

## CATEGORY 6—SENSORS AND “LASERS”

### 6A SYSTEMS, EQUIPMENT AND COMPONENTS

6A001 Acoustic system, equipment and components, as follows: *(L.N. 161 of 2011)*

(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: *(L.N. 42 of 2017)*

(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) 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  $20^\circ$  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 of the following: *(L.N. 85 of 2023)*

(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 meeting any of the following descriptions: *(L.N. 42 of 2017)*

*Technical Note:*

The acoustic sensor pressure rating determines the depth rating of the underwater survey equipment specified in 6A001(a)(1)(a)(2).

- (a) It meets both of the following descriptions:
  - (1) Designed or modified to operate at depths exceeding 300 m;
  - (2) ‘Sounding rate’ greater than 3 800 m/s;

*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 2 directions (3D sonars), the maximum of the ‘sounding rate’ in either direction is to be used for the purposes of 6A001(a)(1)(a)(2)(a)(2).

- (b) It is not specified in 6A001(a)(1)(a)(2)(a) and meets all of the following descriptions:
  - (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) Meets either of the following descriptions:
    - (a) Operating frequency below 350 kHz;
    - (b) Designed to measure seabed topography at a range exceeding 200 m from the acoustic sensor;
  - (4) ‘Enhancement’ of the depth “accuracy” through compensation of all of the following: (*L.N. 85 of 2023*)
    - (a) Motion of the acoustic sensor;
    - (b) In-water propagation from sensor to the seabed and back;
    - (c) Sound speed at the sensor; (*L.N. 42 of 2017*)
- (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 for such sonars: (*L.N. 42 of 2017*)
  - (a) Designed or modified to operate at depths exceeding 500 m; (*L.N. 42 of 2017*)
  - (b) An ‘area coverage rate’ of greater than 570 m<sup>2</sup>/s while operating at the maximum range that it can operate with an ‘along track resolution’ of less than 15 cm; (*L.N. 161 of 2011; L.N. 42 of 2017*)
  - (c) An ‘across track resolution’ of less than 15 cm; (*L.N. 42 of 2017*)

*Technical Notes:*

- 1. ‘Area coverage rate’ (m<sup>2</sup>/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). (*L.N. 42 of 2017*)

*Technical Notes:*

*(Repealed L.N. 85 of 2023)*

- (b) Systems or transmitting and receiving arrays, designed for object detection or location, having any of the following: (*L.N. 89 of 2013*)
  - (1) A transmitting frequency below 10 kHz;
  - (2) Sound pressure level exceeding 224 dB (reference 1  $\mu$ 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  $\mu$ 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 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: (*L.N. 42 of 2017*)

*Notes:*

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. (*L.N. 42 of 2017*)
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. (*E.R. 6 of 2020*)
3. Piezoelectric elements specified in 6A001(a)(1)(c) include those made from lead-magnesium-niobate/lead-titanate ( $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ - $\text{PbTiO}_3$ , or PMN-PT) single crystals grown from solid solution or lead-indium-niobate/lead-magnesium niobate/lead-titanate ( $\text{Pb}(\text{In}_{1/2}\text{Nb}_{1/2})\text{O}_3$ - $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ - $\text{PbTiO}_3$ , or PIN-PMN-PT) single crystals grown from solid solution. (*L.N. 42 of 2017*)

- (1) Operating at frequencies below 10 kHz and meeting either of the following descriptions:
  - (a) Not designed for continuous operation at 100% duty cycle and having a radiated ‘free-field Source Level ( $SL_{RMS}$ )’ exceeding  $(10 \log(f) + 169.77)$  dB (reference 1  $\mu$ Pa at 1 m), where f is the frequency in Hertz of the maximum Transmitting Voltage Response (TVR) below 10 kHz;
  - (b) Designed for continuous operation at 100% duty cycle and having a continuously radiated ‘free-field Source Level ( $SL_{RMS}$ )’ at 100% duty cycle exceeding  $(10 \log(f) + 159.77)$  dB (reference 1  $\mu$ Pa at 1 m), where f is the frequency in Hertz of the maximum Transmitting Voltage Response (TVR) below 10 kHz;

*Technical Note:*

The ‘free-field Source Level ( $SL_{RMS}$ )’ is defined along the maximum response axis and in the far field of an acoustic projector. It can be obtained from the TVR using the following equation:  $SL_{RMS} = (TVR + 20 \log V_{RMS})$  dB (reference 1  $\mu$ Pa at 1 m), where  $SL_{RMS}$  is the source level, TVR is the Transmitting Voltage Response and  $V_{RMS}$  is the Driving Voltage of the Projector. (*L.N. 42 of 2017*)

- (2) (*Repealed L.N. 42 of 2017*)
- (3) Side-lobe suppression exceeding 22 dB; (*L.N. 132 of 2001*)
- (d) Acoustic systems and equipment, designed to determine the position of surface vessels or underwater vehicles and having all of the following, and specially designed components therefor:
  - (1) Detection range exceeding 1 000 m;
  - (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. (*L.N. 161 of 2011*)
- (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 for such sonars: (*L.N. 42 of 2017*)
  - (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;
  - (3) Transmitted pulse signal bandwidth exceeding 3 kHz;

*N.B.:*

For diver detection systems specially designed or modified for military use, see the Munitions List.

