

CATEGORY 6-SENSORS AND "LASERS"

6A Systems, Equipment and Components

6A001 Acoustics

(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:

- (a) Depth sounders operating vertically below the apparatus, not including a scanning function exceeding $\pm 20^\circ$, 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) Wide-swath bathymetric survey systems designed for sea bed topographic mapping, having all of the following: (L.N. 132 of 2001)
 - (1) Being designed to take measurements at an angle exceeding 20° from the vertical;
 - (2) Being designed to measure depths exceeding 600 m below the water surface; and
 - (3) Being designed to provide any of the following:
 - (a) Incorporation of multiple beams any of which is less than 1.9° ; or
 - (b) Data accuracies of better than 0.3% of water depth across the swath averaged over the individual measurements within the swath;
- (b) Object detection or location systems having any of the following:
 - (1) A transmitting frequency below 10 kHz;
 - (2) Sound pressure level exceeding 224 dB (reference $1 \mu\text{Pa}$ at 1m) for equipment with an operating frequency in the band from 10 kHz to 24 kHz inclusive;
 - (3) Sound pressure level exceeding 235 dB (reference $1 \mu\text{Pa}$ at 1m) for equipment with an operating frequency in the band between 24 kHz and 30 kHz;
 - (4) Forming beams of less than 1° on any axis and having an operating frequency of less than 100 kHz;
 - (5) Designed to operate with an unambiguous display range exceeding 5120 m; or
 - (6) Designed to withstand pressure during normal operation at depths exceeding 1000 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, having any of the following:

Notes:

1. The control status of acoustic projectors, including transducers, specially designed for other equipment is determined by the control status of the other equipment.
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;
 - (1) An instantaneous radiated acoustic power density exceeding 0.01 mW/mm²/Hz for devices operating at frequencies below 10 kHz;
 - (2) A continuously radiated acoustic power density exceeding 0.001 mW/mm²/Hz for devices operating at frequencies below 10 kHz;or (L.N. 132 of 2001)

Technical Note:

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

- (3) Side-lobe suppression exceeding 22 dB; (L.N. 132 of 2001)
- (d) Acoustic systems, equipment and specially designed components for determining the position of surface vessels or underwater vehicles designed to operate at a range exceeding 1000 m with a positioning accuracy of less than 10 m rms (root mean square) when measured at a range of 1000 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. (L.N. 132 of 2001)
- (2) Passive (receiving, whether or not related in normal application to separate active equipment) systems, equipment and specially designed components therefor, as follows:
 - (a) Hydrophones having any of the following characteristics: (L.N. 132 of 2001)

Note:

The control status of hydrophones specially designed for other equipment is determined by the control status of the other equipment. (L.N. 132 of 2001)

- (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 copolymers {P(VDF-TrFE) and P(VDF-TFE)}; or

- (c) 'Flexible piezoelectric composites';
- (4) A hydrophone sensitivity better than -180 dB at any depth with no acceleration compensation;
- (5) When designed to operate at depths exceeding 35 m with acceleration compensation; or
- (6) Designed for operation at depths exceeding 1000 m;

Technical Notes:

1. 'Piezoelectric polymer film' sensing elements consist of polarized 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 μ Pa. For example, a hydrophone of -160 dB (reference 1 V per μ Pa) 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. (L.N. 95 of 2006)
- (b) Towed acoustic hydrophone arrays having any of the following:
 - (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; (L.N. 65 of 2004)
 - (2) Designed or able to be modified to operate at depths exceeding 35 m; (L.N. 132 of 2001)

Technical Note:

'Able to be modified' in 6A001(a)(2)(b) means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10% of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group. (L.N. 65 of 2004)

- (3) Heading sensors controlled by 6A001(a)(2)(d);
 - (4) Longitudinally reinforced array hoses;
 - (5) An assembled array of less than 40 mm in diameter;
 - (6) (Repealed L.N. 254 of 2008)
 - (7) Hydrophone characteristics specified in 6A001(a)(2)(a); (L.N. 132 of 2001)
- (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) Any accuracy of better than $\pm 0.5^{\circ}$; 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; (L.N. 132 of 2001)
- (e) Bottom or bay cable systems having any of the following:
 - (1) Incorporating hydrophones specified in 6A001(a)(2)(a); or
 - (2) Incorporating multiplexed hydrophone group signal modules having all of the following characteristics:
 - (a) Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; and
 - (b) Capable of being operationally interchanged with towed acoustic hydrophone array modules; (L.N. 132 of 2001)
 - (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; (L.N. 183 of 1999)
- (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;
 - (b) Having speed accuracy better than 1% of speed; *and*
 - (2) Doppler-velocity sonar log equipment having speed accuracy better than 1% of speed;
- Notes:*
- 1. 6A001(b) does not include depth sounders the function of which is limited to:
 - (a) Measuring the depth of water;
 - (b) Measuring the distance of submerged or buried objects; *or*
 - (c) Fish finding.
 - 2. 6A001(b) does not include equipment specially designed for installation on surface vessels. (L.N. 254 of 2008)
- (c) Diver deterrent acoustic systems specially designed or modified to disrupt divers and having a sound pressure level equal to or exceeding 190 dB (reference 1 μ Pa at 1 m) at frequencies of 200 Hz and below;
- Notes:*
- 1. 6A001(c) does not include diver deterrent systems based on underwater explosive devices, air guns or combustible sources.
 - 2. 6A001(c) includes diver deterrent acoustic systems that use spark gap sources, also known as plasma sound sources. (L.N. 226 of 2009)
(L.N. 65 of 2004)

6A002 Optical sensors

N.B.:

See also 6A102.

