIGARNAU, Director
date of receipt:	17 October 2019
To:	Mr Jeppe TRANHOLM-MIKKELSEN, Secretary-General of the Council of the European Union
No. Cion doc.:	C(2019) 7313 final - Annex 1 Part 8/11
Subject:	ANNEX 1 Part 8/11 to the Commission Delegated Regulation amending Council Regulation (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items

Delegations will find attached document C(2019) 7313 final - Annex 1 Part 8/11.

Encl.: C(2019) 7313 final - Annex 1 Part 8/11

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Brussels, 17.10.2019
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ANNEX 1 – PART 8/11

ANNEX

to the

Commission Delegated Regulation

amending Council Regulation (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items

ANNEX I (PART VIII – Category 6)

CATEGORY 6 - SENSORS AND LASERS

6A Systems, Equipment and Components

6A001 Acoustic systems, equipment and components, as follows:

a. Marine acoustic systems, equipment and specially designed components therefor, as follows:

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

Note: 6A001.a.1. does not control equipment as follows:

a. Depth sounders operating vertically below the apparatus, not including a scanning function exceeding ± 20°, and limited to measuring the depth of water, the distance of submerged or buried objects or fish finding;

b. Acoustic beacons, as follows:

1. Acoustic emergency beacons;

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

a. Acoustic seabed survey equipment as follows:

1. Surface vessel survey equipment designed for seabed topographic mapping and having all of the following:

a. Designed to take measurements at an angle exceeding 20° from the vertical;

b. Designed to measure seabed topography at seabed depths exceeding 600 m;

c. 'Sounding resolution' less than 2; and

d. 'Enhancement' of the depth "accuracy" through compensation for all the following:

1. Motion of the acoustic sensor;

2. In-water propagation from sensor to the seabed and back; and

3. Sound speed at the sensor;

Technical Notes:

1. 'Sounding resolution' is the swath width (degrees) divided by the maximum number of soundings per swath.

2. 'Enhancement' includes the ability to compensate by external means.

2. Underwater survey equipment designed for seabed topographic mapping and having any of the following:

Technical Note:
The acoustic sensor pressure rating determines the depth rating of the equipment specified in 6A001.a.1.a.2.

a. Having all of the following:

1. Designed or modified to operate at depths exceeding 300 m; and

2. 'Sounding rate' greater than 3 800 m/s; or

Technical Note:
'Sounding rate' is the product of the maximum speed (m/s) at which the sensor can operate and the maximum number of soundings per swath assuming 100% coverage. For systems that produce soundings in two directions (3D sonars), the maximum of the 'sounding rate' in either direction should be used.

b. Survey equipment, not specified in 6A001.a.1.a.2.a., having all of the following:

1. Designed or modified to operate at depths exceeding 100 m;

2. Designed to take measurements at an angle exceeding 20° from the vertical;

3. Having any of the following:

a. Operating frequency below 350 kHz; or

b. Designed to measure seabed topography at a range exceeding 200 m from the acoustic sensor; and

4. 'Enhancement' of the depth "accuracy" through compensation of all of the following:

a. Motion of the acoustic sensor;

b. In-water propagation from sensor to the seabed and back; and

c. Sound speed at the sensor;

3. Side Scan Sonar (SSS) or Synthetic Aperture Sonar (SAS), designed for seabed imaging and having all of the following, and specially designed transmitting and receiving acoustic arrays therefor:

   a. Designed or modified to operate at depths exceeding 500 m;

   b. An 'area coverage rate' of greater than 570 m^2/s while operating at the maximum range that it can operate with an 'along track resolution' of less than 15 cm; and

   c. An 'across track resolution' of less than 15 cm;

Technical Notes:

1. 'Area coverage rate' (m^2/s) is twice the product of the sonar range (m) and the maximum speed (m/s) at which the sensor can operate at that range.

2. 'Along track resolution' (cm), for SSS only, is the product of azimuth (horizontal) beamwidth (degrees) and sonar range (m) and 0,873.

3. 'Across track resolution' (cm) is 75 divided by the signal bandwidth (kHz).

b. Systems or transmitting and receiving arrays, designed for object detection or location, having any of the following:

   1. A transmitting frequency below 10 kHz;

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

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

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

6A001.a.1.b. continued

5. Designed to operate with an unambiguous display range exceeding 5 120 m; or

6. Designed to withstand pressure during normal operation at depths exceeding 1 000 m and having transducers with any of the following:

a. Dynamic compensation for pressure; or

b. Incorporating other than lead zirconate titanate as the transduction element;

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

Note 1: *The control status of acoustic projectors, including transducers, specially designed for other equipment not specified in 6A001 is determined by the control status of the other equipment.*

Note 2: *6A001.a.1.c. does not control electronic sources which direct the sound vertically only, or mechanical (e.g., air gun or vapour-shock gun) or chemical (e.g., explosive) sources.*

Note 3: *Piezoelectric elements specified in 6A001.a.1.c. include those made from lead-magnesium-niobate/lead-titanate ($Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$, or PMN-PT) single crystals grown from solid solution or lead-indium-niobate/lead-magnesium niobate/lead-titanate ($Pb(In_{1/2}Nb_{1/2})O_3$–$Pb(Mg_{1/3}Nb_{2/3})O_3$–$PbTiO_3$, or PIN-PMN-PT) single crystals grown from solid solution.*

1. Operating at frequencies below 10 kHz and having any of the following:

a. Not designed for continuous operation at 100% duty cycle and having a radiated 'free-field Source Level (SL_{RMS})' exceeding (10log(f) + 169,77) dB (reference 1 μPa at 1 m) where f is the frequency in Hertz of maximum Transmitting Voltage Response (TVR) below 10kHz; or

b. Designed for continuous operation at 100% duty cycle and having a continuously radiated 'free-field Source Level (SLRMS)' at 100% duty cycle exceeding (10log(f) + 159,77) dB (reference 1 µPa at 1 m) where f is the frequency in Hertz of maximum Transmitting Voltage Response (TVR) below 10kHz; or

Technical Note:
The 'free-field Source Level (SLRMS)' is defined along the maximum response axis and in the far field of the acoustic projector. It can be obtained from the Transmitting Voltage Response using the following equation: SLRMS = (TVR + 20log VRMS) dB (ref 1µPa at 1 m), where SLRMS is the source level, TVR is the Transmitting Voltage Response and VRMS is the Driving Voltage of the Projector.

2. Not used;

3. Side-lobe suppression exceeding 22 dB;

6A001.a.1. continued

d. Acoustic systems and equipment, designed to determine the position of surface vessels or underwater vehicles and having all the following, and specially designed components therefor:

1. Detection range exceeding 1 000 m; and

2. Determined position error of less than 10 m rms (root mean square) when measured at a range of 1 000 m;

Note: 6A001.a.1.d. includes:

a. Equipment using coherent "signal processing" between two or more beacons and the hydrophone unit carried by the surface vessel or underwater vehicle;

b. Equipment capable of automatically correcting speed-of-sound propagation errors for calculation of a point.

e. Active individual sonars, specially designed or modified to detect, locate and automatically classify swimmers or divers, having all of the following, and specially designed transmitting and receiving acoustic arrays therefor:

1. Detection range exceeding 530 m;

2. Determined position error of less than 15 m rms (root mean square) when measured at a range of 530 m; and

3. Transmitted pulse signal bandwidth exceeding 3 kHz;

N.B. For diver detection systems specially designed or modified for military use, see the Military Goods Controls.

Note: For 6A001.a.1.e., where multiple detection ranges are specified for various environments, the greatest detection range is used.

6A001.a. continued

2. Passive systems, equipment and specially designed components therefor, as follows:

Note: *6A001.a.2. also controls receiving equipment, whether or not related in normal application to separate active equipment, and specially designed components therefor.*

a. Hydrophones having any of the following:

Note: *The control status of hydrophones specially designed for other equipment is determined by the control status of the other equipment.*

Technical Notes:

1. Hydrophones consist of one or more sensing elements producing a single acoustic output channel. Those that contain multiple elements can be referred to as a hydrophone group.

2. For the purposes of 6A001.a.2.a., underwater acoustic transducers designed to operate as passive receivers are hydrophones.