*Note:*

For 6A001(a)(1)(e), where multiple detection ranges are specified for various environments, the greatest detection range is used. (*L.N. 161 of 2011*)

- (2) Passive systems, equipment and specially designed components therefor, as follows: (*L.N. 161 of 2011*)

*Note:*

6A001(a)(2) also applies to receiving equipment, whether or not related in normal application to separate active equipment, and specially designed components for the receiving equipment. (*L.N. 85 of 2023*)

- (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*)

*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. (*L.N. 85 of 2023*)
- (1) Incorporating continuous flexible sensing elements; (*L.N. 95 of 2006*)
  - (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; (*L.N. 95 of 2006*)
  - (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'; (*L.N. 95 of 2006*)
    - (d) Lead-magnesium-niobate/lead-titanate (i.e.  $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3\text{-PbTiO}_3$ , or PMN-PT) piezoelectric single crystals grown from solid solution; (*L.N. 42 of 2017*)
    - (e) Lead-indium-niobate/lead-magnesium niobate/lead-titanate (i.e.  $\text{Pb}(\text{In}_{1/2}\text{Nb}_{1/2})\text{O}_3\text{-Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3\text{-PbTiO}_3$ , or PIN-PMN-PT) piezoelectric single crystals grown from solid solution; (*L.N. 42 of 2017*)
  - (4) A 'hydrophone sensitivity' better than -180 dB at any depth with no acceleration compensation; (*L.N. 95 of 2006*)
  - (5) Designed to operate at depths exceeding 35 m with acceleration compensation; or (*L.N. 95 of 2006*)

- (6) Designed for operation at depths exceeding 1 000 m and having a ‘hydrophone sensitivity’ better than -230 dB below 4 kHz; *(L.N. 95 of 2006)*

*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  $\mu$ Pa. For example, a hydrophone of -160 dB (reference 1 V per  $\mu$ 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:

*Technical Note:*

Hydrophone arrays consist of a number of hydrophones providing multiple acoustic output channels. *(L.N. 89 of 2013)*

- (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)*
- (8) Accelerometer-based hydro-acoustic sensors specified in 6A001(a)(2)(g); *(L.N. 42 of 2017)*

- (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 (L.N. 89 of 2021)*
  - (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)*

*N.B.:*

For inertial heading systems, see 7A003(c). *(L.N. 89 of 2021)*

- (e) Bottom or bay-cable hydrophone arrays having any of the following: *(L.N. 89 of 2013)*
  - (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; *(L.N. 132 of 2001)*
  - (3) Incorporating accelerometer-based hydro-acoustic sensors specified in 6A001(a)(2)(g); *(L.N. 42 of 2017)*
- (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)*
- (g) Accelerometer-based hydro-acoustic sensors that meet all of the following descriptions:
  - (1) Composed of 3 accelerometers arranged along 3 distinct axes;
  - (2) Having an overall ‘acceleration sensitivity’ better than 48 dB (reference 1 000 mV rms per 1 g);
  - (3) Designed to operate at depths greater than 35 m;
  - (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 20 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 pre-amplifier, is placed in a plane

wave acoustic field with an rms acceleration of 1 g (i.e. 9.81 m/s<sup>2</sup>). (L.N. 42 of 2017)

*Note:*

*(Repealed L.N. 85 of 2023)*

- (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) *(Repealed L.N. 161 of 2011)*

*(L.N. 65 of 2004; L.N. 85 of 2023)*

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

*N.B.:*

See also 6A102. (L.N. 42 of 2017)

- (a) Optical detectors as follows:
  - (1) “Space-qualified” solid-state detectors as follows: (L.N. 89 of 2013)
    - (a) “Space-qualified” solid-state detectors having all of the following characteristics: (L.N. 89 of 2013)
      - (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: (L.N. 89 of 2013)
      - (1) A peak response in the wavelength range exceeding 900 nm but not exceeding 1 200 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 1 200 nm but not exceeding 30 000 nm; *and (L.N. 226 of 2009)*
- (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; *(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 µm.
- (a) Image intensifier tubes having all of the following characteristics:
  - (1) A peak response in the wavelength range exceeding 400 nm but not exceeding 1 050 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) Any of the following photocathodes:
    - (a) Multialkali photocathodes (e.g. S-20 and S-25) having a luminous sensitivity exceeding 350 µA/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; L.N. 161 of 2011)*
- (b) Image intensifier tubes having all of the following characteristics:
  - (1) A peak response in the wavelength range exceeding 1 050 nm but not exceeding 1 800 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; L.N. 161 of 2011)*
- (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 (E.R. 6 of 2020)*

*Note:*

6A002(a)(2)(c)(3) does not include compound semiconductor photocathodes designed to achieve a maximum “radiant sensitivity” of: *(L.N. 161 of 2011)*

- (a) 10 mA/W or less at the peak response in the wavelength range exceeding 400 nm but not exceeding 1 050 nm; *or*
  - (b) 15 mA/W or less at the peak response in the wavelength range exceeding 1 050 nm but not exceeding 1 800 nm.
- (3) Non-“space-qualified” “focal plane arrays” as follows: *(L.N. 89 of 2013)*

*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; *(L.N. 89 of 2021)*
  - (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: (*L.N. 161 of 2011*)

- (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; (*L.N. 89 of 2021*)

*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. (*L.N. 89 of 2021*)
- (a) Non-“space-qualified” “focal plane arrays” having all of the following characteristics: (*L.N. 89 of 2013*)
  - (1) Having individual elements with a peak response in the wavelength range exceeding 900 nm but not exceeding 1 050 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; (*L.N. 161 of 2011*)
- (b) Non-“space-qualified” “focal plane arrays” having all of the following characteristics: (*L.N. 89 of 2013*)
  - (1) Having individual elements with a peak response in the wavelength range exceeding 1 050 nm but not exceeding 1 200 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; (*L.N. 161 of 2011*)
- (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).

- (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;

- (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 detector elements; *(L.N. 42 of 2017)*

*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 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’ 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; *(L.N. 161 of 2011)*
  - (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  $\mu$ 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”: *(L.N. 89 of 2013)*

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 30 000 nm and having all of the following: *(L.N. 85 of 2023)*
- (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 any of the following: *(L.N. 254 of 2008; L.N. 85 of 2023)*
- (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 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. *(L.N. 85 of 2023)*

*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 (-55°C), as follows:

- (a) Closed cycle type with a specified Mean-Time-To-Failure (MTTF), or Mean-Time-Between-Failures (MTBF), exceeding 2 500 hours;
- (b) Joule-Thomson (JT) self-regulating minicoolers having bore (outside) diameters of less than 8 mm;
- (3) Optical sensing fibres specially fabricated either compositionally or structurally, or modified by coating, to be acoustically, thermally, inertially, electromagnetically or nuclear radiation sensitive;

*Note:*

6A002(d)(3) does not apply to encapsulated optical sensing fibres specially designed for bore hole sensing applications. *(L.N. 161 of 2011)*