- (a) Optical detectors as follows:
 - (1) "Space qualified" solid-state detectors as follows:
 - (a) "Space qualified" solid-state detectors having all of the following characteristics:

- (1) A peak response in the wavelength range exceeding 10 nm but not exceeding 300 nm;
- (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 characteristics:
 - (1) A peak response in the wavelength range exceeding 900 nm but not exceeding 1200 nm;
 - (2) A response "time constant" of 95 ns or less; (L.N. 226 of 2009)
- (c) "Space qualified" solid-state detectors having a peak response in the wavelength range exceeding 1200 nm but not exceeding 30000 nm; *and* (L.N. 226 of 2009)
- (d) "Space qualified" "focal plane arrays" having more than 2048 elements per array and having a peak response in the wavelength range exceeding 300 nm but not exceeding 900 nm; (L.N. 226 of 2009)

Note:

For the purpose of 6A002(a)(1), solid-state detectors include "focal plane arrays". (L.N. 226 of 2009)

- (2) Image intensifier tubes and specially designed components for image intensifier tubes, as follows:

Note:

6A002(a)(2) does not include non-imaging photomultiplier tubes having an electron sensing device in the vacuum space limited solely to:

- (a) A single metal anode; *or*
- (b) Metal anodes with a centre to centre spacing greater than 500 μ m.
- (a) Image intensifier tubes having all of the following characteristics:
 - (1) A peak response in the wavelength range exceeding 400 nm but not exceeding 1050 nm;
 - (2) Electron image amplification using:
 - (a) A microchannel plate with a hole pitch (centre-to-centre spacing) of 12 μ m or less; *or*
 - (b) An electron sensing device with a non-binned pixel pitch of 500 μ m or less, specially designed or modified to achieve 'charge multiplication' other than by a microchannel plate;
 - (3) Any of the following photocathodes:
 - (a) Multialkali photocathodes (e.g. S-20 and S-25) having a luminous sensitivity exceeding 350 μ A/lm; (L.N. 226 of 2009)
 - (b) GaAs or GaInAs photocathodes;
 - (c) Other "III/V compound" semiconductor photocathodes having a maximum radiant sensitivity exceeding 10 mA/W; (L.N. 226 of 2009)

Note:

6A002(a)(2)(a)(3)(c) does not include compound semiconductor photocathodes with a maximum radiant sensitivity of 10 mA/W or less.

- (b) Image intensifier tubes having all of the following characteristics:
 - (1) A peak response in the wavelength range exceeding 1050 nm but

- not exceeding 1800 nm;
- (2) Electron image amplification using:
 - (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;
 - (3) "III/V compound" semiconductor (e.g. GaAs or GaInAs) photocathodes and transferred electron photocathodes, having a maximum radiant sensitivity exceeding 15 mA/W; *and* (L.N. 226 of 2009)

Note:
6A002(a)(2)(b)(3) does not include compound semiconductor photocathodes with a maximum radiant sensitivity of 15 mA/W or less.
- (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; *and*
 - (3) "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes; *and*
- Note:*
6A002(a)(2)(c)(3) does not include compound semiconductor photocathodes designed to achieve a maximum radiant sensitivity of:
- (a) 10 mA/W or less at the peak response in the wavelength range exceeding 400 nm but not exceeding 1050 nm; *or*
 - (b) 15 mA/W or less at the peak response in the wavelength range exceeding 1050 nm but not exceeding 1800 nm.
- (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".
- Notes:*
1. 6A002(a)(3) includes photoconductive arrays and photovoltaic arrays.
 2. 6A002(a)(3) does not include:
 - (a) Multi-element (not to exceed 16 elements) encapsulated photoconductive cells using either lead sulphide or lead selenide;
 - (b) Pyroelectric detectors using:
 - (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; *and*

- (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 characteristics:
 - (1) Incorporating a response limiting mechanism designed not to be removed or modified;
 - (2) Any of the following characteristics:
 - (a) The response limiting mechanism is integral to or combined with the detector element;
 - (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.

- (a) Non-"space qualified" "focal plane arrays" having all of the following characteristics:
 - (1) Having individual elements with a peak response in the wavelength range exceeding 900 nm but not exceeding 1050 nm;
 - (2) Any of the following characteristics:
 - (a) A response "time constant" of less than 0.5 ns;
 - (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 characteristics:
 - (1) Having individual elements with a peak response in the wavelength range exceeding 1050 nm but not exceeding 1200 nm;
 - (2) Any of the following characteristics:
 - (a) A response "time constant" of 95 ns or less;
 - (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 1200 nm but not exceeding 30000 nm;

N.B.:

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

- (d) Non-"space-qualified" linear (1-dimensional) "focal plane arrays" having all of the following:
 - (1) Individual elements with a peak response in the wavelength range exceeding 1200 nm but not exceeding 3000 nm;
 - (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;
 - (b) Signal processing in the element (SPRITE);

Note:

6A002(a)(3)(d) does not include "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' means the axis parallel to the linear array of detector elements and 'scan direction' means 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 3000 nm but not exceeding 30000 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 8000 nm but not exceeding 14000 nm;

Technical Note:

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

- (g) Non-"space-qualified" "focal plane arrays" having all of the following characteristics:
 - (1) Having 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;
 - (3) Greater than 32 elements;

Technical Note:

In 6A002(a), 'charge multiplication' is a form of electronic image amplification, and means 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". (L.N. 254 of 2008)

- (b) "Monospectral imaging sensors" and "multispectral imaging sensors" designed for remote sensing applications, having any of the following:
 - (1) An Instantaneous-Field-Of-View (IFOV) of less than 200 μ rad (microradians); or

Note:

6A002(b)(1) does not include "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';
 - 2. Complementary Metal Oxide Semiconductor (CMOS) devices not designed or modified to achieve 'charge multiplication'. (L.N. 226 of 2009)
- (2) Being specified for operation in the wavelength range exceeding 400 nm but not exceeding 30000 nm and having all the following:
 - (a) Providing output imaging data in digital format; and
 - (b) Being any of the following:

- (1) "Space qualified"; or (L.N. 65 of 2004)
- (2) Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2.5 mrad (milliradians);
- (c) 'Direct view' imaging equipment incorporating: (L.N. 254 of 2008)
 - (1) Image intensifier tubes having the characteristics listed in 6A002(a)(2)(a) or 6A002(a)(2)(b); (L.N. 254 of 2008)
 - (2) "Focal plane arrays" having the characteristics listed in 6A002(a)(3); or (L.N. 254 of 2008; L.N. 226 of 2009)
 - (3) Solid-state detectors specified in 6A002(a)(1); (L.N. 254 of 2008)

Technical Note:

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

Note:

6A002(c) does not control the following equipment incorporating other than GaAs or GaInAs photocathodes:

- (a) Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;
- (b) Medical equipment;
- (c) Industrial equipment used for inspection, sorting or analysis of the properties of materials;
- (d) Flame detectors for industrial furnaces;
- (e) Equipment specially designed for laboratory use.
- (d) Special support components for optical sensors, as follows:
 - (1) "Space qualified" cryocoolers; (L.N. 65 of 2004)
 - (2) Non-"space qualified" cryocoolers, having a cooling source temperature below 218 K (-55⁰C), as follows: (L.N. 65 of 2004)
 - (a) Closed cycle type with a specified Mean-Time-To-Failure (MTTF), or Mean-Time-Between-Failures (MTBF), exceeding 2500 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;
- (e) (Repealed L.N. 226 of 2009)

6A003 Cameras

N.B.:

See also 6A203.

For cameras specially designed or modified for underwater use, see 8A002(d) and 8A002(e).

- (a) Instrumentation cameras and specially designed components therefor, as follows: (L.N. 132 of 2001)

Note:

Instrumentation cameras, controlled by 6A003(a)(3) to 6A003(a)(5), with modular structures should be evaluated by their maximum capability, using plug-ins available according to the camera manufacturer's specifications. (L.N. 132 of

2001)

- (1) High-speed cinema recording cameras using any film format from 8 mm to 16 mm inclusive, in which the film is continuously advanced throughout the recording period, and that are capable of recording at framing rates exceeding 13150 frames/s;

Note:

6A003(a)(1) does not control cinema recording cameras designed for civil purposes. (L.N. 183 of 1999)

- (2) Mechanical high speed cameras, in which the film does not move, capable of recording at rates exceeding 1000000 frames/s for the full framing height of 35 mm film, or at proportionately higher rates for lesser frame heights, or at proportionately lower rates for greater frame heights;
 - (3) Mechanical or electronic streak cameras having writing speeds exceeding 10 mm/μs;
 - (4) Electronic framing cameras having a speed exceeding 1000000 frames/s;
 - (5) Electronic cameras, having all of the following:
 - (a) An electronic shutter speed (gating capability) of less than 1 μs per full frame; and
 - (b) A read out time allowing a framing rate of more than 125 full frames per second;
 - (6) Plug-ins, having all of the following characteristics:
 - (a) Specially designed for instrumentation cameras which have modular structures and which are controlled by 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; (L.N. 132 of 2001)
- (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 30000 nm and having all of the following:
 - (a) Having any of the following:
 - (1) More than 4×10^6 "active pixels" per solid state array for monochrome (black and white) cameras;
 - (2) More than 4×10^6 "active pixels" per solid state array for colour cameras incorporating three solid state arrays; or
 - (3) More than 12×10^6 "active pixels" for solid state array colour cameras incorporating one solid state array; and
 - (b) Having any of the following:
 - (1) Optical mirrors controlled by 6A004(a);
 - (2) Optical control equipment controlled by 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:

- (a) the horizontal angle the camera line of sight makes with respect to the earth's magnetic field direction; and
 - (b) the vertical angle between the camera line of sight and the earth's horizon. (L.N. 65 of 2004)
- (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 30000 nm; (L.N. 65 of 2004)
 - (b) Linear detector arrays with more than 8192 elements per array; and (L.N. 65 of 2004)
 - (c) Mechanical scanning in one direction; (L.N. 65 of 2004)
- (3) Imaging cameras incorporating image intensifier tubes having the characteristics listed in 6A002(a)(2)(a) or 6A002(a)(2)(b); (L.N. 254 of 2008)
- (4) Imaging cameras incorporating "focal plane arrays" having any of the following characteristics: (L.N. 254 of 2008)
- (a) Incorporating "focal plane arrays" specified in 6A002(a)(3)(a) to 6A002(a)(3)(e); (L.N. 254 of 2008)
 - (b) Incorporating "focal plane arrays" specified in 6A002(a)(3)(f); (L.N. 254 of 2008)
 - (c) Incorporating "focal plane arrays" specified in 6A002(a)(3)(g); (L.N. 254 of 2008)
 - (d) (Repealed L.N. 226 of 2009)

Notes:

1. Imaging cameras described 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.
2. 6A003(b)(4)(a) does not control imaging cameras incorporating linear "focal plane arrays" with twelve elements or fewer, not employing time-delay-and-integration within the element, 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.
3. 6A003(b)(4)(b) does not control imaging cameras having any of the following characteristics:
 - (a) A maximum frame rate equal to or less than 9 Hz;
 - (b) Having all of the following:
 - (1) Having a minimum horizontal or vertical Instantaneous-Field-of-View (IFOV) of at least 10 mrad/pixel (milliradians/pixel);
 - (2) Incorporating a fixed focal-length lens that is not designed to be removed;
 - (3) Not incorporating a 'direct view' display; and

Technical Note:

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

- (4) Having any of the following:
 - (a) No facility to obtain a viewable image of the detected field-of-view;
 - (b) The camera is designed for a single kind of application and designed not to be user modified; or

Technical Note:

Instantaneous-Field-of-View (IFOV) specified in Note 3(b) is the lesser figure of the Horizontal FOV or the Vertical FOV.