1. Incorporating continuous flexible sensing elements;

2. Incorporating flexible assemblies of discrete sensing elements with either a diameter or length less than 20 mm and with a separation between elements of less than 20 mm;

3. Having any of the following sensing elements:

a. Optical fibres;
b. 'Piezoelectric polymer films' other than polyvinylidene-fluoride (PVDF) and its co-polymers {P(VDF-TrFE) and P(VDF-TFE)};
c. 'Flexible piezoelectric composites';
d. Lead-magnesium-niobate/lead-titanate (i.e., $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$, or PMN-PT) piezoelectric single crystals grown from solid solution; or
e. Lead-indium-niobate/lead-magnesium niobate/lead-titanate (i.e., $Pb(In_{1/2}Nb_{1/2})O_3$–$Pb(Mg_{1/3}Nb_{2/3})O_3$–$PbTiO_3$, or PIN-PMN-PT) piezoelectric single crystals grown from solid solution;

4. A 'hydrophone sensitivity' better than -180 dB at any depth with no acceleration compensation;

5. Designed to operate at depths exceeding 35 m with acceleration compensation; or

6. Designed for operation at depths exceeding 1 000 m and having a 'hydrophone sensitivity' better than -230 dB below 4 kHz;

Technical Notes:

1. *'Piezoelectric polymer film' sensing elements consist of polarised polymer film that is stretched over and attached to a supporting frame or spool (mandrel).*
2. *'Flexible piezoelectric composite' sensing elements consist of piezoelectric ceramic particles or fibres combined with an electrically insulating, acoustically transparent rubber, polymer or epoxy compound, where the compound is an integral part of the sensing elements.*
3. *'Hydrophone sensitivity' is defined as twenty times the logarithm to the base 10 of the ratio of rms output voltage to a 1 V rms reference, when the hydrophone sensor, without a pre-amplifier, is placed in a plane wave acoustic field with an rms pressure of 1 µPa. For example, a hydrophone of -160 dB (reference 1 V per µPa) would yield an output voltage of 10^{-8} V in such a field, while one of -180 dB sensitivity would yield only 10^{-9} V output. Thus, -160 dB is better than -180 dB.*

6A001.a.2. continued

b. Towed acoustic hydrophone arrays having any of the following:

Technical Note:
Hydrophone arrays consist of a number of hydrophones providing multiple acoustic output channels.

1. Hydrophone group spacing of less than 12,5 m or 'able to be modified' to have hydrophone group spacing of less than 12,5 m;

2. Designed or 'able to be modified' to operate at depths exceeding 35 m;

Technical note:

'Able to be modified' in 6A001.a.2.b.1. and 2. means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10% of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group.

3. Heading sensors specified in 6A001.a.2.d.;

4. Longitudinally reinforced array hoses;

5. An assembled array of less than 40 mm in diameter;

6. Not used;

7. Hydrophone characteristics specified in 6A001.a.2.a.; or

8. Accelerometer-based hydro-acoustic sensors specified in 6A001.a.2.g.;

6A001.a.2. continued

c. Processing equipment, specially designed for towed acoustic hydrophone arrays, having "user-accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes;

d. Heading sensors having all of the following:

1. An "accuracy" of better than 0,5°; and

2. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m;

N.B. *For inertial heading systems, see 7A003.c.*

e. Bottom or bay-cable hydrophone arrays, having any of the following:

1. Incorporating hydrophones specified in 6A001.a.2.a.;

2. Incorporating multiplexed hydrophone group signal modules having all of the following characteristics:

a. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; and

b. Capable of being operationally interchanged with towed acoustic hydrophone array modules; or

3. Incorporating accelerometer-based hydro-acoustic sensors specified in 6A001.a.2.g.;

f. Processing equipment, specially designed for bottom or bay cable systems, having "user-accessible programmability" and time or frequency domain processing and correlation, including spectral analysis, digital filtering and beamforming using Fast Fourier or other transforms or processes;

6A001.a.2. continued

g. Accelerometer-based hydro-acoustic sensors having all of the following:

1. Composed of three accelerometers arranged along three distinct axes;

2. Having an overall 'acceleration sensitivity' better than 48 dB (reference 1 000 mV rms per 1g);

3. Designed to operate at depths greater than 35 meters; and

4. Operating frequency below 20 kHz.

Note: 6A001.a.2.g. does not control particle velocity sensors or geophones.

Technical Notes:

1. Accelerometer-based hydro-acoustic sensors are also known as vector sensors.

2. 'Acceleration sensitivity' is defined as twenty times the logarithm to the base 10 of the ratio of rms output voltage to a 1 V rms reference, when the hydro-acoustic sensor, without a preamplifier, is placed in a plane wave acoustic field with an rms acceleration of 1 g (i.e., 9,81 m/s^2).

b. Correlation-velocity and Doppler-velocity sonar log equipment, designed to measure the horizontal speed of the equipment carrier relative to the sea bed, as follows:

1. Correlation-velocity sonar log equipment having any of the following characteristics:

a. Designed to operate at distances between the carrier and the sea bed exceeding 500 m; or

b. Having speed "accuracy" better than 1% of speed;

2. Doppler-velocity sonar log equipment having speed "accuracy" better than 1% of speed.

Note 1: 6A001.b. does not control depth sounders limited to any of the following:

a. Measuring the depth of water;
b. Measuring the distance of submerged or buried objects; or
c. Fish finding.

Note 2: 6A001.b. does not control equipment specially designed for installation on surface vessels.

c. Not used.

6A002 Optical sensors or equipment and components therefor, as follows:

N.B. *SEE ALSO 6A102.*

a. Optical detectors as follows:

1. "Space-qualified" solid-state detectors as follows:

Note: *For the purpose of 6A002.a.1., solid-state detectors include "focal plane arrays".*

a. "Space-qualified" solid-state detectors having all of the following:

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

2. A response of less than 0,1% relative to the peak response at a wavelength exceeding 400 nm;

b. "Space-qualified" solid-state detectors having all of the following:

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

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

c. "Space-qualified" solid-state detectors having a peak response in the wavelength range exceeding 1 200 nm but not exceeding 30 000 nm;

d. "Space-qualified" "focal plane arrays" having more than 2 048 elements per array and having a peak response in the wavelength range exceeding 300 nm but not exceeding 900 nm;

6A002.a. continued

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

Note: *6A002.a.2. does not control non-imaging photomultiplier tubes having an electron sensing device in the vacuum space limited solely to any of the following:*

a. A single metal anode; or

b. Metal anodes with a centre to centre spacing greater than 500 µm.

Technical Note:

'Charge multiplication' is a form of electronic image amplification and is defined as the generation of charge carriers as a result of an impact ionization gain process. 'Charge multiplication' sensors may take the form of an image intensifier tube, solid state detector or "focal plane array".

a. Image intensifier tubes having all of the following:

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

2. Electron image amplification using any of the following:

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

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

3. Any of the following photocathodes:

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

b. GaAs or GaInAs photocathodes; or

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

6A002.a.2. continued

b. Image intensifier tubes having all of the following:

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

2. Electron image amplification using any of the following:

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

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

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

c. Specially designed components as follows:

1. Microchannel plates having a hole pitch (centre-to-centre spacing) of 12 μm or less;

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

3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes;

Note: 6A002.a.2.c.3. does not control compound semiconductor photocathodes designed to achieve a maximum "radiant sensitivity" of any of the following:

a. 10 mA/W or less at the peak response in the wavelength range exceeding 400 nm but not exceeding 1 050 nm; or

b. 15 mA/W or less at the peak response in the wavelength range exceeding 1 050 nm but not exceeding 1 800 nm.

6A002.a. continued

3. Non-"space-qualified" "focal plane arrays" as follows:

N.B. *'Microbolometer' non-"space-qualified" "focal plane arrays" are only specified in 6A002.a.3.f.*

Technical Note:
Linear or two-dimensional multi-element detector arrays are referred to as "focal plane arrays";

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

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

a. *Multi-element (not to exceed 16 elements) encapsulated photoconductive cells using either lead sulphide or lead selenide;*

b. *Pyroelectric detectors using any of the following:*
1. *Triglycine sulphate and variants;*
2. *Lead-lanthanum-zirconium titanate and variants;*
3. *Lithium tantalate;*
4. *Polyvinylidene fluoride and variants; or*
5. *Strontium barium niobate and variants;*

c. *"Focal plane arrays" specially designed or modified to achieve 'charge multiplication' and limited by design to have a maximum "radiant sensitivity" of 10 mA/W or less for wavelengths exceeding 760 nm, having all of the following:*

1. *Incorporating a response limiting mechanism designed not to be removed or modified; and*

2. *Any of the following:*

a. *The response limiting mechanism is integral to or combined with the detector element; or*

b. *The "focal plane array" is only operable with the response limiting mechanism in place.*

Technical Note:
A response limiting mechanism integral to the detector element is designed not to be removed or modified without rendering the detector inoperable.

d. *Thermopile arrays having less than 5 130 elements.*

Technical Note:
'Charge multiplication' is a form of electronic image amplification and is defined as the generation of charge carriers as a result of an impact ionization gain process. 'Charge multiplication' sensors may take the form of an image intensifier tube, solid state detector or "focal plane array".

a. Non-"space-qualified" "focal plane arrays" having all of the following:

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

2. Any of the following:
   a. A response "time constant" of less than 0,5 ns; or
   b. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W;

b. Non-"space-qualified" "focal plane arrays" having all of the following:

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

2. Any of the following:

   a. A response "time constant" of 95 ns or less; or

   b. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W;

c. Non-"space-qualified" non-linear (2-dimensional) "focal plane arrays" having individual elements with a peak response in the wavelength range exceeding 1 200 nm but not exceeding 30 000 nm;

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

6A002.a.3. continued

d. Non-"space-qualified" linear (1-dimensional) "focal plane arrays" having all of the following:

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

2. Any of the following:
   a. A ratio of 'scan direction' dimension of the detector element to the 'cross-scan direction' dimension of the detector element of less than 3,8; or
   b. Signal processing in the detector elements;

Note: 6A002.a.3.d. does not control "focal plane arrays" (not to exceed 32 elements) having detector elements limited solely to germanium material.

