CATEGORY 6 - SENSORS AND LASERS

6A Systems, Equipment and Components

6A001 Acoustics:

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

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

Note: *6A001.a.1. does not control:*

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

b. Acoustic beacons, as follows:

1. Acoustic emergency beacons;

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

a. Wide-swath bathymetric survey systems designed for sea bed topographic mapping, having all of the following:
   1. Being designed to take measurements at an angle exceeding 20° from the vertical;
   2. Being designed to measure depths exceeding 600 m below the water surface; and
   3. Being designed to provide any of the following:
      a. Incorporation of multiple beams any of which is less than 1.9°; or
      b. Data accuracies of better than 0.3% of water depth across the swath averaged over the individual measurements within the swath;

b. Object detection or location systems having any of the following:
   1. A transmitting frequency below 10 kHz;
   2. Sound pressure level exceeding 224 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band from 10 kHz to 24 kHz inclusive;
   3. Sound pressure level exceeding 235 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band between 24 kHz and 30 kHz;
   4. Forming beams of less than 1° on any axis and having an operating frequency of less than 100 kHz;
   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, having any of the following:
   Note 1: *The control status of acoustic projectors, including transducers, specially designed for other equipment is determined by the control status of the other equipment.*
   Note 2: *6A001.a.1.c. does not control electronic sources which direct the sound vertically only, or mechanical (e.g., air gun or vapour-shock gun) or chemical (e.g., explosive) sources.*
   1. An instantaneous radiated 'acoustic power density' exceeding 0.01 $mW/mm^2/Hz$ for devices operating at frequencies below 10 kHz;
   2. A continuously radiated 'acoustic power density' exceeding 0.001 $mW/mm^2/Hz$ for devices operating at frequencies below 10 kHz; or

   Technical Note:
   'Acoustic power density' is obtained by dividing the output acoustic power by the product of the area of the radiating surface and the frequency of operation.
   3. Side-lobe suppression exceeding 22 dB;

d. Acoustic systems, equipment and specially designed components for determining the position of surface vessels or underwater vehicles designed to operate at a range exceeding 1,000 m with a positioning accuracy 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.

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

   a. Hydrophones having any of the following characteristics:
      Note: *The control status of hydrophones specially designed for other equipment is determined by the control status of the other equipment.*

      1. Incorporating continuous flexible sensing elements;

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

      3. Having any of the following sensing elements:
         a. Optical fibres;
         b. 'Piezoelectric polymer films' other than polyvinylidene-fluoride (PVDF) and its co-polymers {P(VDF-TrFE) and P(VDF-TFE)}; or
         c. 'Flexible piezoelectric composites';

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

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

      6. Designed for operation at depths exceeding 1,000 m;

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

b. Towed acoustic hydrophone arrays having any of the following:
   1. Hydrophone group spacing of less than 12.5 m or 'able to be modified' to have hydrophone group spacing of less than 12.5 m;
   2. Designed or 'able to be modified' to operate at depths exceeding 35 m;
      Technical Note:
      'Able to be modified' in 6A001.a.2.b.1. and 2. means having provisions to allow a change of the wiring or interconnections to alter hydrophone group spacing or operating depth limits. These provisions are: spare wiring exceeding 10% of the number of wires, hydrophone group spacing adjustment blocks or internal depth limiting devices that are adjustable or that control more than one hydrophone group.
   3. Heading sensors specified in 6A001.a.2.d.;
   4. Longitudinally reinforced array hoses;
   5. An assembled array of less than 40 mm in diameter;
   6. Multiplexed hydrophone group signals 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; or
   7. Hydrophone characteristics specified in 6A001.a.2.a.;

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 beam forming using Fast Fourier or other transforms or processes;

d. Heading sensors having all of the following:
   1. An accuracy of better than ± 0.5°; and
   2. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m;

e. Bottom or bay cable systems having any of the following:
   1. Incorporating hydrophones specified in 6A001.a.2.a.; or
   2. Incorporating multiplexed hydrophone group signal modules having all of the following characteristics:
      a. Designed to operate at depths exceeding 35 m or having an adjustable or removable depth sensing device in order to operate at depths exceeding 35 m; and
      b. Capable of being operationally interchanged with towed acoustic hydrophone array modules;