- (e) *(Repealed L.N. 226 of 2009)*
- (f) ‘Read-out integrated circuits’ (‘ROIC’) specially designed for “focal plane arrays” specified in 6A002(a)(3); *(L.N. 85 of 2023)*

*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” 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’. *(L.N. 89 of 2021; L.N. 85 of 2023)*

*(L.N. 89 of 2013)*

6A003 Cameras, systems or equipment, and components therefor, as follows: *(L.N. 161 of 2011)*

*N.B.:*

See also 6A203. *(L.N. 161 of 2011; L.N. 89 of 2021)*

- (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)-(2) *(Repealed L.N. 89 of 2021)*
- (3) Electronic streak cameras having temporal resolution better than 50 ns; *(L.N. 89 of 2021)*
- (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  $\mu$ s 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 30 000 nm and having all of the following:
  - (a) Having any of the following:
    - (1) More than  $4 \times 10^6$  "active pixels" per solid state array for monochrome (black and white) cameras;
    - (2) More than  $4 \times 10^6$  "active pixels" per solid state array for colour cameras incorporating three solid state arrays; *or*
    - (3) More than  $12 \times 10^6$  "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'; (*L.N. 85 of 2023*)

*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: (*L.N. 85 of 2023*)
  - (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 30 000 nm; (*L.N. 65 of 2004*)

- (b) Linear detector arrays with more than 8 192 elements per array; *and (L.N. 65 of 2004)*
- (c) Mechanical scanning in one direction; *(L.N. 65 of 2004)*

*Note:*

6A003(b)(2) does not apply to scanning cameras and scanning camera systems, specially designed for any of the following:

- (a) Industrial or civilian photocopiers;
  - (b) Image scanners specially designed for civil, stationary, close proximity scanning applications (e.g. reproduction of images or print contained in documents, artwork or photographs);
  - (c) Medical equipment. *(L.N. 161 of 2011)*
- (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 2 mrad (milliradians); (*L.N. 89 of 2021; L.N. 85 of 2023*)

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

(3) Not incorporating a ‘direct view’ display; *and*

*Technical Note:*

*(Repealed L.N. 42 of 2017)*

(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:*

*(Repealed L.N. 42 of 2017)*

(c) The camera is specially designed for installation into a civilian passenger land vehicle and meets all of the following descriptions: (*L.N. 42 of 2017*)

(1) The configuration of the camera and its placement within the vehicle are solely to assist its driver in the safe operation of the vehicle;

(2) Is only operable when installed in:

(a) A civilian passenger land vehicle that weighs less than 4 500 kg (gross vehicle weight), and for which the camera 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 vehicle for which it was intended.

*Technical Notes:*

1. ‘Instantaneous-Field-of-View (IFOV)’ in 6A003(b)(4) Note 3(b) is the lesser figure of the ‘Horizontal IFOV’ or the ‘Vertical IFOV’.

*N.B.:*

‘Horizontal IFOV’ = horizontal Field of View / number of horizontal detector elements.

‘Vertical IFOV’ = vertical Field of View / 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. (*L.N. 42 of 2017*)

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(s) or equipment for which it was intended; *or (L.N. 85 of 2023)*
    - (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(s) or equipment for which it was intended; *(L.N. 85 of 2023)*
- (b) The camera is specially designed for installation into a civilian passenger land vehicle or a passenger and vehicle ferry, and meets all of the following descriptions: *(L.N. 42 of 2017)*
  - (1) The placement and configuration of the camera within the vehicle or ferry is solely to assist its driver or operator in the safe operation of the vehicle or ferry; *(L.N. 42 of 2017)*
  - (2) Is only operable when installed in: *(L.N. 42 of 2017)*
    - (a) A civilian passenger land vehicle that weighs less than 4 500 kg (gross vehicle weight), and for which the camera was intended; *(L.N. 42 of 2017)*
    - (b) A passenger and vehicle ferry that has a length overall (LOA) of 65 m or greater, and for which the camera was intended; *or (L.N. 42 of 2017)*
    - (c) A specially designed, authorized maintenance test facility; *(L.N. 42 of 2017)*
  - (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 characteristics: *(L.N. 161 of 2011)*
  - (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;

- (3) Not specially designed or modified for underwater use; (*L.N. 161 of 2011*)
- (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, as follows: (*L.N. 254 of 2008; L.N. 42 of 2017*)

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

*Technical Note:*

For the purposes 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. (*L.N. 42 of 2017*)

- (1) “Deformable mirrors” having an active optical aperture greater than 10 mm and either of the following, and specially designed components for such mirrors: (*L.N. 42 of 2017*)
  - (a) All of the following:
    - (1) A mechanical resonant frequency of 750 Hz or more;
    - (2) More than 200 actuators;
  - (b) A Laser Induced Damage Threshold (LIDT) that is:
    - (1) Greater than 1 kW/cm<sup>2</sup> when using a “CW laser”; *or*
    - (2) Greater than 2 J/cm<sup>2</sup> when using 20 ns “laser” pulses at a repetition rate of 20 Hz; (*L.N. 42 of 2017*)
- (2) Lightweight monolithic mirrors having an average “equivalent density” of less than 30 kg/m<sup>2</sup> 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. (*L.N. 89 of 2021*)

- (3) Lightweight “composite” or foam mirror structures with an average “equivalent density” of less than 30 kg/m<sup>2</sup> 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. *(L.N. 89 of 2021)*

- (4) Mirrors specially designed for beam steering mirror stages specified in 6A004(d)(2)(a), with a flatness of  $\lambda/10$  or better ( $\lambda$  is equal to 633 nm) and meeting either of the following descriptions: *(L.N. 89 of 2021)*
  - (a) Having a diameter or major axis length that is equal to or greater than 100 mm;
  - (b) Having all of the following: *(L.N. 89 of 2021)*
    - (1) A diameter or major axis length that is greater than 50 mm but less than 100 mm;
    - (2) A Laser Induced Damage Threshold (LIDT) that is:
      - (a) Greater than 10 kW/cm<sup>2</sup> when using a “CW laser”; *or*
      - (b) Greater than 20 J/cm<sup>2</sup> when using 20 ns “laser” pulses at a repetition rate of 20 Hz; *(L.N. 42 of 2017)*