Technical Note:
For the purposes of 6A002.a.3.d., 'cross-scan direction' is defined as the axis parallel to the linear array of detector elements and the 'scan direction' is defined as the axis perpendicular to the linear array of detector elements.

e. Non-"space-qualified" linear (1-dimensional) "focal plane arrays" having individual elements with a peak response in the wavelength range exceeding 3 000 nm but not exceeding 30 000 nm;

f. Non-"space-qualified" non-linear (2-dimensional) infrared "focal plane arrays" based on 'microbolometer' material having individual elements with an unfiltered response in the wavelength range equal to or exceeding 8 000 nm but not exceeding 14 000 nm;

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

6A002.a.3. continued

g. Non-"space-qualified" "focal plane arrays" having all of the following:

1. Individual detector elements with a peak response in the wavelength range exceeding 400 nm but not exceeding 900 nm;
2. Specially designed or modified to achieve 'charge multiplication' and having a maximum "radiant sensitivity" exceeding 10 mA/W for wavelengths exceeding 760 nm; and
3. Greater than 32 elements;

b. "Monospectral imaging sensors" and "multispectral imaging sensors", designed for remote sensing applications and having any of the following:

1. An Instantaneous-Field-Of-View (IFOV) of less than 200 µrad (microradians); or

2. Specified for operation in the wavelength range exceeding 400 nm but not exceeding 30 000 nm and having all the following;

a. Providing output imaging data in digital format; and

b. Having any of the following characteristics:

1. "Space-qualified"; or

2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2,5 mrad (milliradians);

Note: 6A002.b.1. does not control "monospectral imaging sensors" with a peak response in the wavelength range exceeding 300 nm but not exceeding 900 nm and only incorporating any of the following non–"space-qualified" detectors or non–"space-qualified" "focal plane arrays":

1. Charge Coupled Devices (CCD) not designed or modified to achieve 'charge multiplication'; or

2. Complementary Metal Oxide Semiconductor (CMOS) devices not designed or modified to achieve 'charge multiplication'.

c. 'Direct view' imaging equipment incorporating any of the following:

1. Image intensifier tubes specified in 6A002.a.2.a. or 6A002.a.2.b.;

2. "Focal plane arrays" specified in 6A002.a.3.; or

3. Solid state detectors specified in 6A002.a.1.;

Technical Note:
'Direct view' refers to imaging equipment that presents a visual image to a human observer without converting the image into an electronic signal for television display, and that cannot record or store the image photographically, electronically or by any other means.

Note: 6A002.c. does not control equipment as follows, when incorporating other than GaAs or GaInAs photocathodes:
a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;
b. Medical equipment;
c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;
d. Flame detectors for industrial furnaces;
e. Equipment specially designed for laboratory use.

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

1. "Space-qualified" cryocoolers;

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

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

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

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

Note: 6A002.d.3. does not control encapsulated optical sensing fibres specially designed for bore hole sensing applications.

6A002 continued

e. Not used.

f. 'Read-out integrated circuits' ('ROIC') specially designed for "focal plane arrays" specified in 6A002.a.3.

Note: *6A002.f. does not control 'read-out integrated circuits' specially designed for civil automotive applications.*

Technical Note:
A 'Read-Out Integrated Circuit' ('ROIC') is an integrated circuit designed to underlie or be bonded to a "focal plane array" ("FPA") and used to read-out (i.e., extract and register) signals produced by the detector elements. At a minimum the 'ROIC' reads the charge from the detector elements by extracting the charge and applying a multiplexing function in a manner that retains the relative spatial position and orientation information of the detector elements for processing inside or outside the 'ROIC'.

6A003 Cameras, systems or equipment, and components therefor, as follows:

N.B. *SEE ALSO 6A203.*

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

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

1. Not used;

2. Not used;

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

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

5. Electronic cameras having all of the following:

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

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

6A003.a. continued

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

a. Specially designed for instrumentation cameras which have modular structures and which are specified in 6A003.a.; and

b. Enabling these cameras to meet the characteristics specified in 6A003.a.3., 6A003.a.4., or 6A003.a.5., according to the manufacturer's specifications;

b. Imaging cameras as follows:

Note: *6A003.b. does not control television or video cameras, specially designed for television broadcasting.*

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

a. Having any of the following:

1. More than 4 x 10^6 "active pixels" per solid state array for monochrome (black and white) cameras;
2. More than 4 x 10^6 "active pixels" per solid state array for colour cameras incorporating three solid state arrays; or
3. More than 12 x 10^6 "active pixels" for solid state array colour cameras incorporating one solid state array; and

b. Having any of the following:

1. Optical mirrors specified in 6A004.a.;
2. Optical control equipment specified in 6A004.d.; or
3. The capability for annotating internally generated 'camera tracking data';

Technical Notes:

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

2. For the purpose of this entry, 'camera tracking data' is the information necessary to define camera line of sight orientation with respect to the earth. This includes: 1) the horizontal angle the camera line of sight makes with respect to the earth's magnetic field direction and; 2) the vertical angle between the camera line of sight and the earth's horizon.

6A003.b. continued

2. Scanning cameras and scanning camera systems, having all of the following:

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

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

   c. Mechanical scanning in one direction;

   Note: 6A003.b.2. does not control scanning cameras and scanning camera systems, specially designed for any of the following:
   a. Industrial or civilian photocopiers;
   b. Image scanners specially designed for civil, stationary, close proximity scanning applications (e.g., reproduction of images or print contained in documents, artwork or photographs); or
   c. Medical equipment.

3. Imaging cameras incorporating image intensifier tubes specified in 6A002.a.2.a. or 6A002.a.2.b.;

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

   a. Incorporating "focal plane arrays" specified in 6A002.a.3.a. to 6A002.a.3.e.;

   b. Incorporating "focal plane arrays" specified in 6A002.a.3.f.; or

   c. Incorporating "focal plane arrays" specified in 6A002.a.3.g.;

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

Note 2: *6A003.b.4.a. does not control imaging cameras incorporating linear "focal plane arrays" with 12 elements or fewer, not employing time-delay-and-integration within the element and designed for any of the following:*

- *a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;*
- *b. Industrial equipment used for inspection or monitoring of heat flows in buildings, equipment or industrial processes;*
- *c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;*
- *d. Equipment specially designed for laboratory use; or*
- *e. Medical equipment.*

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

- *a. A maximum frame rate equal to or less than 9 Hz ;*
- *b. Having all of the following:*
  - *1. Having a minimum horizontal or vertical 'Instantaneous-Field-of-View (IFOV)' of at least 2 mrad (milliradians);*
  - *2. Incorporating a fixed focal-length lens that is not designed to be removed;*
  - *3. Not incorporating a 'direct view' display, and*
  - *4. Having any of the following:*
    - *a. No facility to obtain a viewable image of the detected field-of-view, or*
    - *b. The camera is designed for a single kind of application and designed not to be user modified; or*
- *c. The camera is specially designed for installation into a civilian passenger land vehicle and having all of the following:*
  - *1 The placement and configuration of the camera within the vehicle are solely to assist the driver in the safe operation of the vehicle;*
  - *2. Is only operable when installed in any of the following:*
    - *a. The civilian passenger land vehicle for which it was intended and the vehicle weighs less than 4 500 kg (gross vehicle weight); or*
    - *b. A specially designed, authorized maintenance test facility; and*
  - *3. Incorporates an active mechanism that forces the camera not to function when it is removed from the vehicle for which it was intended.*

Technical Notes:

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

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

a. *Having all of the following:*
   1. *Where the camera is specially designed for installation as an integrated component into indoor and wall-plug-operated systems or equipment, limited by design for a single kind of application, as follows;*
      a. *Industrial process monitoring, quality control, or analysis of the properties of materials;*
      b. *Laboratory equipment specially designed for scientific research;*
      c. *Medical equipment;*
      d. *Financial fraud detection equipment; and*
   2. *Is only operable when installed in any of the following:*
      a. *The system(s) or equipment for which it was intended; or*
      b. *A specially designed, authorised maintenance facility; and*
   3. *Incorporates an active mechanism that forces the camera not to function when it is removed from the system(s) or equipment for which it was intended;*

b. Where the camera is specially designed for installation into a civilian passenger land vehicle or passenger and vehicle ferries, and having all of the following:

1. The placement and configuration of the camera within the vehicle or ferry is solely to assist the driver or operator in the safe operation of the vehicle or ferry;

2. Is only operable when installed in any of the following:

a. The civilian passenger land vehicle for which it was intended and the vehicle weighs less than 4 500 kg (gross vehicle weight);

b. The passenger and vehicle ferry for which it was intended and having a length overall (LOA) 65 m or greater; or

c. A specially designed, authorised maintenance test facility; and

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

c. Limited by design to have a maximum "radiant sensitivity" of 10 mA/W or less for wavelengths exceeding 760 nm, having all of the following:

1. Incorporating a response limiting mechanism designed not to be removed or modified;

2. Incorporates an active mechanism that forces the camera not to function when the response limiting mechanism is removed; and

3. Not specially designed or modified for underwater use: or

d. Having all of the following:

1. Not incorporating a 'direct view' or electronic image display;

2. Has no facility to output a viewable image of the detected field of view;

3. The "focal plane array" is only operable when installed in the camera for which it was intended; and

4. The "focal plane array" incorporates an active mechanism that forces it to be permanently inoperable when removed from the camera for which it was intended

5. Imaging cameras incorporating solid-state detectors specified in 6A002.a.1.

6A004 Optical equipment and components, as follows:

a. Optical mirrors (reflectors) as follows:

Technical Note:
For the purpose of 6A004.a., Laser Induced Damage Threshold (LIDT) is measured according to ISO 21254-1:2011.

N.B. For optical mirrors specially designed for lithography equipment, see 3B001.

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

a. Having all the following:

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

2. More than 200 actuators; or

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

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

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

Technical Note:

'Deformable mirrors' are mirrors having any of the following:

a. A single continuous optical reflecting surface which is dynamically deformed by the application of individual torques or forces to compensate for distortions in the optical waveform incident upon the mirror; or

b. Multiple optical reflecting elements that can be individually and dynamically repositioned by the application of torques or forces to compensate for distortions in the optical waveform incident upon the mirror.

'Deformable mirrors' are also known as adaptive optic mirrors.

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

Note: 6A004.a.2. does not control mirrors specially designed to direct solar radiation for terrestrial heliostat installations.

6A004.a. continued

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

Note: *6A004.a.3. does not control mirrors specially designed to direct solar radiation for terrestrial heliostat installations.*

4. Mirrors specially designed for beam steering mirror stages specified in 6A004.d.2.a. with a flatness of $\lambda/10$ 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% "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;

6A004.c. continued

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;

d. Optical control equipment as follows:

1. Equipment specially designed to maintain the surface figure or orientation of the "space-qualified" components specified in 6A004.c.1. or 6A004.c.3.;

2. Steering, tracking, stabilisation and resonator alignment equipment as follows

a. Beam steering mirror stages designed to carry mirrors having diameter or major axis length greater than 50 mm and having all of the following, and specially designed electronic control equipment therefor:

1. A maximum angular travel of ±26 mrad or more;
2. A mechanical resonant frequency of 500 Hz or more; and
3. An angular "accuracy" of 10 µrad (microradians) or less (better);

b. Resonator alignment equipment having bandwidths equal to or more than 100 Hz and an "accuracy" of 10 µrad or less (better);

3. Gimbals having all of the following:

a. A maximum slew exceeding 5°;

b. A bandwidth of 100 Hz or more;

c. Angular pointing errors of 200 µrad (microradians) or less; and

d. Having any of the following:

1. Exceeding 0,15 m but not exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 2 rad (radians)/s^2; or
2. Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0,5 rad (radians)/s^2;

6A004.d. continued

4. Not used

e. 'Aspheric optical elements' having all of the following:

1. Largest dimension of the optical-aperture greater than 400 mm;

2. Surface roughness less than 1 nm (rms) for sampling lengths equal to or greater than 1 mm; and

3. Coefficient of linear thermal expansion's absolute magnitude less than $3x10^{-6}$/K at 25°C.

Technical Notes:

1. An 'aspheric optical element' is any element used in an optical system whose imaging surface or surfaces are designed to depart from the shape of an ideal sphere.

2. Manufacturers are not required to measure the surface roughness listed in 6A004.e.2. unless the optical element was designed or manufactured with the intent to meet, or exceed, the control parameter.

Note 6A004.e. does not control 'aspheric optical elements' having any of the following:

a. Largest optical-aperture dimension less than 1 m and focal length to aperture ratio equal to or greater than 4,5:1;

b. Largest optical-aperture dimension equal to or greater than 1 m and focal length to aperture ratio equal to or greater than 7:1;

c. Designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;

d. Fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than $2,5x10^{-6}$ /K at 25 °C; or

e. An x-ray optical element having inner mirror capabilities (e.g., tube-type mirrors).

N.B. For 'aspheric optical elements' specially designed for lithography equipment, see 3B001.

f. Dynamic wavefront measuring equipment having all of the following:

1. 'Frame rates' equal to or more than 1 kHz; and

2. A wavefront accuracy equal to or less (better) than λ/20 at the designed wavelength.

Technical Note:

For the purposes of 6A004.f., 'frame rate' is a frequency at which all "active pixels" in the "focal plane array" are integrated for recording images projected by the wavefront sensor optics.

6A005 "Lasers", other than those specified in 0B001.g.5. or 0B001.h.6., components and optical equipment, as follows:

N.B. SEE ALSO 6A205.

Note 1: Pulsed "lasers" include those that run in a continuous wave (CW) mode with pulses superimposed.

Note 2: Excimer, semiconductor, chemical, CO, CO_2, and 'non-repetitive pulsed' Nd:glass "lasers" are only specified in 6A005.d.
Technical Note:
'Non-repetitive pulsed' refers to "lasers" that produce either a single output pulse or that have a time interval between pulses exceeding one minute.

Note 3: 6A005 includes fibre "lasers".

Note 4: The control status of "lasers" incorporating frequency conversion (i.e., wavelength change) by means other than one "laser" pumping another "laser" is determined by applying the control parameters for both the output of the source "laser" and the frequency-converted optical output.

Note 5: 6A005 does not control "lasers" as follows:
a. Ruby with output energy below 20 J;
b. Nitrogen;
c. Krypton.

Note 6: For the purposes of 6A005.a. and 6A005.b., 'single transverse mode' refers to "lasers" with a beam profile having an M^2-factor of less than 1,3, while 'multiple transverse mode' refers to "lasers" with a beam profile having an M^2-factor of 1,3 or higher.

Technical Note:
In 6A005 'Wall-plug efficiency' is defined as the ratio of "laser" output power (or "average output power") to total electrical input power required to operate the "laser", including the power supply/conditioning and thermal conditioning/heat exchanger.

6A005 continued

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

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

2. Output wavelength of 150 nm or more but not exceeding 510 nm and output power exceeding 30 W;
Note: 6A005.a.2. does not control Argon "lasers" having an output power equal to or less than 50 W.

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

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

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

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

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

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

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

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

a. 'Single transverse mode' output and any of the following:

1. Average output power exceeding 1 000 W; or

2. Having all of the following:

a. Average output power exceeding 500 W; and

b. Spectral bandwidth less than 40 GHz; or

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

1. 'Wall-plug efficiency' exceeding 18% and output power exceeding 1 000 W; or

2. Output power exceeding 2 kW;

Note 1: 6A005.a.6.b. does not control 'multiple transverse mode', industrial "lasers" with output power exceeding 2 kW and not exceeding 6 kW with a total mass greater than 1 200 kg. For the purpose of this note, total mass includes all components required to operate the "laser", e.g., "laser", power supply, heat exchanger, but excludes external optics for beam conditioning or delivery.

Note 2: *6A005.a.6.b. does not control 'multiple transverse mode', industrial "lasers" having any of the following:*

a. Not used;

b. Output power exceeding 1 kW but not exceeding 1,6 kW and having a BPP exceeding 1,25 mm•mrad

c. Output power exceeding 1,6 kW but not exceeding 2,5 kW and having a BPP exceeding 1,7 mm•mrad;

d. Output power exceeding 2,5 kW but not exceeding 3,3 kW and having a BPP exceeding 2,5 mm•mrad;

e. Output power exceeding 3,3 kW but not exceeding 6 kW and having a BPP exceeding 3,5 mm•mrad;

f. Not used;

g. Not used;

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 purpose of 6A005.a.6.b. 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)/BPP^2.