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 beam forming using Fast Fourier or other transforms or processes;

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

6A002 Optical sensors

N.B.: SEE ALSO 6A102.

a. Optical detectors, as follows:

Note: *6A002.a. does not control germanium or silicon photodevices.*

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

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

a. "Space-qualified" solid-state detectors, having all of the following:
1. A peak response in the wavelength range exceeding 10 nm but not exceeding 300 nm; and
2. A response of less than 0.1% relative to the peak response at a wavelength exceeding 400 nm;

b. "Space-qualified" solid-state detectors, having all of the following:
1. A peak response in the wavelength range exceeding 900 nm but not exceeding 1,200 nm; and
2. A response "time constant" of 95 ns or less;

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

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

a. Image intensifier tubes having all of the following:
1. A peak response in the wavelength range exceeding 400 nm but not exceeding 1,050 nm;
2. A microchannel plate for electron image amplification with a hole pitch (centre-to-centre spacing) of 12 μm or less; and
3. Any of the following photocathodes:

a. S-20, S-25 or multialkali photocathodes with a luminous sensitivity exceeding 350 µA/lm;
b. GaAs or GaInAs photocathodes; or
c. Other III-V compound semiconductor photocathodes;
Note: *6A002.a.2.a.3.c. does not apply to compound semiconductor photocathodes with a maximum radiant sensitivity of 10 mA/W or less.*

b. Specially designed components, as follows:
1. Microchannel plates having a hole pitch (centre-to-centre spacing) of 12 µm or less;
2. GaAs or GaInAs photocathodes;
3. Other III-V compound semiconductor photocathodes;
Note: *6A002.a.2.b.3. does not control compound semiconductor photocathodes with a maximum radiant sensitivity of 10 mA/W or less.*

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

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

Technical Notes:
1. *Linear or two-dimensional multi-element detector arrays are referred to as "focal plane arrays";*
2. *For the purposes of 6A002.a.3. 'cross scan direction' is defined as the axis parallel to the linear array of detector elements and the 'scan direction' is defined as the axis perpendicular to the linear array of detector elements.*

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

Note 2: *6A002.a.3. does not control:*
a. Multi-element (not to exceed 16 elements) encapsulated photoconductive cells using either lead sulphide or lead selenide;
b. Pyroelectric detectors using any of the following:
1. Triglycine sulphate and variants;
2. Lead-lanthanum-zirconium titanate and variants;
3. Lithium tantalate;
4. Polyvinylidene fluoride and variants; or
5. Strontium barium niobate and variants.

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

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

b. Non-"space-qualified" "focal plane arrays", having all of the following:
1. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; and
2. A response "time constant" of 95 ns or less;

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 6A.002.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; and
2. Any of the following:
a. A ratio of scan direction dimension of the detector element to the cross-scan direction dimension of the detector element of less than 3.8; or
b. Signal processing in the element (SPRITE);

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 'micro-bolometer' 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. 'micro-bolometer' is defined as a thermal imaging detector that, as a result of a temperature change in the detector caused by the absorption of infrared radiation, is used to generate any usable signal.

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 µrad (microradians); or

2. Being specified for operation in the wavelength range exceeding 400 nm but not exceeding 30,000 nm and having all the following:
   a. Providing output imaging data in digital format; and
   b. Being any of the following:
      1. "Space-qualified"; or
      2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2.5 mrad (milliradians).

c. 'Direct view' imaging equipment operating in the visible or infrared spectrum, incorporating any of the following:
   1. Image intensifier tubes specified in 6A002.a.2.a. ; or
   2. "Focal plane arrays" specified in 6A002.a.3.

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

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

d. Special support components for optical sensors, as follows:
   1. "Space-qualified" cryocoolers;
   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.

e. "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.