*N.B.:*

*(Repealed L.N. 42 of 2017)*

- (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<sup>3</sup> 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; L.N. 89 of 2013)*
  - (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  $5 \times 10^{-6}/\text{K}$  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; L.N. 89 of 2013)*
  - (2) Steering, tracking, stabilization and resonator alignment equipment, as follows:
    - (a) Beam steering mirror stages designed to carry mirrors that have a diameter or major axis length that is greater than 50 mm, and having all of the

following, and specially designed electronic control equipment for such mirror stages: *(L.N. 85 of 2023)*

- (1) A maximum angular travel of  $\pm 26$  mrad or more;
  - (2) A mechanical resonant frequency of 500 Hz or more;
  - (3) An angular “accuracy” of 10  $\mu$ rad (microradians) or less (better);
- (b) Resonator alignment equipment having bandwidths equal to or more than 100 Hz and an “accuracy” of 10  $\mu$ rad or less (better); *(L.N. 42 of 2017)*
- (3) Gimbals having all of the following:
- (a) A maximum slew exceeding  $5^\circ$ ;
  - (b) A bandwidth of 100 Hz or more;
  - (c) Angular pointing errors of 200  $\mu$ 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)/s<sup>2</sup>; *or*
    - (2) Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0.5 rad (radians)/s<sup>2</sup>;
- (4) *(Repealed L.N. 42 of 2017)*
- (e) ‘Aspheric optical elements’ having all of the following characteristics: *(L.N. 85 of 2023)*
- (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  $3 \times 10^{-6}/\text{K}$  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: *(L.N. 85 of 2023)*

- (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*)

- (f) Dynamic wavefront measuring equipment having all of the following:

- (1) ‘Frame rates’ equal to or more than 1 kHz;
- (2) A wavefront accuracy equal to or less (better) than  $\lambda/20$  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. (*L.N. 89 of 2021*)

(*L.N. 85 of 2023*)

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, CO<sub>2</sub>, 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 1 minute. (*L.N. 85 of 2023*)

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.
6. For the purposes of 6A005(a) and 6A005(b), ‘single transverse mode’ refers to “lasers” with a beam profile having an M<sup>2</sup>-factor of less than 1.3, while ‘multiple transverse mode’ refers to “lasers” with a beam profile having an M<sup>2</sup>-factor of 1.3 or higher. (*L.N. 85 of 2023*)

*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 or conditioning and thermal conditioning or heat exchanger. (*L.N. 42 of 2017*)

(a) Non-“tunable” continuous wave “(CW) lasers” having any of the following: (*L.N. 42 of 2017*)

- (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 include 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: (*L.N. 42 of 2017*)

- (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: (*L.N. 42 of 2017*)

- (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: (*L.N. 42 of 2017*)

(a) ‘Single transverse mode’ output and:

- (1) Output power exceeding 1 000 W; *or*
- (2) Output power exceeding 500 W and spectral bandwidth less than 40 GHz; *or (L.N. 85 of 2023)*

(b) ‘Multiple transverse mode’ output and: (*L.N. 42 of 2017; L.N. 85 of 2023*)

- (1) ‘Wall-plug efficiency’ exceeding 18% and output power exceeding 1 000 W; *or*
- (2) Output power exceeding 2 kW;

*Notes:*

1. 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 1 200 kg. For the purposes of this Note, total mass includes all components required to operate the “laser”, e.g. “laser”, power supply, heat exchanger, but excludes external optics for beam conditioning or delivery, or both.
2. 6A005(a)(6)(b) does not include ‘multiple transverse mode’, industrial “lasers” that meet any of the following descriptions: (*L.N. 85 of 2023*)
  - (a) (*Repealed L.N. 85 of 2023*)

- (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)-(g) *(Repealed L.N. 85 of 2023)*
- (h) Output power exceeding 6 kW but not exceeding 8 kW and having a BPP exceeding 12 mm•mrad;
- (i) Output power exceeding 8 kW but not exceeding 10 kW and having a BPP exceeding 24 mm•mrad.