6A005.a. continued

7. Output wavelength exceeding 1 150 nm but not exceeding 1 555 nm and any of the following:

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

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

8. Output wavelength exceeding 1 555 nm but not exceeding 1 850 nm and output power exceeding 1 W;

9. Output wavelength exceeding 1 850 nm but not exceeding 2 100 nm, and any of the following:

   a. 'Single transverse mode' and output power exceeding 1 W; or

   b. 'Multiple transverse mode' output and output power exceeding 120 W; or

10. Output wavelength exceeding 2 100 nm and output power exceeding 1 W;

b. Non-"tunable" "pulsed lasers" having any of the following:

1. Output wavelength less than 150 nm and any of the following:

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

   b. "Average output power" exceeding 1 W;

2. Output wavelength of 150 nm or more but not exceeding 510 nm and any of the following:

   a. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 30 W; or

   b. "Average output power" exceeding 30 W;

      Note: *6A005.b.2.b. does not control Argon "lasers" having an "average output power" equal to or less than 50 W.*

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

   a. 'Single transverse mode' output and any of the following:

      1. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 50 W; or

      2. "Average output power" exceeding 50 W; or

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

      1. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 150 W; or

      2. "Average output power" exceeding 150 W;

6A005.b. continued

4. Output wavelength exceeding 540 nm but not exceeding 800 nm and any of the following:

   a. "Pulse duration" less than 1 ps and any of the following:

      1. Output energy exceeding 0,005 J per pulse and "peak power" exceeding 5 GW; or

      2. "Average output power" exceeding 20 W; or

   b. "Pulse duration" equal to or exceeding 1 ps and any of the following:

      1. Output energy exceeding 1,5 J per pulse and "peak power" exceeding 30 W; or

      2. "Average output power" exceeding 30 W;

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

   a. "Pulse duration" less than 1 ps and any of the following:

      1. Output energy exceeding 0,005 J per pulse and "peak power" exceeding 5 GW; or

      2. 'Single transverse mode' output and "average output power" exceeding 20 W;

   b. "Pulse duration" equal to or exceeding 1 ps and not exceeding 1 μs and any of the following:

      1. Output energy exceeding 0,5 J per pulse and "peak power" exceeding 50 W;

      2. 'Single transverse mode' output and "average output power" exceeding 20 W; or

      3. 'Multiple transverse mode' output and "average output power" exceeding 50 W; or

   c. "Pulse duration" exceeding 1 μs and any of the following:

      1. Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;

      2. 'Single transverse mode' output and "average output power" exceeding 50 W; or

      3. 'Multiple transverse mode' output and "average output power" exceeding 80 W;

6A005.b. continued

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

a. "Pulse duration" of less than 1 ps, and any of the following:

1. Output "peak power" exceeding 2 GW per pulse;

2. "Average output power" exceeding 30 W; or

3. Output energy exceeding 0,002 J per pulse;

b. "Pulse duration" equal to or exceeding 1 ps and less than 1 ns and any of the following:

1. Output "peak power" exceeding 5 GW per pulse;

2. "Average output power" exceeding 50 W; or

3. Output energy exceeding 0,1 J per pulse;

c. "Pulse duration" equal to or exceeding 1 ns but not exceeding 1 μs, and any of the following:

1. 'Single transverse mode' output and any of the following:

a. "Peak power" exceeding 100 MW;

b. "Average output power" exceeding 20 W limited by design to a maximum pulse repetition frequency less than or equal to 1 kHz;

c. 'Wall-plug efficiency' exceeding 12%, "average output power" exceeding 100 W and capable of operating at a pulse repetition frequency greater than 1 kHz;

d. "Average output power" exceeding 150 W and capable of operating at a pulse repetition frequency greater than 1 kHz; or

e. Output energy exceeding 2 J per pulse; or

2. 'Multiple transverse mode' output and any of the following:

a. "Peak power" exceeding 400 MW;

b. 'Wall-plug efficiency' exceeding 18% and "average output power" exceeding 500 W;

c. "Average output power" exceeding 2 kW; or

d. Output energy exceeding 4 J per pulse; or

6A005.b.6. continued

d. "Pulse duration" exceeding 1 μs and any of the following:

1. 'Single transverse mode' output and any of the following:

a. "Peak power" exceeding 500 kW;

b. 'Wall-plug efficiency' exceeding 12% and "average output power" exceeding 100 W; or

c. "Average output power" exceeding 150 W; or

2. 'Multiple transverse mode' output and any of the following:

a. "Peak power" exceeding 1 MW;

b. 'Wall-plug efficiency' exceeding 18% and "average output power" exceeding 500 W; or

c. "Average output power" exceeding 2 kW;

7. Output wavelength exceeding 1 150 nm but not exceeding 1 555 nm, and any of the following:

a. "Pulse duration" not exceeding 1 μs and any of the following:

1. Output energy exceeding 0,5 J per pulse and "peak power" exceeding 50 W;

2. 'Single transverse mode' output and "average output power" exceeding 20 W; or

3. 'Multiple transverse mode' output and "average output power" exceeding 50 W; or

b. "Pulse duration" exceeding 1 μs and any of the following:

1. Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;

2. 'Single transverse mode' output and "average output power" exceeding 50 W; or

3. 'Multiple transverse mode' output and "average output power" exceeding 80 W;

6A005.b. continued

8. Output wavelength exceeding 1 555 nm but not exceeding 1 850 nm, and any of the following:

   a. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; or

   b. "Average output power" exceeding 1 W;

9. Output wavelength exceeding 1 850 nm but not exceeding 2 100 nm, and any of the following

   a. 'Single transverse mode' and any of the following:

      1. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; or

      2. "Average output power" exceeding 1 W; or

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

      1. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 10 kW; or

      2. "Average output power" exceeding 120 W; or

10. Output wavelength exceeding 2 100 nm and any of the following:

   a. Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; or

   b. "Average output power" exceeding 1 W;

6A005.b. continued

c. "Tunable" "lasers" having any of the following:

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

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

b. Average or CW output power exceeding 1 W;

Note: 6A005.c.1. does not control dye "lasers" or other liquid "lasers", having a multimode output and a wavelength of 150 nm or more but not exceeding 600 nm and all of the following:

1. Output energy less than 1,5 J per pulse or a "peak power" less than 20 W; and

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

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

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

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

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

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

b. Average or CW output power exceeding 1 W;

d. Other "lasers", not specified in 6A005.a., 6A005.b. or 6A005.c. as follows:

1. Semiconductor "lasers" as follows:

Note 1: 6A005.d.1. includes semiconductor "lasers" having optical output connectors (e.g., fibre optic pigtails).

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

6A005.d.1. continued

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 15W;

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;

6A005.d.1. continued

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

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

a. Average or CW total output power less than 3 kW and having average or CW output 'power density' greater than 500 W/cm^2;

b. Average or CW total output power equal to or exceeding 3 kW but less than or equal to 5 kW, and having average or CW output 'power density' greater than 350 W/cm^2;

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

d. Peak pulsed 'power density' exceeding 2 500 W/cm^2; or

Note: 6A005.d.1.d.1.d. does not control epitaxially-fabricated monolithic devices.

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

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

a. Average or CW total output power less than 250 W and average or CW output 'power density' greater than 150 W/cm^2;

b. Average or CW total output power equal to or exceeding 250 W but less than or equal to 500 W, and having average or CW output 'power density' greater than 50 W/cm^2;

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

d. Peak pulsed 'power density' exceeding 500 W/cm^2; or

Note: 6A005.d.1.d.2.d. does not control epitaxially-fabricated monolithic devices.

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

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

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

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

   c. Spatially coherent average or CW total output power, exceeding 1,5 W; or

4. At least one "laser" 'bar' specified in 6A005.d.1.c.;

Technical Note:
For the purposes of 6A005.d.1.d., 'power density' means the total "laser" output power divided by the emitter surface area of the 'stacked array'.

e. Semiconductor "laser" 'stacked arrays', other than those specified in 6A005.d.1.d., having all of the following:

1. Specially designed or modified to be combined with other 'stacked arrays' to form a larger 'stacked array'; and

2. Integrated connections, common for both electronics and cooling;

Note 1: *'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified in 6A005.d.1.e., that are not designed to be further combined or modified are specified in 6A005.d.1.d.*

Note 2: *'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified in 6A005.d.1.e., that are designed to be further combined or modified are specified in 6A005.d.1.e.*

Note 3: *6A005.d.1.e. does not control modular assemblies of single 'bars' designed to be fabricated into end-to-end stacked linear arrays.*

Technical Notes:
1. Semiconductor "lasers" are commonly called "laser" diodes.
2. A 'bar' (also called a semiconductor "laser" 'bar', a "laser" diode 'bar' or diode 'bar') consists of multiple semiconductor "lasers" in a one-dimensional array.
3. A 'stacked array' consists of multiple 'bars' forming a two-dimensional array of semiconductor "lasers".