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

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

- (c) The camera is specially designed for installation into a civilian passenger land vehicle of less than three tonnes (gross vehicle weight) and having all of the following characteristics: (L.N. 254 of 2008)
 - (1) Is only operable when installed in: (L.N. 254 of 2008)
 - (a) The civilian passenger land vehicle for which it was intended; or
 - (b) A specially designed, authorized maintenance test facility; (L.N. 254 of 2008)
 - (2) Incorporates an active mechanism that forces the camera not to function when it is removed from the vehicle for which it was intended. (L.N. 95 of 2006; L.N. 226 of 2009)

- 4. 6A003(b)(4)(c) does not include imaging cameras having any of the following characteristics:

- (a) Having all of the following characteristics:
 - (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; *and*
 - (d) Financial fraud detection equipment;
 - (2) Is only operable when installed in:
 - (a) The system or equipment for which it was intended;
or
 - (b) A specially designed, authorized maintenance test facility;
 - (3) Incorporates an active mechanism that forces the camera not to function when it is removed from the system or

- equipment for which it was intended;
- (b) The camera is specially designed for installation into a civilian passenger land vehicle of less than three tonnes (gross vehicle weight), or passenger and vehicle ferries having a length overall (LOA) 65 m or greater, and having all of the following characteristics:
 - (1) Is only operable when installed in:
 - (a) The civilian passenger land vehicle or passenger and vehicle ferry for which it was intended; *or*
 - (b) A specially designed, authorized maintenance test facility;
 - (2) 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 characteristics:
 - (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;
 - (d) Having all of the following characteristics:
 - (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;
 - (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. (L.N. 254 of 2008)
 - (5) Imaging cameras incorporating solid-state detectors specified in 6A002(a)(1); (L.N. 254 of 2008)

6A004 Optical equipment and components (L.N. 254 of 2008)

- (a) Optical mirrors (reflectors), as follows:
 - (1) "Deformable mirrors" having either continuous or multi-element surfaces, and specially designed components therefor, capable of dynamically repositioning portions of the surface of the mirror at rates exceeding 100 Hz;
 - (2) Lightweight monolithic mirrors having an average "equivalent density" of less than 30 kg/m² and a total mass exceeding 10 kg;
 - (3) Lightweight "composite" or foam mirror structures with an average "equivalent density" of less than 30 kg/m² and a total mass exceeding 2 kg;
 - (4) Beam steering mirrors more than 100 mm in diameter or length of major axis, which maintain a flatness of $\lambda/2$ or better (λ is equal to 633 nm) having a control bandwidth exceeding 100 Hz;

N.B.:

For optical mirrors specially designed for lithography equipment, see 3B001. (L.N. 254 of 2008)

- (b) Optical components made from zinc selenide (ZnSe) or zinc sulphide (ZnS) with transmission in the wavelength range exceeding 3000 nm but not exceeding 25000 nm and having any of the following:
 - (1) Exceeding 100 cm³ 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: (L.N. 65 of 2004)
 - (1) Components lightweighted to less than 20% "equivalent density" compared with a solid blank of the same aperture and thickness; (L.N. 226 of 2009)
 - (2) Raw substrates, processed substrates having surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or having protective films; (L.N. 183 of 1999)
 - (3) Segments or assemblies of mirrors designed to be assembled in space into an optical system with a collecting aperture equivalent to or larger than a single optic 1 m in diameter;
 - (4) Components manufactured from "composite" materials having a coefficient of linear thermal expansion equal to or less than 5×10^{-6} in any coordinate direction; (L.N. 226 of 2009)
- (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); (L.N. 65 of 2004; L.N. 226 of 2009)
 - (2) Equipment having steering, tracking, stabilization or resonator alignment bandwidths equal to or more than 100 Hz and an accuracy of 10 μ rad (microradians) or less; (L.N. 226 of 2009)
 - (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 μ rad (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)/s²; or
 - (2) Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0.5 rad (radians)/s²;
 - (4) Specially designed to maintain the alignment of phased array or phased segment mirror systems consisting of mirrors with a segment diameter or major axis length of 1 m or more;
- (e) Aspheric optical elements having all of the following characteristics:
 - (1) The largest dimension of the optical-aperture is greater than 400 mm;
 - (2) The surface roughness is less than 1 nm rms for sampling lengths equal to or greater than 1 mm; and
 - (3) The coefficient of linear thermal expansion's absolute magnitude is less than 3×10^{-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) A largest optical-aperture dimension less than 1 m and a focal length to aperture ratio equal to or greater than 4.5:1;
- (b) A largest optical-aperture dimension equal to or greater than 1 m and a focal length to aperture ratio equal to or greater than 7:1;
- (c) Being designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;
- (d) Being fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than $2.5 \times 10^{-6}/\text{K}$ at 25°C ; or
- (e) Being 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. (L.N. 132 of 2001)

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.

Notes:

1. Pulsed "lasers" include those that run in a continuous wave (CW) mode with pulses superimposed.
2. Excimer, semiconductor, chemical, CO, CO₂, and non-repetitive pulsed Nd:glass "lasers" are only specified in 6A005(d).
3. 6A005 includes fibre "lasers".
4. The status of "lasers" incorporating frequency conversion (i.e. wavelength change) by means other than one "laser" pumping another "laser" is determined by applying the specified parameters for both the output of the source "laser" and the frequency-converted optical output.
5. 6A005 does not include the following "lasers":
 - (a) Ruby with output energy below 20 J;
 - (b) Nitrogen; *and*
 - (c) Krypton.
- (a) Non-"tunable" continuous wave "(CW) lasers" having any of the following characteristics:
 - (1) Output wavelength less than 150 nm and output power exceeding 1 W;
 - (2) Output wavelength of 150 nm or more but not exceeding 520 nm and output power exceeding 30 W;

Note:

6A005(a)(2) does not include Argon "lasers" having an output power equal to or less than 50 W.