*Technical Note:*

*(Repealed L.N. 85 of 2023)*

- (7) Output wavelength exceeding 1 150 nm but not exceeding 1 555 nm and having either of the following:
  - (a) ‘Single transverse mode’ and output power exceeding 50 W;
  - (b) ‘Multiple transverse mode’ and output power exceeding 80 W; *(L.N. 42 of 2017)*
- (8) Output wavelength exceeding 1 555 nm but not exceeding 1 850 nm and output power exceeding 1 W; *(L.N. 89 of 2021)*
- (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;
  - (b) ‘Multiple transverse mode’ output and output power exceeding 120 W; *(L.N. 89 of 2021)*
- (10) Output wavelength exceeding 2 100 nm and output power exceeding 1 W; *(L.N. 89 of 2021)*
- (b) Non-“tunable” “pulsed lasers” having any of the following: *(L.N. 42 of 2017)*
  - (1) Output wavelength less than 150 nm and: *(L.N. 42 of 2017)*
    - (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: *(L.N. 42 of 2017)*
    - (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 510 nm but not exceeding 540 nm and: *(L.N. 42 of 2017)*
  - (a) ‘Single transverse mode’ output and: *(L.N. 42 of 2017; L.N. 85 of 2023)*
    - (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: *(L.N. 42 of 2017; L.N. 85 of 2023)*
    - (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:
  - (a) “Pulse duration” less than 1 ps and:
    - (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:
    - (1) Output energy exceeding 1.5 J per pulse and “peak power” exceeding 30 W; *or*
    - (2) “Average output power” exceeding 30 W; *(L.N. 42 of 2017)*
- (5) Output wavelength exceeding 800 nm but not exceeding 975 nm and: *(L.N. 42 of 2017)*
  - (a) “Pulse duration” less than 1 ps and: *(L.N. 42 of 2017)*
    - (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;
    - (3) *(Repealed L.N. 42 of 2017)*
  - (b) “Pulse duration” equal to or exceeding 1 ps and not exceeding 1  $\mu$ s and: *(L.N. 42 of 2017)*
    - (1) Output energy exceeding 0.5 J per pulse and “peak power” exceeding 50 W; *(L.N. 89 of 2021)*
    - (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  $\mu$ s and:
    - (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; *(L.N. 42 of 2017)*
- (6) Output wavelength exceeding 975 nm but not exceeding 1 150 nm and: *(L.N. 42 of 2017)*
  - (a) ‘Pulse duration’ of less than 1 ps and:
    - (1) Output ‘peak power’ exceeding 2 GW per pulse;
    - (2) ‘Average output power’ exceeding 30 W; *or (L.N. 89 of 2021)*
    - (3) Output energy exceeding 0.002 J per pulse;
  - (b) ‘Pulse duration’ equal to or exceeding 1 ps and less than 1 ns and:
    - (1) Output ‘peak power’ exceeding 5 GW per pulse;
    - (2) ‘Average output power’ exceeding 50 W; *or (L.N. 89 of 2021)*
    - (3) Output energy exceeding 0.1 J per pulse;
  - (c) ‘Pulse duration’ equal to or exceeding 1 ns but not exceeding 1  $\mu$ s and:
    - (1) ‘Single transverse mode’ output and: *(L.N. 85 of 2023)*
      - (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: *(L.N. 85 of 2023)*
      - (a) ‘Peak power’ exceeding 400 MW;
      - (b) ‘Wall-plug efficiency’ exceeding 18% and ‘average output power’ exceeding 500 W;
      - (c) ‘Average output power’ exceeding 2 kW; *or*
      - (d) Output energy exceeding 4 J per pulse; *or*
  - (d) ‘Pulse duration’ exceeding 1  $\mu$ s and:
    - (1) ‘Single transverse mode’ output and: *(L.N. 85 of 2023)*
      - (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: *(L.N. 85 of 2023)*
      - (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: *(L.N. 42 of 2017)*
- (a) “Pulse duration” not exceeding 1  $\mu$ s and: *(L.N. 42 of 2017)*
- (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  $\mu$ s and: *(L.N. 42 of 2017)*
- (1) Output energy exceeding 2 J per pulse and “peak power” exceeding 50 W;
  - (2) ‘Single transverse mode’ output and “average output power” exceeding 50 W; *or*
  - (3) ‘Multiple transverse mode’ output and “average output power” exceeding 80 W;
- (8) Output wavelength exceeding 1 555 nm but not exceeding 1 850 nm and: *(L.N. 42 of 2017; L.N. 89 of 2021)*
- (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:
- (a) ‘Single transverse mode’ and any of the following: *(L.N. 85 of 2023)*
- (1) Output energy exceeding 100 mJ per pulse and “peak power” exceeding 1 W;
  - (2) “Average output power” exceeding 1 W; *or*
- (b) ‘Multiple transverse mode’ and any of the following: *(L.N. 85 of 2023)*
- (1) Output energy exceeding 100 mJ per pulse and “peak power” exceeding 10 kW;
  - (2) “Average output power” exceeding 120 W; *(L.N. 89 of 2021)*
- (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;
- (b) “Average output power” exceeding 1 W; *(L.N. 89 of 2021)*
- (c) “Tunable” “lasers” having any of the following characteristics:
- Note:*
- (Repealed L.N. 42 of 2017)*
- (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;
- Note:*

6A005(c)(1) does not apply to dye “lasers” or other liquid “lasers”, having a multimode output and a wavelength of 150 nm or more but not exceeding 600 nm and all of the following: *(L.N. 85 of 2023)*

- (1) Output energy less than 1.5 J per pulse or a “peak power” less than 20 W;
- (2) Average or CW output power less than 20 W. *(L.N. 161 of 2011)*
- (2) Output wavelength of 600 nm or more but not exceeding 1 400 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 1 400 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 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:
  - (1) Wavelength of less than 1 400 nm and average or CW output power exceeding 25 W; *(L.N. 161 of 2011)*
  - (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: *(L.N. 161 of 2011)*
  - (1) Wavelength of less than 1 400 nm and average or CW output power exceeding 100 W; *(L.N. 161 of 2011)*
  - (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; *and*
- (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<sup>2</sup>;
  - (b) Average or CW total output power equal to or exceeding 3 kW but less than or equal to 5 kW, and having average or CW output ‘power density’ greater than 350W/cm<sup>2</sup>;
  - (c) Average or CW total output power exceeding 5 kW;
  - (d) Peak pulsed ‘power density’ exceeding 2 500 W/cm<sup>2</sup>;

*Note:*

6A005(d)(1)(d)(1)(d) does not control epitaxially-fabricated monolithic devices. (*L.N. 89 of 2021*)

- (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<sup>2</sup>;
  - (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<sup>2</sup>;
  - (c) Average or CW total output power exceeding 500 W;
  - (d) Peak pulsed ‘power density’ exceeding 500 W/cm<sup>2</sup>;

*Note:*

6A005(d)(1)(d)(2)(d) does not control epitaxially-fabricated monolithic devices. (*L.N. 89 of 2021*)

- (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<sup>2</sup>;
  - (b) Average or CW output power greater than 10 W;
  - (c) Spatially coherent average or CW total output power, exceeding 1.5 W;

- (4) At least one “laser” ‘bar’ specified by 6A005(d)(1)(c);

*Technical Note:*

For the purposes of 6A005(d)(1)(d), ‘power density’ means the total “laser” output power divided by the emitter surface area of the ‘stacked array’. (*L.N. 161 of 2011*)

- (e) Semiconductor “laser” ‘stacked arrays’, other than those specified by 6A005(d)(1)(d), having all of the following:
  - (1) Specially designed or modified to be combined with other ‘stacked arrays’ to form a larger ‘stacked array’;

- (2) Integrated connections, common for both electronics and cooling;

*Notes:*

1. 'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified by 6A005(d)(1)(e), that are not designed to be further combined or modified are specified by 6A005(d)(1)(d).
2. 'Stacked arrays', formed by combining semiconductor "laser" 'stacked arrays' specified by 6A005(d)(1)(e), that are designed to be further combined or modified are specified by 6A005(d)(1)(e).
3. 6A005(d)(1)(e) does not control modular assemblies of single 'bars' designed to be fabricated into end-to-end stacked linear arrays. (*L.N. 161 of 2011*)

*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". (*L.N. 161 of 2011*)
- (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 (CO<sub>2</sub>) "lasers" having:
    - (a) CW output power exceeding 15 kW;
    - (b) Pulsed output with a "pulse duration" exceeding 10 μs 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 μs 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”;
  - (c) “Transfer lasers” as follows:
    - (1) Oxygen Iodine (O<sub>2</sub>-I) “lasers”;
    - (2) Deuterium Fluoride-Carbon dioxide (DF-CO<sub>2</sub>) “lasers”;
- (6) ‘Non-repetitive pulsed’ Nd: glass “lasers” having:
  - (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 or Multi-Layer Dielectric gratings (MLDs), specially designed for use with specified “lasers”;

*Note:*

Fibre combiners and MLDs are specified in 6A005(e)(3).