6A003 Cameras

N.B.: **SEE ALSO 6A203.**

N.B.: *For cameras specially designed or modified for underwater use, see 8A002.d. and 8A002.e.*

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

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

1. High-speed cinema recording cameras using any film format from 8 mm to 16 mm inclusive, in which the film is continuously advanced throughout the recording period, and that are capable of recording at framing rates exceeding 13,150 frames/s;
   Note: *6A003.a.1. does not control cinema recording cameras designed for civil purposes.*

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

3. Mechanical or electronic streak cameras having writing speeds exceeding 10mm/μs;

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

5. Electronic cameras, having all of the following:
   a. An electronic shutter speed (gating capability) of less than 1 μs per full frame; and
   b. A read out time allowing a framing rate of more than 125 full frames per second.

6. Plug-ins, having all of the following characteristics:
   a. Specially designed for instrumentation cameras which have modular structures and which are specified in 6A003.a.; and
   b. Enabling these cameras to meet the characteristics specified in 6A003.a.3., 6A003.a.4., or 6A003.a.5., according to the manufacturer's specifications.

b. Imaging cameras, as follows:

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

1. Video cameras incorporating solid state sensors, having a peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm and having all of the following:
   a. Having any of the following:
      1. More than 4 x 10^6 "active pixels" per solid state array for monochrome (black and white) cameras;
      2. More than 4 x 10^6 "active pixels" per solid state array for colour cameras incorporating three solid state arrays; or
      3. More than 12 x 10^6 "active pixels" for solid state array colour cameras incorporating one solid state array; and
   b. Having any of the following:
      1. Optical mirrors controlled by 6A004.a.;
      2. Optical control equipment controlled by 6A004.d.; or
      3. The capability for annotating internally generated camera tracking data.

   Technical Notes:
   1. For the purpose of this entry, digital video cameras should be evaluated by the maximum number of "active pixels" used for capturing moving images.
   2. For the purpose of this entry, camera tracking data is the information necessary to define camera line of sight orientation with respect to the earth. This includes: 1) the horizontal angle the camera line of sight makes with respect to the earth's magnetic field direction and; 2) the vertical angle between the camera line of sight and the earth's horizon.

2. Scanning cameras and scanning camera systems, having all of the following:
   a. A peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm;
   b. Linear detector arrays with more than 8,192 elements per array; and
   c. Mechanical scanning in one direction;

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

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

   a. Incorporating "focal plane arrays" controlled by 6A002.a.3.a. to 6A002.a.3.e.; or

b. Incorporating "focal plane arrays" controlled by 6A002.a.3.f.

Note 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.*

Note 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.*

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

- *a. A maximum frame rate equal to or less than 9 Hz;*
- *b. Having all of the following:*
  - *1. Having a minimum horizontal or vertical Instantaneous-Field-of-View (IFOV) of at least 10 mrad/pixel (milliradians/pixel);*
  - *2. Incorporating a fixed focal-length lens that is not designed to be removed;*
  - *3. Not incorporating a 'direct view' display; and*
  - *4. Having any of the following:*
    - *a. No facility to obtain a viewable image of the detected field-of-view, or*
    - *b. The camera is designed for a single kind of application and designed not to be user modified; or*
- *c. Where the camera is specially designed for installation into a civilian passenger land vehicle of less than three tonnes (gross vehicle weight) and having all of the following:*
  - *1. Is only operable when installed in any of the following:*
    - *a. The civilian passenger land vehicle for which it was intended; or*
    - *b. A specially designed, authorized maintenance test facility; and*

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

Technical Notes:

1. Instantaneous Field of View (IFOV) specified in 6A003.b.4. Note 3.b. is the lesser figure of the Horizontal IFOV or the Vertical IFOV.
Horizontal IFOV = horizontal Field of View (FOV) / number of horizontal detector elements
Vertical IFOV = vertical Field of View (FOV) / number of vertical detector elements.

2. 'Direct view' in 6A003.b.4. Note 3.b. refers to an imaging camera operating in the infrared spectrum that presents a visual image to a human observer using a near-to-eye micro display incorporating any light-security mechanism.