- (3) Output wavelength exceeding 520 nm but not exceeding 540 nm and having:
 - (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 having:
 - (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 1150 nm and having:
 - (a) Single-transverse mode output and having:
 - (1) 'Wall-plug efficiency' exceeding 12% and output power exceeding 100 W; *or*
 - (2) Output power exceeding 150 W; *or*
 - (b) Multiple-transverse mode output and having:
 - (1) 'Wall-plug efficiency' exceeding 18% and output power exceeding 500 W; *or*
 - (2) Output power exceeding 2 kW;
- Note:*
6A005(a)(6)(b) does not include multiple-transverse mode, industrial "lasers" with output power exceeding 2 kW and not exceeding 6 kW with a total mass greater than 1200 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 or both.
- (7) Output wavelength exceeding 1150 nm but not exceeding 1555 nm and having:
 - (a) Single-transverse mode output and output power exceeding 50 W; *or*
 - (b) Multiple-transverse mode output and output power exceeding 80 W;
 - (8) Output wavelength exceeding 1555 nm and output power exceeding 1 W;
 - (b) Non-"tunable" "pulsed lasers" having any of the following characteristics:
 - (1) Output wavelength less than 150 nm and having:
 - (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 520 nm and having:
 - (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 include Argon "lasers" having an "average output power" equal to or less than 50 W.
- (3) Output wavelength exceeding 520 nm but not exceeding 540 nm and having:
 - (a) Single-transverse mode output and having:
 - (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 having:
 - (1) Output energy exceeding 1.5 J per pulse and "peak power" exceeding 150 W; *or*
 - (2) "Average output power" exceeding 150 W;
 - (4) Output wavelength exceeding 540 nm but not exceeding 800 nm and having:
 - (a) Output energy exceeding 1.5 J per pulse and "peak power" exceeding 30 W; *or*
 - (b) "Average output power" exceeding 30 W;

- (5) Output wavelength exceeding 800 nm but not exceeding 975 nm and having:
- (a) "Pulse duration" not exceeding 1 μ s and having:
 - (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 μ s and having:
 - (1) Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;
 - (2) Single-transverse mode output and "average output power" exceeding 50 W; *or*
 - (3) Multiple-transverse mode output and "average output power" exceeding 80 W;
- (6) Output wavelength exceeding 975 nm but not exceeding 1150 nm and having:
- (a) "Pulse duration" of less than 1 ns and having:
 - (1) Output "peak power" exceeding 5 GW per pulse;
 - (2) "Average output power" exceeding 10 W; *or*
 - (3) Output energy exceeding 0.1 J per pulse;
 - (b) "Pulse duration" equal to or exceeding 1 ns but not exceeding 1 μ s and having: (L.N. 226 of 2009)
 - (1) Single-transverse mode output and having:
 - (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 having:
 - (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*
 - (c) "Pulse duration" exceeding 1 μ s and having:
 - (1) Single-transverse mode output and having:
 - (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 having:
 - (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 1150 nm but not exceeding 1555 nm and having:
 - (a) "Pulse duration" not exceeding 1 μ s and having:
 - (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 μ s and having:
 - (1) Output energy exceeding 2 J per pulse and "peak power" exceeding 50 W;
 - (2) Single-transverse mode output and "average output power" exceeding 50 W; *or*
 - (3) Multiple-transverse mode output and "average output power" exceeding 80 W;
- (8) Output wavelength exceeding 1555 nm and having:
 - (a) Output energy exceeding 100 mJ per pulse and "peak power" exceeding 1 W; *or*
 - (b) "Average output power" exceeding 1 W;
- (c) "Tunable" "lasers" having any of the following characteristics:

Note:
6A005(c) includes titanium-sapphire (Ti: Al₂O₃), thulium-YAG (Tm: YAG), thulium-YSGG (Tm: YSGG), alexandrite (Cr: B₆Al₂O₄), colour centre "lasers", dye "lasers" and liquid "lasers".

 - (1) Output wavelength less than 600 nm and having:
 - (a) Output energy exceeding 50 mJ per pulse and "peak power" exceeding 1 W; *or*
 - (b) Average or CW output power exceeding 1 W;
 - (2) Output wavelength of 600 nm or more but not exceeding 1400 nm and having:
 - (a) Output energy exceeding 1 J per pulse and "peak power" exceeding 20 W; *or*
 - (b) Average or CW output power exceeding 20 W;
 - (3) Output wavelength exceeding 1400 nm and having:
 - (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:

Notes:

 - 1. 6A005(d)(1) includes semiconductor "lasers" having optical output connectors (e.g. fibre optic pigtails).
 - 2. The status of semiconductor "lasers" specially designed for other equipment is determined by the status of the other equipment.
 - (a) Individual single-transverse mode semiconductor "lasers" having:
 - (1) Wavelength equal to or less than 1510 nm and average or CW output power exceeding 1.5 W; *or*

- (2) Wavelength greater than 1510 nm and average or CW output power exceeding 500 mW;
- (b) Individual multiple-transverse mode semiconductor "lasers" having:
 - (1) Wavelength of less than 1400 nm and average or CW output power exceeding 10 W;
 - (2) Wavelength equal to or greater than 1400 nm and less than 1900 nm and average or CW output power exceeding 2.5 W; *or*
 - (3) Wavelength equal to or greater than 1900 nm and average or CW output power exceeding 1 W;
- (c) Individual semiconductor "laser" 'arrays' having:
 - (1) Wavelength of less than 1400 nm and average or CW output power exceeding 80 W;
 - (2) Wavelength equal to or greater than 1400 nm and less than 1900 nm and average or CW output power exceeding 25 W; *or*
 - (3) Wavelength equal to or greater than 1900 nm and average or CW output power exceeding 10 W; *and*
- (d) 'Array stacks' of semiconductor "lasers" containing at least one 'array' specified in 6A005(d)(1)(c);

Technical Notes:

1. Semiconductor "lasers" are commonly called "laser" diodes.
 2. An 'array' consists of multiple semiconductor "laser" emitters fabricated as a single chip so that the centres of the emitted light beams are on parallel paths.
 3. An 'array stack' is fabricated by stacking, or otherwise assembling, 'arrays' so that the centres of the emitted light beams are on parallel paths.
- (2) Carbon monoxide (CO) "lasers" having:
 - (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 (CO₂) "lasers" having:
 - (a) CW output power exceeding 15 kW;
 - (b) Pulsed output with a "pulse duration" exceeding 10 μ s and having:
 - (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 μ s and having:
 - (1) Pulse energy exceeding 5 J per pulse; *or*
 - (2) "Average output power" exceeding 2.5 kW;
 - (4) Excimer "lasers" having:
 - (a) Output wavelength not exceeding 150 nm and having:
 - (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 having:
 - (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 having:
 - (1) Output energy exceeding 10 J per pulse; *or*
 - (2) "Average output power" exceeding 500 W; *or*

- (d) Output wavelength exceeding 360 nm and having:
 - (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"; *and*
 - (c) "Transfer lasers" as follows:
 - (1) Oxygen Iodine (O₂-I) "lasers"; *and*
 - (2) Deuterium Fluoride-Carbon dioxide (DF-CO₂) "lasers"; *and*
- (6) 'Non-repetitive pulsed' Nd: glass "lasers" having:
 - (a) "Pulse duration" not exceeding 1 μ s and output energy exceeding 50 J per pulse; *or*
 - (b) "Pulse duration" exceeding 1 μ s 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; *and*
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, specially designed for use with specified "lasers"; *and*
- (f) Optical equipment as follows:

N.B.:

For shared aperture optical elements, capable of operating in "Super High Power Laser" ("SHPL") applications, see Note 2(d) to ML19.

- (1) Dynamic wavefront (phase) measuring equipment capable of mapping at least 50 positions on a beam wavefront and having:
 - (a) Frame rates equal to or more than 100 Hz and phase discrimination of at least 5% of the beam's wavelength; *or*
 - (b) Frame rates equal to or more than 1000 Hz and phase discrimination of at least 20% of the beam's wavelength;
- (2) "Laser" diagnostic equipment capable of measuring "SHPL" system angular beam steering errors of equal to or less than 10 μ rad;
- (3) Optical equipment and components, specially designed for a phased-array "SHPL" system for coherent beam combination to an accuracy of $\lambda/10$ at the designed wavelength, or 0.1 μ m, whichever is the smaller; *and*
- (4) Projection telescopes specially designed for use with "SHPL" systems;

Technical Note:

In 6A005, 'wall-plug efficiency' means the ratio of "laser" output power (or "average output power") to total electrical input power required to operate the "laser", including the power supply/conditioning and thermal conditioning/heat exchanger.

(L.N. 254 of 2008)

6A006 "Magnetometers", "magnetic gradiometers", "intrinsic magnetic gradiometers", underwater electric field sensors, and "compensation systems", and specially designed components therefor, as follows: (L.N. 254 of 2008)

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 characteristics:
 - (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)/square root Hz at frequencies of less than 1 Hz;
 - (b) 1×10^{-3} nT (rms)/square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or
 - (c) 1×10^{-4} nT (rms)/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 meter per square root Hz when measured at 1 Hz;
- (c) "Magnetic gradiometers", as follows:
 - (1) "Magnetic gradiometers" using multiple "magnetometers" controlled by 6A006(a);
 - (2) Fibre optic "intrinsic magnetic gradiometers" having a magnetic gradient field 'sensitivity' lower (better) than 0.3 nT/m (rms) per square root Hz;
 - (3) "Intrinsic magnetic gradiometers", using "technology" other than fibre-optic "technology", having a magnetic gradient field 'sensitivity' lower (better) than 0.015 nT/m (rms) per square root Hz;
- (d) "Compensation systems" for magnetic or underwater electric field sensors resulting in a performance equal to or better than the control parameters of 6A006(a), 6A006(b) or 6A006(c); (L.N. 254 of 2008)

Technical Note:

For the purposes of 6A006, the term 'sensitivity' (noise level) means the root mean square of the device-limited noise floor which is the lowest signal that can be measured. (L.N. 226 of 2009)

(L.N. 95 of 2006; L.N. 226 of 2009)

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

N.B.:

See also 6A107.

- (a) Gravity meters designed or modified for ground use having a static accuracy of less (better) than 10 μ gal; (L.N. 183 of 1999)

Note:

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

- (b) Gravity meters designed for mobile platforms, having all of the following: (L.N. 183 of 1999)
 - (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 characteristics, and specially designed components therefor:

N.B.:

See also 6A108.

Note:

6A008 does not include: (L.N. 254 of 2008)

- (a) Secondary surveillance radar (SSR);
- (b) Civil Automotive Radar; (L.N. 254 of 2008)
- (c) Displays or monitors used for air traffic control (ATC) having no more than 12 resolvable elements per mm;
- (d) Meteorological (weather) radar.
- (a) Operating at frequencies from 40 GHz to 230 GHz and having:
 - (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; (L.N. 254 of 2008)
- (b) Having a tunable bandwidth exceeding $\pm 6.25\%$ 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 steerable phased array antennae";
- (f) Capable of heightfinding non-cooperative targets;

Note:

6A008(f) does not control precision approach radar (PAR) equipment conforming to ICAO standards.