6A005.d. continued

2. Carbon monoxide (CO) "lasers" having any of the following:

   a. Output energy exceeding 2 J per pulse and "peak power" exceeding 5 kW; or

   b. Average or CW output power exceeding 5 kW;

3. Carbon dioxide (CO_2) "lasers" having any of the following:

   a. CW output power exceeding 15 kW;

   b. Pulsed output with a "pulse duration" exceeding 10 μs and any of the following:

      1. "Average output power" exceeding 10 kW; or

      2. "Peak power" exceeding 100 kW; or

   c. Pulsed output with a "pulse duration" equal to or less than 10 μs and any of the following:

      1. Pulse energy exceeding 5 J per pulse; or

      2. "Average output power" exceeding 2,5 kW;

4. Excimer "lasers" having any of the following:

   a. Output wavelength not exceeding 150 nm and any of the following:

      1. Output energy exceeding 50 mJ per pulse; or

      2. "Average output power" exceeding 1 W;

   b. Output wavelength exceeding 150 nm but not exceeding 190 nm and any of the following:

      1. Output energy exceeding 1,5 J per pulse; or

      2. "Average output power" exceeding 120 W;

   c. Output wavelength exceeding 190 nm but not exceeding 360 nm and any of the following:

      1. Output energy exceeding 10 J per pulse; or

      2. "Average output power" exceeding 500 W; or

6A005.d.4. continued

d. Output wavelength exceeding 360 nm and any of the following:

1. Output energy exceeding 1,5 J per pulse; or

2. "Average output power" exceeding 30 W;

N.B. For excimer "lasers" specially designed for lithography equipment, see 3B001.

5. "Chemical lasers" as follows:

a. Hydrogen Fluoride (HF) "lasers";

b. Deuterium Fluoride (DF) "lasers";

c. 'Transfer lasers' as follows:

1. Oxygen Iodine (O_2-I) "lasers";

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

Technical Note:
'Transfer lasers' are "lasers" in which the lasing species are excited through the transfer of energy by collision of a non- lasing atom or molecule with a lasing atom or molecule species.

6. 'Non-repetitive pulsed' Nd: glass "lasers" having any of the following:

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

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

Note: 'Non-repetitive pulsed' refers to "lasers" that produce either a single output pulse or that have a time interval between pulses exceeding one minute.

e. Components as follows:

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

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

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

Note: Fibre combiners and MLDs are specified in 6A005.e.3.

6A005.e. continued

3. Fibre "laser" components as follows:

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

1. An insertion loss better (less) than or equal to 0,3 dB maintained at a rated total average or CW output power (excluding output power transmitted through the single mode core if present) exceeding 1 000 W; and

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

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

1. An insertion loss better (less) than 0,5 dB maintained at a rated total average or CW output power exceeding 4 600 W;

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

3. Having any of the following:

a. A Beam Parameter Product (BPP) measured at the output not exceeding 1,5 mm mrad for a number of input fibres less than or equal to 5; or

b. A BPP measured at the output not exceeding 2,5 mm mrad for a number of input fibres greater than 5;

c. MLDs having all of the following:

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

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

6A005 continued

f. Optical equipment as follows:

N.B. For shared aperture optical elements, capable of operating in "Super-High Power Laser" ("SHPL") applications, see the Military Goods Controls.

1. Not used;

2. "Laser" diagnostic equipment specially designed for dynamic measurement of "SHPL" system angular beam steering errors and having an angular "accuracy" of 10 μrad (microradians) or less (better);

3. Optical equipment and components, specially designed for coherent beam combination in a phased-array "SHPL" system and having any of the following:

   a. An "accuracy" of 0,1 μm or less, for wavelengths greater than 1 μm; or

   b. An "accuracy" of λ/10 or less (better) at the designed wavelength, for wavelengths equal to or less than 1 μm;

4. Projection telescopes specially designed for use with "SHPL" systems;

g. 'Laser acoustic detection equipment' having all of the following:

1. CW "laser" output power equal to or exceeding 20 mW;

2. "Laser" frequency stability equal to or better (less) than 10 MHz;

3. "Laser" wavelengths equal to or exceeding 1 000 nm but not exceeding 2 000 nm;

4. Optical system resolution better (less) than 1 nm; and

5. Optical Signal to Noise ratio equal to or exceeding 10^3.

Technical Note:
'Laser acoustic detection equipment' is sometimes referred to as a "Laser" Microphone or Particle Flow Detection Microphone.

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

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

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

a. "Magnetometers" and subsystems as follows:

1. "Magnetometers" using "superconductive" (SQUID) "technology" and having any of the following:

a. SQUID systems designed for stationary operation, without specially designed subsystems designed to reduce in-motion noise, and having a 'sensitivity' equal to or lower (better) than 50 fT (rms) per square root Hz at a frequency of 1 Hz; or

b. SQUID systems having an in-motion-magnetometer 'sensitivity' lower (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz and specially designed to reduce in-motion noise;

2. "Magnetometers" using optically pumped or nuclear precession (proton/Overhauser) "technology" having a 'sensitivity' lower (better) than 20 pT (rms) per square root Hz at a frequency of 1 Hz;

3. "Magnetometers" using fluxgate "technology" having a 'sensitivity' equal to or lower (better) than 10 pT (rms) per square root Hz at a frequency of 1 Hz;

4. Induction coil "magnetometers" having a 'sensitivity' lower (better) than any of the following:

a. 0,05 nT (rms) per square root Hz at frequencies of less than 1 Hz;

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

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

5. Fibre optic "magnetometers" having a 'sensitivity' lower (better) than 1 nT (rms) per square root Hz;

b. Underwater electric field sensors having a 'sensitivity' lower (better) than 8 nanovolt per metre per square root Hz when measured at 1 Hz;

c. "Magnetic gradiometers" as follows:

1. "Magnetic gradiometers" using multiple "magnetometers" specified in 6A006.a.;

2. Fibre optic "intrinsic magnetic gradiometers" having a magnetic gradient field 'sensitivity' lower (better) than 0,3 nT/m rms per square root Hz;

3. "Intrinsic magnetic gradiometers", using "technology" other than fibre-optic "technology", having a magnetic gradient field 'sensitivity' lower (better) than 0,015 nT/m rms per square root Hz;

d. "Compensation systems" for magnetic or underwater electric field sensors resulting in a performance equal to or better than the specified parameters of 6A006.a., 6A006.b. or 6A006.c.;

e. Underwater electromagnetic receivers incorporating magnetic field sensors specified in 6A006.a. or underwater electric field sensors specified in 6A006.b.

Technical Note:
For the purposes of 6A006, 'sensitivity' (noise level) is the root mean square of the device-limited noise floor which is the lowest signal that can be measured.

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

N.B. *SEE ALSO 6A107.*

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

Note: 6A007.a. does not control ground gravity meters of the quartz element (Worden) type.

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

1. A static "accuracy" of less (better) than 0,7 mGal; and

2. An in-service (operational) "accuracy" of less (better) than 0,7 mGal having a "time-to-steady-state registration" of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

c. Gravity gradiometers.

6A008 Radar systems, equipment and assemblies, having any of the following, and specially designed components therefor:

N.B. *SEE ALSO 6A108.*

Note: *6A008 does not control:*
- *Secondary surveillance radar (SSR);*
- *Civil Automotive Radar;*
- *Displays or monitors used for air traffic control (ATC);*
- *Meteorological (weather) radar;*
- *Precision approach radar (PAR) equipment conforming to ICAO standards and employing electronically steerable linear (1-dimensional) arrays or mechanically positioned passive antennae.*

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

1. An average output power exceeding 100 mW; or

2. Locating "accuracy" of 1 m or less (better) in range and 0,2 degree or less (better) in azimuth;

b. A tunable bandwidth exceeding ± 6,25% of the 'centre operating frequency';

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

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

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

e. Incorporating electronically scanned array antennae;

Technical Note:
Electronically scanned array antennae are also known as electronically steerable array antennae.

f. Capable of heightfinding non-cooperative targets;

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

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

1. "Radar spread spectrum" techniques; or

2. "Radar frequency agility" techniques;

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

Note: 6A008.i. does not control:

a. Fishing ground surveillance radar;

b. Ground radar equipment specially designed for enroute air traffic control and having all the following:

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

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

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

4. Permanently installed;

c. Weather balloon tracking radars.