6A004 Optics

a. Optical mirrors (reflectors), as follows:
N.B.: For optical mirrors specially designed for lithography equipment, see 3B001.
1. "Deformable mirrors" having either continuous or multi-element surfaces, and specially designed components therefor, capable of dynamically repositioning portions of the surface of the mirror at rates exceeding 100 Hz;
2. Lightweight monolithic mirrors having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 10 kg;
3. Lightweight "composite" or foam mirror structures having an average "equivalent density" of less than 30 kg/m^2 and a total mass exceeding 2 kg;
4. Beam steering mirrors more than 100 mm in diameter or length of major axis, which maintain a flatness of lambda/2 or better (lambda is equal to 633 nm) having a control bandwidth exceeding 100 Hz.

b. Optical components made from zinc selenide (ZnSe) or zinc sulphide (ZnS) with transmission in the wavelength range exceeding 3,000 nm but not exceeding 25,000 nm and having any of the following:
1. Exceeding 100 cm^3 in volume; or
2. Exceeding 80 mm in diameter or length of major axis and 20 mm in thickness (depth).

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

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

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

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

4. Manufactured from "composite" materials having a coefficient of linear thermal expansion equal to or less than 5×10^{-6} in any coordinate direction.

d. Optical control equipment, as follows:

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

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

3. Gimbals having all of the following:
   a. A maximum slew exceeding 5°;
   b. A bandwidth of 100 Hz or more;
   c. Angular pointing errors of 200 µrad (microradians) or less; and
   d. Having any of the following:
      1. Exceeding 0.15 m but not exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 2 rad (radians)/s^2; or
      2. Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0.5 rad (radians)/s^2;

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

e. 'Aspheric optical elements' having all of the following characteristics:
   1. The largest dimension of the optical-aperture is greater than 400 mm;
   2. The surface roughness is less than 1 nm (rms) for sampling lengths equal to or greater than 1 mm; and
   3. The coefficient of linear thermal expansion's absolute magnitude is less than 3×10^{-6}/K at 25°C.

   Technical Notes:

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

6A004 e. continued

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

Note *6A004.e. does not control aspheric optical elements having any of the following:*
- a. *A largest optical-aperture dimension less than 1 m and a focal length to aperture ratio equal to or greater than 4.5:1;*
- b. *A largest optical-aperture dimension equal to or greater than 1 m and a focal length to aperture ratio equal to or greater than 7:1;*
- c. *Being designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;*
- d. *Being fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than $2.5x10^{-6}$ /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.*

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

N.B.: SEE ALSO 6A205.

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

Note 2: *Excimer, semiconductor, chemical, CO, CO_2, and non-repetitive pulsed Nd:glass "lasers" are only specified in 6A005.d.*

Note 3: *6.A005 includes fibre "lasers".*

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

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

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

6A005 continued

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

1. An output wavelength less than 150 nm with an output power exceeding 1 W;

2. An output wavelength of 150 nm or more but not exceeding 520 nm and having an output power exceeding 30 W;
   Note: *6.A005.a.2. does not control Argon "lasers" having an output power equal to or less than 50 W.*

3. An output wavelength exceeding 520 nm but not exceeding 540 nm and having any of the following:
   a. A single transverse mode output having an output power exceeding 50 W; or
   b. A multiple transverse mode output having an output power exceeding 150 W;

4. An output wavelength exceeding 540 nm but not exceeding 800 nm and having an output power exceeding 30 W;

5. An output wavelength exceeding 800 nm but not exceeding 975 nm and having any of the following:
   a. A single transverse mode output having an output power exceeding 50 W; or
   b. A multiple transverse mode output having an output power exceeding 80 W;

6. An output wavelength exceeding 975 nm but not exceeding 1,150 nm and having any of the following:
   a. A single transverse mode output having any of the following:
      1. A 'wall-plug efficiency' exceeding 12% and an output power exceeding 100 W; or
      2. An output power exceeding 150 W; or
   b. A multiple transverse mode output having any of the following:
      1. A 'wall-plug efficiency' exceeding 18% and an output power exceeding 500 W; or
      2. An output power exceeding 2 kW;
      Note: *6.A005.a.6.b. does not control multiple transverse mode, industrial "lasers" with output power exceeding 2 kW and not exceeding 6 kW with a total mass greater than 1,200 kg. For the purpose of this note, total mass includes all components required to operate the "laser", e.g., "laser", power supply, heat exchanger, but excludes external optics for beam conditioning and/or delivery.*