- (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 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, provided that all the following conditions are met:
 - (1) It has a maximum "instrumented range" of 500 km or less;
 - (2) It is configured so that radar target data can be transmitted only one way from the radar site to one or more civil ATC centres;
 - (3) It contains no provisions for remote control of the radar scan rate from the enroute ATC centre; and
 - (4) It is to be permanently installed;
- (c) Weather balloon tracking radars. (L.N. 226 of 2009)
- (j) Being "laser" radar or Light Detection and Ranging (LIDAR) equipment, having any of the following:
 - (1) "Space qualified"; (L.N. 65 of 2004; L.N. 226 of 2009)
 - (2) Employing coherent heterodyne or homodyne detection techniques and having an angular resolution of less (better) than 20 μ rad (microradians);
 - (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; (L.N. 226 of 2009)

Notes:

1. LIDAR equipment specially designed for surveying is only specified in 6A008(j)(3).
 2. 6A008(j) does not include LIDAR equipment specially designed for meteorological observation.
 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. (L.N. 226 of 2009)
- (k) Having "signal processing" sub-systems using "pulse compression", with any of the following:
 - (1) A "pulse compression" ratio exceeding 150; or
 - (2) A pulse width of less than 200 ns; or
 - (l) Having data processing sub-systems with 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;

Note:
6A008(l)(1) does not control conflict alert capability in ATC systems, or marine or harbour radar.
 - (2) Calculation of target velocity from primary radar having non-periodic (variable) scanning rates;
 - (3) Processing for automatic pattern recognition (feature extraction) and comparison with target characteristic data bases (waveforms or imagery) to

- identify or classify targets; or
- (4) Superposition and correlation, or fusion, of target data from two or more "geographically dispersed" and "interconnected radar sensors" to enhance and discriminate targets;

Note:

6A008(1)(4) does not control systems, equipment and assemblies used for marine traffic control.

- 6A102 Radiation hardened 'detectors', other than those controlled by 6A002, specially designed or modified for protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and thermal effects), and usable for "missiles", designed or rated to withstand radiation levels which meet or exceed a total irradiation does of 5×10^5 rads (Si); (L.N. 65 of 2004; L.N. 95 of 2006)

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. (L.N. 65 of 2004)

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

- (a) Gravity meters, other than those controlled by 6A007(b), designed or modified for airborne or marine use, and having a static or operational accuracy of 7×10^{-6} m/s² (0.7 milligal) or less (better), and having a time-to-ready-state registration of two minutes or less; (L.N. 65 of 2004)
- (b) Specially designed components for gravity meters controlled by 6A007(b) or 6A107(a) and gravity gradiometers controlled by 6A007(c); (L.N. 183 of 1999)

- 6A108 Radar systems and tracking systems, other than those controlled by 6A008, as follows:

- (a) Radar and laser radar systems designed or modified for use in space launch vehicles controlled by 9A004, "unmanned aerial vehicles" controlled by 9A012 or sounding rockets controlled by 9A104; (L.N. 183 of 1999; L.N. 95 of 2006)

Note:

6A108(a) includes the following:

- (a) Terrain contour mapping equipment;
- (b) Imaging sensor equipment;
- (c) Scene mapping and correlation (both digital and analogue) equipment;
- (d) Doppler navigation radar equipment. (L.N. 65 of 2004)
- (b) Precision tracking systems, usable for 'missiles', as follows: (L.N. 65 of 2004; L.N. 95 of 2006)
- (1) Tracking systems which use a code translator in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of in-flight position and velocity;
- (2) Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:
- (a) Angular resolution better than 3 milliradians; (L.N. 254 of 2008)
- (b) Range of 30 km or greater with a range resolution better than 10 m rms;
- (c) Velocity resolution better than 3 m/s;

Technical Note:

In 6A108(b), the term 'missiles' means complete rocket systems and "unmanned

aerial vehicle" systems capable of a range exceeding 300 km. (L.N. 226 of 2009)

(L.N. 226 of 2009)

6A202 Photomultiplier tubes having both of the following characteristics:

- (a) Photocathode area of greater than 20 cm²; and
- (b) Anode pulse rise time of less than 1 ns;

(L.N. 65 of 2004)

6A203 Cameras and components, other than those controlled by 6A003, as follows:

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

- (1) Framing cameras with recording rates greater than 225000 frames per second; or
- (2) Streak cameras with writing speeds greater than 0.5 mm per μ s;

Note:

Components of such cameras include their synchronizing electronic units and rotor assemblies consisting of turbines, mirrors and bearings.

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

- (1) Electronic streak cameras capable of 50 ns or less time resolution;
- (2) Streak tubes for cameras controlled by 6A203(b)(1); (L.N. 95 of 2006)
- (3) Electronic (or electronically shuttered) framing cameras capable of 50 ns or less frame exposure time;
- (4) Framing tubes and solid-state imaging devices for use with cameras controlled by 6A203(b)(3), as follows: (L.N. 95 of 2006)

- (a) Proximity focused image intensifier tubes having the photocathode deposited on a transparent conductive coating to decrease photocathode sheet resistance;
- (b) Gate silicon intensifier target (SIT) videcon tubes, where a fast system allows gating the photoelectrons from the photocathode before they impinge on the SIT plate;
- (c) Kerr or Pockels cell electro-optical shuttering;
- (d) Other framing tubes and solid-state imaging devices having a fast-image gating time of less than 50 ns specially designed for cameras controlled by 6A203(b)(3); (L.N. 132 of 2001; L.N. 95 of 2006)

(c) Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand greater than 50 x 10³ grays (Silicon) (5 x 10⁶ rad (Silicon)) without operational degradation;

Technical Note:

The term grays (Silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionizing radiation. (L.N. 132 of 2001)

6A205 "Lasers", "laser" amplifiers and oscillators, other than those controlled by 0B001(g)(5), 0B001(h)(6) and 6A005, as follows: (L.N. 65 of 2004; L.N. 95 of 2006)

(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; (L.N. 65 of 2004)

(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; (L.N. 65 of 2004)
- (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. (L.N. 65 of 2004)

- (d) Pulsed carbon dioxide "lasers" having all of the following characteristics:
- (1) Operating at wavelengths between 9000 nm and 11000 nm;
 - (2) A repetition rate greater than 250 Hz;
 - (3) An average output power greater than 500 W; and
 - (4) Pulse width less than 200 ns; (L.N. 65 of 2004)
- (e) Para-hydrogen Raman shifters designed to operate at 16 micrometre output wavelength and at a repetition rate greater than 250 Hz; (L.N. 65 of 2004)
- (f) Neodymium-doped (other than glass) "lasers" with an output wavelength between 1000 nm and 1100 nm, having any of the following characteristics:
- (1) Pulse-excited and Q-switched with a pulse duration equal to or more than 1 ns, and having:
 - (a) A single-transverse mode output with an average output power greater than 40 W; *or*
 - (b) A multiple-transverse mode output with an average output power greater than 50 W;
 - (2) Incorporating frequency doubling to give an output wavelength between 500 nm and 550 nm with an average output power greater than 40 W; (L.N. 254 of 2008)

N.B.:

For copper vapour lasers, see 6A005(b). (L.N. 226 of 2009)

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

Note:

6A225 includes velocity interferometers such as VISARs (Velocity interferometer systems for any reflector) and DLIs (Doppler laser interferometers).