- (3) Fibre “laser” components, as follows: (*L.N. 85 of 2023*)
  - (a) Multimode-to-multimode fused tapered fibre combiners having:
    - (1) An insertion loss better (less) than or equal to 0.3 dB maintained at a rated total average or CW output power exceeding 1 000 W, excluding any output power transmitted through the single mode core (if any); *and*
    - (2) At least 3 input fibres;
  - (b) Single mode to multimode fused tapered fibre combiners having:
    - (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) At least 3 input fibres; *and*
    - (3) Any of the following:

- (a) A Beam Parameter Product (BPP) measured at an output not exceeding 1.5 mm mrad for less than or equal to 5 input fibres; (*L.N. 89 of 2021*)
- (b) A BPP measured at an output not exceeding 2.5 mm mrad for more than 5 input fibres; (*L.N. 42 of 2017*)
- (c) (*Repealed L.N. 85 of 2023*)
- (c) MLDs:
  - (1) that are designed for the spectral or coherent beam combination of 5 or more fibre “lasers”; and
  - (2) that have a CW “Laser” Induced Damage Threshold (LIDT) that is equal to or greater than 10 kW/cm<sup>2</sup>; (*L.N. 85 of 2023*)
- (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) (*Repealed L.N. 89 of 2021*)
- (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); (*L.N. 89 of 2021*)
- (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;
  - (b) An “accuracy” of  $\lambda/10$  or less (better) at the designed wavelength, for wavelengths equal to or less than 1 µm; (*L.N. 89 of 2021*)
- (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<sup>3</sup>;

*Technical Note:*

‘Laser acoustic detection equipment’ is sometimes referred to as a Laser Microphone or Particle Flow Detection Microphone. (*L.N. 161 of 2011*)

*Technical Note:*

(*Repealed L.N. 42 of 2017*)

(*L.N. 254 of 2008; L.N. 42 of 2017; L.N. 85 of 2023*)

6A006 “Magnetometers”, “magnetic gradiometers”, “intrinsic magnetic gradiometers”, underwater electric field sensors, “compensation systems”, and specially designed components therefor, as follows: (*L.N. 254 of 2008; L.N. 85 of 2023*)

*N.B.:*

See also 7A103(d). (*L.N. 42 of 2017*)

*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; (*L.N. 226 of 2009*)

(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)  $1 \times 10^{-3}$  nT (rms)/square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; *or*

(c)  $1 \times 10^{-4}$  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)*
- (e) Underwater electromagnetic receivers incorporating magnetic field sensors specified by 6A006(a) or underwater electric field sensors specified by 6A006(b); *(L.N. 161 of 2011)*

*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 and having a static “accuracy” of less (better) than 10 µGal; *(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 and, having all of the following: *(L.N. 183 of 1999; L.N. 42 of 2017)*

- (1) A static “accuracy” of less (better) than 0.7 mGal;
- (2) An in-service (operational) “accuracy” of less (better) than 0.7 mGal having a ‘time-to-steady-state registration’ of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

*Technical Note:*

For the purposes of 6A007(b)(2), ‘time-to-steady-state registration’ (also referred to as the gravimeter’s response time) is the time over which the disturbing effects of platform induced accelerations (high frequency noise) are reduced. *(L.N. 42 of 2017)*

- (c) Gravity gradiometers;

*(L.N. 42 of 2017; L.N. 85 of 2023)*

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); (*L.N. 161 of 2011*)
- (d) Meteorological (weather) radar; (*L.N. 161 of 2011*)
- (e) Precision Approach Radar (PAR) equipment conforming to ICAO standards and employing electronically steerable linear (1-dimensional) arrays or mechanically positioned passive antennae. (*L.N. 161 of 2011*)
- (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; L.N. 85 of 2023*)
- (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. (*L.N. 85 of 2023*)
- (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. (*L.N. 85 of 2023*)
- (f) Capable of heightfinding non-cooperative targets; (*L.N. 161 of 2011*)
- (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; (*L.N. 85 of 2023*)

*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 of the following conditions are met: (*L.N. 85 of 2023*)
  - (1) It has a maximum ‘instrumented range’ of 500 km or less; (*L.N. 85 of 2023*)
  - (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)

*Technical Note:*

For the purposes of 6A008(i), ‘instrumented range’ is the specified unambiguous display range of a radar. (L.N. 85 of 2023)

(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; L.N. 161 of 2011)
- (2) Employing coherent heterodyne or homodyne detection techniques and having an angular resolution of less (better) than 20  $\mu$ 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; L.N. 85 of 2023)

*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 compressed pulse width of less than 200 ns;

*Note:*

6A008(k)(2) does not control 2-dimensional ‘marine radar’ or ‘vessel traffic service’ radar, that meets all of the following descriptions:

- (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;
  - (e) Not capable of “frequency hopping”. (*L.N. 42 of 2017*)
- (1) Having data processing sub-systems that meet any of the following descriptions: (*L.N. 42 of 2017*)
- (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 radar’. (*L.N. 161 of 2011; L.N. 42 of 2017*)
  - (2)-(3) (*Repealed L.N. 161 of 2011*)
  - (4) Configured to provide superposition and correlation, or fusion, of target data within six seconds from two or more “geographically dispersed” radar sensors to improve the aggregate performance beyond that of any single sensor specified by 6A008(f) or 6A008(i);  
*N.B.:*  
See also the Munitions List.  
*Note:*  
6A008(l)(4) does not control systems, equipment and assemblies designed for ‘vessel traffic service’. (*L.N. 161 of 2011; L.N. 42 of 2017; L.N. 85 of 2023*)