7. An output wavelength exceeding 1,150 nm but not exceeding 1,555 nm and having any of the following:
   a. A single transverse mode having an output power exceeding 50 W; or

b. A multiple transverse mode having an output power exceeding 80 W; or

8. An output wavelength exceeding 1,555 nm and having an output power exceeding 1 W.

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

1. An output wavelength less than 150 nm and having any of the following:
   a. An output energy exceeding 50 mJ per pulse and a "peak power" exceeding 1 W; or
   b. An "average output power" exceeding 1 W;

2. An output wavelength of 150 nm or more but not exceeding 520 nm and having any of the following:
   a. An output energy exceeding 1.5 J per pulse and a "peak power" exceeding 30 W; or
   b. An "average output power" exceeding 30 W;
      Note: *6.A005.b.2.b. does not control Argon "lasers" having an "average output power" equal to or less than 50 W.*

3. An output wavelength exceeding 520 nm but not exceeding 540 nm and having any of the following:
   a. A single transverse mode output having any of the following:
      1. An output energy exceeding 1.5 J per pulse and a "peak power" exceeding 50 W; or
      2. An "average output power" exceeding 50 W; or
   b. A multiple transverse mode output having any of the following:
      1. An output energy exceeding 1.5 J per pulse and a "peak power" exceeding 150 W; or
      2. An "average output power" exceeding 150 W;

4. An output wavelength exceeding 540 nm but not exceeding 800 nm and having any of the following:
   a. An output energy exceeding 1.5 J per pulse and a "peak power" exceeding 30 W; or
   b. An "average output power" exceeding 30 W;

5. An output wavelength exceeding 800 nm but not exceeding 975 nm and having any of the following:
   a. A "pulse duration" not exceeding 1 μs and having any of the following:
      1. An output energy exceeding 0.5 J per pulse and a "peak power" exceeding 50 W;
      2. A single transverse mode output having an "average output power" exceeding 20 W; or
      3. A multiple transverse mode output having an "average output power" exceeding 50 W; or
   b. A "pulse duration" exceeding 1 μs and having any of the following:

1. An output energy exceeding 2 J per pulse and a "peak power" exceeding 50 W;
2. A single transverse mode output having an "average output power" exceeding 50 W; or
3. A multiple transverse mode output having an "average output power" exceeding 80 W;

6. An output wavelength exceeding 975 nm but not exceeding 1,150 nm and having any of the following:
   a. A "pulse duration" of less than 1 ns and having any of the following:
      1. An output "peak power" exceeding 5 GW per pulse;
      2. An "average output power" exceeding 10 W; or
      3. An output energy exceeding 0.1 J per pulse;
   b. A "pulse duration" exceeding 1 ns but not exceeding 1 μs, and having any of the following:
      1. A single transverse mode output having any of the following:
         a. A "peak power" exceeding 100 MW;
         b. An "average output power" exceeding 20 W limited by design to a maximum pulse repetition frequency less than or equal to 1 kHz;
         c. A 'wall-plug efficiency' exceeding 12% and an "average output power" exceeding 100 W and capable of operating at a pulse repetition frequency greater than 1 kHz;
         d. An "average output power" exceeding 150 W and capable of operating at a pulse repetition frequency greater than 1 kHz; or
         e. An output energy exceeding 2 J per pulse; or
      2. A multiple transverse mode output having any of the following:
         a. A "peak power" exceeding 400 MW;
         b. A 'wall-plug efficiency' exceeding 18% and an "average output power" exceeding 500 W;
         c. An "average output power" exceeding 2 kW; or
         d. An output energy exceeding 4 J per pulse; or

   c. A "pulse duration" exceeding 1 μs and having any of the following:
      1. A single transverse mode output having any of the following:
         a. A "peak power" exceeding 500 kW;
         b. A 'wall-plug efficiency' exceeding 12% and an "average output power" exceeding 100 W; or
         c. An "average output power" exceeding 150 W; or
      2. A multiple transverse mode output having any of the following:
         a. A "peak power" exceeding 1 MW;
         b. A 'wall-plug efficiency' exceeding 18% and an "average output power" exceeding 500 W; or
         c. An "average output power" exceeding 2 kW;