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;

6A008.j. continued

Note 1: *LIDAR equipment specially designed for surveying is only specified in 6A008.j.3.*

Note 2: *6A008.j. does not control LIDAR equipment specially designed for meteorological observation.*

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

– *Horizontal Accuracy (95% Confidence Level) = 5 m + 5% of depth.*

– *Depth Accuracy for Reduced Depths (95% confidence level) = $\pm\sqrt{(a^2+(b*d)^2)}$, where:*

a = 0,5 m = constant depth error,
i.e. the sum of all constant depth errors
b = 0,013 = factor of depth dependent error
*b*d = depth dependent error,*
i.e. the sum of all depth dependent errors
d = depth

– *Feature Detection = Cubic features > 2 m in depths up to 40 m; 10% of depth beyond 40 m.*

k. Having "signal processing" sub-systems using "pulse compression" and having any of the following:

1. A "pulse compression" ratio exceeding 150; or

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

Note: *6A008.k.2. does not control two dimensional 'marine radar' or 'vessel traffic service' radar, having all of the following;*
a. "Pulse compression" ratio not exceeding 150;
b. Compressed pulse width of greater than 30 ns;
c. Single and rotating mechanically scanned antenna;
d. Peak output power not exceeding 250 W; and
e. Not capable of "frequency hopping".

l. Having data processing sub-systems and having any of the following:

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

Note: 6A008.l.1. does not control conflict alert capability in ATC systems, or 'marine radar'.

Technical Note:
'Automatic target tracking' is a processing technique that automatically determines and provides as output an extrapolated value of the most probable position of the target in real time.

2. Not used;

3. Not used;

4. Configured to provide superposition and correlation, or fusion, of target data within six seconds from two or more 'geographically dispersed' radar sensors to improve the aggregate performance beyond that of any single sensor specified in 6A008.f. or 6A008.i.

Technical Note:
Sensors are considered 'geographically dispersed' when each location is distant from any other more than 1 500 m in any direction. Mobile sensors are always considered 'geographically dispersed'.

N.B. See also Military Goods Controls.

Note: 6A008.l.4. does not control systems, equipment and assemblies used for 'vessel traffic service'.

Technical Notes:
1. For the purposes of 6A008, 'marine radar' is a radar that is used to navigate safely at sea, inland waterways or near-shore environments.
2. For the purposes of 6A008, 'vessel traffic service' is a vessel traffic monitoring and control service similar to air traffic control for "aircraft".

6A102 Radiation hardened 'detectors', other than those specified in 6A002, specially designed or modified for protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and thermal effects) and usable for "missiles", designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of 5×10^5 rads (silicon).

Technical Note:
In 6A102, a 'detector' is defined as a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material. This includes devices that sense by one time operation or failure.

6A107 Gravity meters (gravimeters) and components for gravity meters and gravity gradiometers, as follows:

a. Gravity meters, other than those specified in 6A007.b, designed or modified for airborne or marine use, and having a static or operational accuracy equal to or less (better) than 0,7 milligal (mgal), and having a time-to-steady-state registration of two minutes or less;

b. Specially designed components for gravity meters specified in 6A007.b or 6A107.a. and gravity gradiometers specified in 6A007.c.

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

a. Radar and laser radar systems designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;

Note: 6A108.a. includes the following:
a. Terrain contour mapping equipment;
b. Scene mapping and correlation (both digital and analogue) equipment;
c. Doppler navigation radar equipment;
d. Passive interferometer equipment;
e. Imaging sensor equipment (both active and passive).

b. Precision tracking systems, usable for 'missiles', as follows:

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

2. Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:
   a. Angular resolution better than 1,5 milliradians;
   b. Range of 30 km or greater with a range resolution better than 10 m rms; and
   c. Velocity resolution better than 3 m/s;

Technical Note:
In 6A108.b. 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

c. Radomes designed to withstand a combined thermal shock greater than $4{,}184 \times 10^6$ J/m^2 accompained by a peak over pressure of greater than 50 kPa, and usable in "missiles" for protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and thermal effects).

6A202 Photomultiplier tubes having both of the following characteristics:

a. Photocathode area of greater than 20 cm^2; and

b. Anode pulse rise time of less than 1 ns.

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

N.B.1. *"Software" specially designed to enhance or release the performance of a camera or imaging device to meet the characteristics of 6A203.a., 6A203.b. or 6A203.c. is specified in 6D203.*

N.B.2. *"Technology" in the form of codes or keys to enhance or release the performance of a camera or imaging device to meet the characteristics of 6A203.a., 6A203.b. or 6A203.c is specified in 6E203.*

Note: *6A203.a. to 6A203.c. does not control cameras or imaging devices if they have hardware, "software" or "technology" constraints that limit the performance to less than that specified below, provided they meet any of the following:*

1. They need to be returned to the original manufacturer to make the enhancements or release the constraints;

2. They require "software" as specified in 6D203 to enhance or release the performance to meet the characteristics of 6A203; or

3. They require "technology" in the form of keys or codes as specified in 6E203 to enhance or release the performance to meet the characteristics of 6A203.

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

1. Streak cameras with writing speeds greater than 0,5 mm/µs;

2. Electronic streak cameras capable of 50 ns or less time resolution;

3. Streak tubes for cameras specified in 6A203.a.2.;

4. Plug-ins specially designed for use with streak cameras which have modular structures and that enable the performance specifications in 6A203.a.1. or 6A203.a.2.;

5. Synchronizing electronics units, rotor assemblies consisting of turbines, mirrors and bearings specially designed for cameras specified in 6A203.a.1.;

b. Framing cameras, and specially designed components therefor, as follows:

1. Framing cameras with recording rates greater than 225 000 frames per second;

2. Framing cameras capable of 50 ns or less frame exposure time;

3. Framing tubes and solid-state imaging devices having a fast image gating (shutter) time of 50 ns or less specially designed for cameras specified in 6A203.b.1. or 6A203.b.2.;

4. Plug-ins specially designed for use with framing cameras which have modular structures and that enable the performance specifications in 6A203.b.1. or 6A203.b.2.;

5. Synchronizing electronics units, rotor assemblies consisting of turbines, mirrors and bearings specially designed for cameras specified in 6A203.b.1. or 6A203.b.2.;

Technical Note:
In 6A203.b., high speed single frame cameras can be used alone to produce a single image of a dynamic event, or several such cameras can be combined in a sequentially-triggered system to produce multiple images of an event.

c. Solid state or electron tube cameras, and specially designed components therefor, as follows:

1. Solid-state cameras or electron tube cameras with a fast image gating (shutter) time of 50 ns or less;

2. Solid-state imaging devices and image intensifiers tubes having a fast image gating (shutter) time of 50 ns or less specially designed for cameras specified in 6A203.c.1.;

3. Electro-optical shuttering devices (Kerr or Pockels cells) with a fast image gating (shutter) time of 50 ns or less;

4. Plug-ins specially designed for use with cameras which have modular structures and that enable the performance specifications in 6A203.c.1.

d. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 50×10^3 Gy(silicon) (5×10^6 rad (silicon)) without operational degradation.

Technical Note:
The term Gy(silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.

6A205 "Lasers", "laser" amplifiers and oscillators, other than those specified in 0B001.g.5., 0B001.h.6. and 6A005; as follows:

N.B. *For copper vapour lasers, see 6A005.b.*

a. Argon ion "lasers" having both of the following characteristics:

1. Operating at wavelengths between 400 nm and 515 nm; and

2. An average output power greater than 40 W;

b. Tunable pulsed single-mode dye laser oscillators having all of the following characteristics:

1. Operating at wavelengths between 300 nm and 800 nm;

2. An average output power greater than 1 W;

3. A repetition rate greater than 1 kHz; and

4. Pulse width less than 100 ns;

c. Tunable pulsed dye laser amplifiers and oscillators, having all of the following characteristics:

1. Operating at wavelengths between 300 nm and 800 nm;

2. An average output power greater than 30 W;

3. A repetition rate greater than 1 kHz; and

4. Pulse width less than 100 ns;

Note: 6A205.c. does not control single mode oscillators;

6A205 continued

d. Pulsed carbon dioxide (CO_2) "lasers" having all of the following characteristics:

1. Operating at wavelengths between 9 000 nm and 11 000 nm;

2. A repetition rate greater than 250 Hz;

3. An average output power greater than 500 W; and

4. Pulse width of less than 200 ns;

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

f. Neodymium-doped (other than glass) "lasers" with an output wavelength between 1 000 and 1 100 nm having either of the following:

1. Pulse-excited and Q-switched with a pulse duration equal to or more than 1 ns, and having either of the following:

a. A single–transverse mode output with an average output power greater than 40W; or

b. A multiple-transverse mode output having an average power greater than 50 W; or

2. Incorporating frequency doubling to give an output wavelength between 500 and 550 nm with an average output power of more than 40 W;

g. Pulsed carbon monoxide (CO) "lasers", other than those specified in 6A005.d.2., having all of the following:

1. Operating at wavelengths between 5 000 and 6 000 nm;

2. A repetition rate greater than 250 Hz;

3. An average output power greater than 200 W; and

4. Pulse width of less than 200 ns.

6A225 Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 microseconds.