*Technical Notes:*

1. For the purposes of 6A008, ‘marine radar’ is a radar that is designed to navigate safely at sea, inland waterways or near-shore environments.
2. For the purposes of 6A008, ‘vessel traffic service’ is a vessel traffic monitoring and control service similar to air traffic control for “aircraft”. (*L.N. 42 of 2017; L.N. 85 of 2023*)

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  $5 \times 10^5$  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. This includes devices that sense by one time operation or failure. (*L.N. 65 of 2004; L.N. 85 of 2023*)

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; *(L.N. 65 of 2004)*
- (b) Specially designed components for gravity meters specified in 6A007(b) or 6A107(a) and gravity gradiometers specified in 6A007(c); *(L.N. 183 of 1999)*

*(L.N. 42 of 2017)*

6A108 Radar systems, tracking systems and radomes, other than those controlled by 6A008, as follows: *(L.N. 85 of 2023)*

- (a) Radar and laser radar systems designed or modified for use in space launch vehicles controlled by 9A004 or sounding rockets controlled by 9A104; *(L.N. 183 of 1999; L.N. 95 of 2006; L.N. 89 of 2021)*

*Note:*

6A108(a) includes the following:

- (a) Terrain contour mapping equipment;
- (b) Scene mapping and correlation (both digital and analogue) equipment; *(L.N. 89 of 2021)*
- (c) Doppler navigation radar equipment; *(L.N. 89 of 2021)*
- (d) Passive interferometer equipment; *(L.N. 89 of 2021)*
- (e) Imaging sensor equipment (both active and passive). *(L.N. 89 of 2021)*
- (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; *(L.N. 161 of 2011)*
  - (2) Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:
    - (a) Angular resolution better than 1.5 milliradians; *(L.N. 254 of 2008; L.N. 89 of 2021)*
    - (b) Range of 30 km or greater with a range resolution better than 10 m rms;
    - (c) Velocity resolution better than 3 m/s; *(L.N. 226 of 2009)*

*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. 85 of 2023)*

- (c) Radomes designed to withstand a combined thermal shock greater than  $4.184 \times 10^6$  J/m<sup>2</sup> accompanied 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); *(L.N. 85 of 2023)*

6A202 Photomultiplier tubes having both of the following characteristics:

- (a) Photocathode area of greater than 20 cm<sup>2</sup>; *and*
- (b) Anode pulse rise time of less than 1 ns;

*(L.N. 65 of 2004)*

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 an imaging device to meet the characteristics of 6A203(a), 6A203(b) or 6A203(c) is specified in 6D203.
- 2. “Technology” in the form of keys or codes to enhance or release the performance of a camera or an imaging device to meet the characteristics of 6A203(a), 6A203(b) or 6A203(c) is specified in 6E203.

*Note:*

6A203(a), 6A203(b) and 6A203(c) does not control cameras or imaging devices that have hardware, “software” or “technology” constraints limiting their performance to less than that specified in 6A203(a), 6A203(b) and 6A203(c), if such cameras or imaging devices meet any of the following descriptions: *(L.N. 89 of 2021)*

- (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;
- (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 for such cameras, 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 that have modular structures and that enable the streak cameras to achieve the performance specifications in 6A203(a)(1) or 6A203(a)(2); *(L.N. 85 of 2023)*
  - (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 for such cameras, 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 that have modular structures and that enable the framing cameras to achieve the performance specifications in 6A203(b)(1) or 6A203(b)(2); *(L.N. 85 of 2023)*
- (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 cameras or electron tube cameras, and specially designed components for such cameras, as follows:
  - (1) Solid-state cameras or electron tube cameras having a fast-image gating (shutter) time of 50 ns or less;
  - (2) Solid-state imaging devices and image intensifier 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) having a fast-image gating (shutter) time of 50 ns or less;
  - (4) Plug-ins specially designed for use with cameras that have modular structures and that enable the cameras to achieve the performance specifications in 6A203(c)(1); *(L.N. 85 of 2023)*
- (d) Radiation-hardened TV cameras, or lenses for such cameras, specially designed or rated as radiation-hardened to withstand a total radiation dose greater than  $50 \times 10^3$  Gy (Silicon) ( $5 \times 10^6$  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 ionizing radiation.

*(L.N. 42 of 2017)*

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 (CO<sub>2</sub>) “lasers” having all of the following characteristics: (*L.N. 85 of 2023*)

- (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 less than 200 ns; (*L.N. 65 of 2004*)

(e) Para-hydrogen Raman shifters designed to operate at 16 µm output wavelength and at a repetition rate greater than 250 Hz; (*L.N. 65 of 2004; L.N. 42 of 2017*)

(f) Neodymium-doped (other than glass) “lasers” with an output wavelength between 1 000 nm and 1 100 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 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*)

(g) Pulsed carbon monoxide (CO) “lasers”, other than those specified in 6A005(d)(2), that meet all of the following descriptions: (*L.N. 85 of 2023*)

- (1) Operating at wavelengths between 5 000 nm and 6 000 nm;
- (2) A repetition rate greater than 250 Hz;
- (3) An “average output power” greater than 200 W;
- (4) Pulse width of less than 200 ns; (*L.N. 42 of 2017*)

*N.B.:*

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

(*L.N. 85 of 2023*)

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). *(L.N. 42 of 2017)*

*(L.N. 65 of 2004)*

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<sub>2</sub>); *or (L.N. 42 of 2017; L.N. 89 of 2021)*
- (b) Quartz pressure transducers for pressures greater than 10 GPa; *(L.N. 132 of 2001; L.N. 42 of 2017)*

*(L.N. 161 of 2011)*

## 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);

*(L.N. 85 of 2023)*

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; *(L.N. 89 of 2021)*
- (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;

*(L.N. 42 of 2017; L.N. 85 of 2023)*

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’; *(L.N. 85 of 2023)*
  - (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; L.N. 85 of 2023)*