(L.N. 65 of 2004)

- 6A226 Pressure sensors, as follows:

- (a) Manganin gauges for pressures greater than 10 GPa; or
- (b) Quartz pressure transducers for pressures greater than 10 GPa; (L.N. 132 of 2001)

6B TEST, INSPECTION AND PRODUCTION EQUIPMENT

- 6B004 Optical equipment, as follows:

- (a) Equipment for measuring absolute reflectance to an accuracy of $\pm 0.1\%$ 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 controlled by 6B008, specially designed for radar cross-section measurement usable for 'missiles' and their subsystems; (L.N. 254 of 2008)

Technical Note:

In 6B108, 'missiles' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km. (L.N. 254 of 2008)

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; (L.N. 65 of 2004)

Technical Note:

Mole fraction is defined as the ratio of moles of ZnTe to the sum of the moles of CdTe and ZnTe present in the crystal. (L.N. 65 of 2004)

6C004 Optical materials, as follows:

- (a) Zinc selenide (ZnSe) and zinc sulphide (ZnS) "substrate blanks" produced by the chemical vapour deposition process, having any of the following:
 - (1) A volume greater than 100 cm³; or
 - (2) A diameter greater than 80 mm having a thickness of 20 mm or more;
- (b) Boules of the following electro-optic materials:
 - (1) Potassium titanyl arsenate (KTA);
 - (2) Silver gallium selenide (AgGaSe₂);
 - (3) Thallium arsenic selenide (Tl₃AsSe₃, also known as TAS);
- (c) Non-linear optical materials, having all of the following:
 - (1) Third order susceptibility (χ_3) of 10⁻⁶ m²/V² or more; and
 - (2) A response time of less than 1 ms;
- (d) "Substrate blanks" of silicon carbide or beryllium beryllium (Be/Be) deposited materials exceeding 300 mm in diameter or major axis length;
- (e) Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF₄) and hafnium fluoride (HfF₄), 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 14000 nm;

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

- (a) Titanium doped sapphire;
- (b) Alexandrite;

6D SOFTWARE

6D001 "Software" specially designed for the "development" or "production" of equipment controlled by 6A004, 6A005, 6A008 or 6B008;

6D002 "Software" specially designed for the "use" of equipment controlled by 6A002(b), 6A008 or 6B008;

6D003 Other "software", as follows:

- (a) (1) "Software" specially designed for acoustic beam forming for the "real time processing" of acoustic data for passive reception using towed hydrophone arrays;
- (2) "Source code" for the "real time processing" of acoustic data for passive reception using towed hydrophone arrays;
- (3) "Software" specially designed for acoustic beam forming for the "real time processing" of acoustic data for passive reception using bottom or bay cable systems; (L.N. 183 of 1999)
- (4) "Source code" for the "real time processing" of acoustic data for passive reception using bottom or bay cable systems; (L.N. 183 of 1999)
- (b) Deleted;
- (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) Deleted;
- (e) Deleted;
- (f) (1) "Software" specially designed for magnetic and electric field compensation systems for magnetic sensors designed to operate on mobile platforms; (L.N. 95 of 2006)
- (2) "Software" specially designed for magnetic and electric field anomaly detection on mobile platforms; (L.N. 95 of 2006)
- (g) "Software" specially designed to correct motional influences of gravity meters or gravity gradiometers;
- (h) (1) Air Traffic Control "software" application "programmes" hosted on general purpose computers located at Air Traffic Control centres and capable of any of the following:
 - (a) Processing and displaying more than 150 simultaneous "system tracks"; or
 - (b) Accepting radar target data from more than four primary radars;
- (2) "Software" for the design or "production" of radomes which:
 - (a) Are specially designed to protect the "electronically steerable phased

- array antennae" controlled by 6A008(e); and
- (b) Result 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.

(L.N. 226 of 2009)

6D102 "Software" specially designed for the "use" of goods controlled by 6A108;

6D103 "Software" which processes post-flight, recorded data, enabling determination of vehicle position throughout its flight path, specially designed or modified for 'missiles'; (L.N. 132 of 2001; L.N. 65 of 2004; L.N. 95 of 2006)

Technical Note:

In 6D103, 'missiles' means complete rocket systems and "unmanned aerial vehicle" systems capable of a range exceeding 300 km. (L.N. 95 of 2006)

6E TECHNOLOGY

6E001 "Technology" according to the General Technology Note for the "development" of equipment, materials or "software" controlled by 6A, 6B, 6C or 6D;

6E002 "Technology" according to the General Technology Note for the "production" of equipment or materials controlled by 6A, 6B or 6C;

6E003 Other "technology", as follows:

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

N.B.:

See also 2E003(f).

- (2) Optical fabrication "technology" using single point diamond turning techniques to produce surface finish accuracies of better than 10 nm rms on non-planar surfaces exceeding 0.5 m²;

- (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;

(L.N. 95 of 2006)

6E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" controlled by 6A002, 6A007(b) and (c), 6A008, 6A102, 6A107, 6A108, 6B108, 6D102 or 6D103;

Note:

6E101 only controls "technology" for equipment controlled by 6A008 when it is designed for airborne applications and is usable in "missiles".

6E201 "Technology" according to the General Technology Note for the "use" of equipment 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;

(L.N. 254 of 2008)