Note: *6A225 includes velocity interferometers such as VISARs (Velocity Interferometer Systems for Any Reflector), DLIs (Doppler Laser Interferometers) and PDV (Photonic Doppler Velocimeters) also known as Het-V (Heterodyne Velocimeters).*

6A226 Pressure sensors, as follows:

a. Shock pressure gauges capable of measuring pressures greater than 10 GPa, including gauges made with manganin, ytterbium, and polyvinylidene fluoride (PVDF) / polyvinyl difluoride (PVF_2);
b. Quartz pressure transducers for pressures greater than 10 GPa.

6B Test, Inspection and Production Equipment

6B002 Masks and reticles, specially designed for optical sensors specified in 6A002.a.1.b. or 6A002.a.1.d.

6B004 Optical equipment as follows:

a. Equipment for measuring absolute reflectance to an "accuracy" of equal to or better than 0,1% of the reflectance value;

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

Note: 6B004 does not control microscopes.

6B007 Equipment to produce, align and calibrate land-based gravity meters with a static "accuracy" of better than 0,1 mGal.

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

N.B. SEE ALSO 6B108.

6B108 Systems, other than those specified in 6B008, specially designed for radar cross section measurement usable for 'missiles' and their subsystems.

Technical Note:
In 6B108 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

6C Materials

6C002 Optical sensor materials as follows:

a. Elemental tellurium (Te) of purity levels of 99,9995% or more;

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

1. Cadmium zinc telluride (CdZnTe), with zinc content of less than 6% by 'mole fraction';

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

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

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

6C004 Optical materials as follows:

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

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

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

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

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

2. Silver gallium selenide ($AgGaSe_2$, also known as AGSE) (CAS 12002-67-4);

3. Thallium arsenic selenide (Tl_3AsSe_3 , also known as TAS) (CAS 16142-89-5);

4. Zinc germanium phosphide ($ZnGeP_2$, also known as ZGP, zinc germanium biphosphide or zinc germanium diphosphide); or

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

6C004 continued

c. Non-linear optical materials, other than those specified in 6C004.b., having any of the following:

1. Having all of the following:

a. Dynamic (also known as non-stationary) third order non-linear susceptibility ($\chi^{(3)}$, chi 3) of 10^{-6} m^2/V^2 or more; and

b. Response time of less than 1 ms; or

2. Second order non-linear susceptibility ($\chi^{(2)}$, chi 2) of $3{,}3\times10^{-11}$ m/V or more;

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

e. Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF_4) (CAS 7783-64-4) and hafnium fluoride (HfF_4) (CAS 13709-52-9) and having all of the following:

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

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

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

f. Synthetically produced diamond material with an absorption of less than 10^{-5} cm^{-1} for wavelengths exceeding 200 nm but not exceeding 14 000 nm.

6C005 "Laser" materials as follows:

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

1. Titanium doped sapphire;

2. Not used.

6C005 continued

b. Rare-earth-metal doped double-clad fibres having any of the following:

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

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

b. Core 'Numerical Aperture' ('NA') less than 0,065; or

Note: 6C005.b.1. does not control double-clad fibres having an inner glass cladding diameter exceeding 150 µm and not exceeding 300 µm.

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

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

b. Core 'NA' less than 0,1.

Technical Notes:

1. For the purposes of 6C005, the core 'Numerical Aperture' ('NA') is measured at the emission wavelengths of the fibre.

2. 6C005.b. includes fibres assembled with end caps.

6D Software

6D001 "Software" specially designed for the "development" or "production" of equipment specified in 6A004, 6A005, 6A008 or 6B008.

6D002 "Software" specially designed for the "use" of equipment specified in 6A002.b., 6A008 or 6B008.

6D003 Other "software" as follows:

a. "Software" as follows:

1. "Software" specially designed for acoustic beam forming for the "real-time processing" of acoustic data for passive reception using towed hydrophone arrays;

2. "Source code" for the "real-time processing" of acoustic data for passive reception using towed hydrophone arrays;

3. "Software" specially designed for acoustic beam forming for "real-time processing" of acoustic data for passive reception using bottom or bay cable systems;

4. "Source code" for "real-time processing" of acoustic data for passive reception using bottom or bay cable systems;

6D003.a. continued

5. "Software" or "source code", specially designed for all of the following:
   a. "Real-time processing" of acoustic data from sonar systems specified in 6A001.a.1.e.; and
   b. Automatically detecting, classifying and determining the location of divers or swimmers;

   N.B. *For diver detection "software" or "source code", specially designed or modified for military use, see the Military Goods Controls.*

b. Not used;

c. "Software" designed or modified for cameras incorporating "focal plane arrays" specified in 6A002.a.3.f. and designed or modified to remove a frame rate restriction and allow the camera to exceed the frame rate specified in 6A003.b.4. Note 3.a.

d. Software" specially designed to maintain the alignment and phasing of segmented mirror systems consisting of mirror segments having a diameter or major axis length equal to or larger than 1 m;

e. Not used;

f. "Software" as follows:

   1. "Software" specially designed for magnetic and electric field "compensation systems" for magnetic sensors designed to operate on mobile platforms;

   2. "Software" specially designed for magnetic and electric field anomaly detection on mobile platforms;

   3. "Software" specially designed for "real-time processing" of electromagnetic data using underwater electromagnetic receivers specified in 6A006.e.;

   4. "Source code" for "real time processing" of electromagnetic data using underwater electromagnetic receivers specified in 6A006.e.;

g. "Software" specially designed to correct motional influences of gravity meters or gravity gradiometers;

6D003 continued

h. "Software" as follows:

1. Air Traffic Control (ATC) "software" application "programs" designed to be hosted on general purpose computers located at Air Traffic Control centres and capable of accepting radar target data from more than four primary radars;

2. "Software" for the design or "production" of radomes having all of the following:

a. Specially designed to protect the electronically scanned array antennae specified in 6A008.e.; and

b. Resulting in an antenna pattern having an 'average side lobe level' more than 40 dB below the peak of the main beam level.

Technical Note:
'Average side lobe level' in 6D003.h.2.b. is measured over the entire array excluding the angular extent of the main beam and the first two side lobes on either side of the main beam.

6D102 "Software" specially designed or modified for the "use" of goods specified in 6A108.

6D103 "Software" which processes post-flight, recorded data, enabling determination of vehicle position throughout its flight path, specially designed or modified for 'missiles'.

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

6D203 "Software" specially designed to enhance or release the performance of cameras or imaging devices to meet the characteristics of 6A203.a. to 6A203.c.

6E Technology

6E001 "Technology" according to the General Technology Note for the "development" of equipment, materials or "software" specified in 6A, 6B, 6C or 6D.

6E002 "Technology" according to the General Technology Note for the "production" of equipment or materials specified in 6A, 6B or 6C.

6E003 Other "technology" as follows:

a. "Technology" as follows:

1. "Technology" "required" for the coating and treatment of optical surfaces to achieve an 'optical thickness' uniformity of 99,5% or better for optical coatings 500 mm or more in diameter or major axis length and with a total loss (absorption and scatter) of less than 5×10^{-3};

N.B. *See also 2E003.f.*

Technical Note:
'Optical thickness' is the mathematical product of the index of refraction and the physical thickness of the coating.

6E003.a. continued

2. "Technology" for the fabrication of optics using single point diamond turning techniques to produce surface finish "accuracies" of better than 10 nm rms on non-planar surfaces exceeding 0,5 m^2;

b. "Technology" "required" for the "development", "production" or "use" of specially designed diagnostic instruments or targets in test facilities for "SHPL" testing or testing or evaluation of materials irradiated by "SHPL" beams;

6E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 6A002, 6A007.b. and c., 6A008, 6A102, 6A107, 6A108, 6B108, 6D102 or 6D103.

Note: 6E101 only controls "technology" for items specified in 6A002, 6A007 and 6A008 if the items were designed for airborne applications and are usable in "missiles".

6E201 "Technology" according to the General Technology Note for the "use" of equipment specified in 6A003, 6A005.a.2., 6A005.b.2., 6A005.b.3., 6A005.b.4., 6A005.b.6., 6A005.c.2., 6A005.d.3.c., 6A005.d.4.c., 6A202, 6A203, 6A205, 6A225 or 6A226.

Note 1: 6E201 only controls "technology" for cameras specified in 6A003 if the cameras are also specified by any of the control parameters of 6A203.

Note 2: 6E201 only controls "technology" for lasers in 6A005.b.6. that are neodymium-doped and specified by any of the control parameters of 6A205.f.

6E203 "Technology", in the form of codes or keys, to enhance or release the performance of cameras or imaging devices to meet the characteristics of 6A203.a. to 6A203.c.