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: *(L.N. 42 of 2017)*
  - (1) A volume greater than 100 cm<sup>3</sup>; *or*
  - (2) A diameter greater than 80 mm and a thickness of 20 mm or more; *(L.N. 42 of 2017)*
- (b) Electro-optic materials and non-linear optical materials, as follows: *(L.N. 42 of 2017)*
  - (1) Potassium titanyl arsenate (KTA) (CAS 59400-80-5);
  - (2) Silver gallium selenide (AgGaSe<sub>2</sub>, also known as AGSE) (CAS 12002-67-4); *(L.N. 42 of 2017)*
  - (3) Thallium arsenic selenide (Tl<sub>3</sub>AsSe<sub>3</sub>, also known as TAS) (CAS 16142-89-5); *(L.N. 161 of 2011)*
  - (4) Zinc germanium phosphide (ZnGeP<sub>2</sub>, also known as ZGP, zinc germanium biphosphide or zinc germanium diphosphide); *(L.N. 42 of 2017)*
  - (5) Gallium selenide (GaSe) (CAS 12024-11-2); *(L.N. 42 of 2017)*
- (c) Non-linear optical materials, other than those specified in 6C004(b), that meet any of the following descriptions:
  - (1) Having all of the following:

- (a) Dynamic (also known as non-stationary) third order non-linear susceptibility ( $\chi^{(3)}$ , chi 3) of  $10^{-6} \text{ m}^2/\text{V}^2$  or more;
- (b) Response time of less than 1 ms;
- (2) Second order non-linear susceptibility ( $\chi^{(2)}$ , chi 2) of  $3.3 \times 10^{-11} \text{ m/V}$  or more; (*L.N. 42 of 2017*)
- (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 ( $\text{ZrF}_4$ ) (CAS 7783-64-4) and hafnium fluoride ( $\text{HfF}_4$ ) (CAS 13709-52-9), having all of the following: (*L.N. 161 of 2011*)
  - (1) A hydroxyl ion ( $\text{OH}^-$ ) 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  $5 \times 10^{-6}$ ;
- (f) Synthetically produced diamond material with an absorption of less than  $10^{-5} \text{ cm}^{-1}$  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;
- (b) Rare-earth-metal doped double-clad fibres that have:
  - (1) A nominal “laser” wavelength of 975 nm to 1 150 nm, with: (*L.N. 85 of 2023*)
    - (a) An average core diameter that is equal to or greater than 25  $\mu\text{m}$ ; *and*
    - (b) A core ‘Numerical Aperture’ (‘NA’) that is less than 0.065; *or*
  - Note:*  
6C005(b)(1) does not control double-clad fibres that have an inner glass cladding diameter exceeding 150  $\mu\text{m}$  but not exceeding 300  $\mu\text{m}$ .
  - (2) A nominal “laser” wavelength exceeding 1 530 nm, with: (*L.N. 85 of 2023*)
    - (a) An average core diameter that is equal to or greater than 20  $\mu\text{m}$ ; *and*
    - (b) A core ‘Numerical Aperture’ (‘NA’) that is less than 0.1;

*Technical Notes:*

1. For the purposes of 6C005(b), core ‘Numerical Aperture’ (‘NA’) is measured at the emission wavelengths of the fibre.
2. 6C005(b) includes fibres assembled with end caps.

*(L.N. 42 of 2017; L.N. 85 of 2023)*

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

*N.B.:*

For diver detection “software” or “source code”, specially designed or modified for military use, see the Munitions List. (*L.N. 161 of 2011*)

- (b) Deleted; (*L.N. 226 of 2009*)
- (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); (*L.N. 226 of 2009*)
- (d) “Software” specially designed to maintain the alignment and phasing of segmented mirror systems that consist of mirror segments with a diameter or major axis length that is equal to or greater than 1 m; (*L.N. 226 of 2009; L.N. 42 of 2017; L.N. 85 of 2023*)
- (e) Deleted; (*L.N. 226 of 2009*)
- (f) (1) “Software” specially designed for magnetic and electric field “compensation systems” for magnetic sensors designed to operate on mobile platforms; (*L.N. 85 of 2023*)
- (2) “Software” specially designed for magnetic and electric field anomaly detection on mobile platforms; (*L.N. 95 of 2006*)
- (3) “Software” specially designed for “real time processing” of electromagnetic data using underwater electromagnetic receivers specified by 6A006(e); (*L.N. 161 of 2011*)
- (4) “Source code” for “real time processing” of electromagnetic data using underwater electromagnetic receivers specified by 6A006(e); (*L.N. 161 of 2011*)

- (g) “Software” specially designed to correct motional influences of gravity meters or gravity gradiometers;
- (h) (1) Air Traffic Control (ATC) “software” 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; *(L.N. 161 of 2011; L.N. 85 of 2023)*
- (2) “Software” for the design or “production” of radomes which:
  - (a) Are specially designed to protect the electronically scanned array antennae controlled by 6A008(e); *and (L.N. 85 of 2023)*
  - (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 or modified for the “use” of goods controlled by 6A108;  
*(L.N. 89 of 2021)*

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; L.N. 85 of 2023)*

6D203 “Software” specially designed to enhance or release the performance of a camera or an imaging device to meet the characteristics of 6A203(a), 6A203(b) or 6A203(c);  
*(L.N. 42 of 2017)*

## 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 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  $5 \times 10^{-3}$ ; (*L.N. 161 of 2011*)
- 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. (*L.N. 161 of 2011*)
- (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 m<sup>2</sup>; (*L.N. 85 of 2023*)
- (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 6A002, 6A007 and 6A008 when it is designed for airborne applications and is usable in “missiles”. (*L.N. 89 of 2021*)
- 
- 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;
- Notes:*
1. 6E201 only controls “technology” for cameras specified in 6A003 if the cameras are also specified in any of the control parameters of 6A203.
  2. 6E201 only controls “technology” for “lasers” in 6A005(b)(6) that are neodymium-doped and specified in any of the control parameters of 6A205(f). (*L.N. 89 of 2021*)
- (*L.N. 254 of 2008*)
- 
- 6E203 “Technology” in the form of keys or codes to enhance or release the performance of a camera or an imaging device to meet the characteristics of 6A203(a), 6A203(b) and 6A203(c);

*(L.N. 42 of 2017)*