7. An output wavelength exceeding 1,150 nm but not exceeding 1,555 nm and having any of the following:
   a. A "pulse duration" not exceeding 1 μs and having any of the following:
      1. An output energy exceeding 0.5 J per pulse and a "peak power" exceeding 50 W;
      2. A single transverse mode output having an "average output power" exceeding 20 W; or
      3. A multiple transverse mode output having an "average output power" exceeding 50 W; or
   b. A "pulse duration" exceeding 1 μs and having any of the following:
      1. An output energy exceeding 2 J per pulse and a "peak power" exceeding 50 W;
      2. A single transverse mode output having an "average output power" exceeding 50 W; or
      3. A multiple transverse mode output having an "average output power" exceeding 80 W; or

8. An output wavelength exceeding 1,555 nm and having any of the following:
   a. An output energy exceeding 100 mJ per pulse and a "peak power" exceeding 1 W; or
   b. An "average output power" exceeding 1 W;

c. "Tunable" "lasers", having any of the following:
   Note: *6.A005.c. includes titanium–sapphire (Ti: Al2O3), thulium-YAG (Tm: YAG), thulium-YSGG (Tm: YSGG), alexandrite (Cr: BeAl2O4), colour centre "lasers", dye "lasers", and liquid "lasers".*

   1. An output wavelength less than 600 nm and having any of the following:
      a. An output energy exceeding 50 mJ per pulse and a "peak power" exceeding 1 W; or
      b. An average or CW output power exceeding 1 W;

   2. An output wavelength of 600 nm or more but not exceeding 1,400 nm and having any of the following:
      a. An output energy exceeding 1 J per pulse and a "peak power" exceeding 20 W; or
      b. An average or CW output power exceeding 20 W; or

   3. An output wavelength exceeding 1,400 nm and having any of the following:
      a. An output energy exceeding 50 mJ per pulse and a "peak power" exceeding 1 W; or
      b. An average or CW output power exceeding 1 W;

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

1. Semiconductor "lasers", as follows:
Note 1: *6A005.d.1. includes semiconductor "lasers" having optical output connectors (e.g., fibre optic pigtails).*
Note 2: *The control status of semiconductor "lasers" specially designed for other equipment is determined by the control status of the other equipment.*

a. Individual single-transverse mode semiconductor "lasers", having any of the following:
1. A wavelength equal to or less than 1,510 nm and having an average or CW output power exceeding 1.5 W; or
2. A wavelength greater than 1,510 nm, and having an average or CW output power exceeding 500 mW;

b. Individual, multiple-transverse mode semiconductor "lasers", having any of the following:
1. A wavelength of less than 1,400 nm and having an average or CW output power exceeding 10W;
2. A wavelength equal to or greater than 1,400 nm and less than 1,900 nm, and having an average or CW output power exceeding 2.5 W; or
3. A wavelength equal to or greater than 1,900 nm and having an average or CW output power exceeding 1 W;

c. Individual semiconductor "laser" arrays, having any of the following:
1. A wavelength of less than 1,400 nm and having an average or CW output power exceeding 80 W;
2. A wavelength equal to or greater than 1,400 nm and less than 1,900 nm and having an average or CW output power exceeding 25 W; or
3. A wavelength equal to or greater than 1,900 nm and having an average or CW output power exceeding 10 W;

d. Array stacks of semiconductor "lasers" containing at least one array that is controlled under 6A005.d.1.c.;

Technical Notes:
1. *Semiconductor "lasers" are commonly called "laser" diodes.*
2. *An 'array' consists of multiple semiconductor "laser" emitters fabricated as a single chip so that the centres of the emitted light beams are on parallel paths.*
3. *An 'array stack' is fabricated by stacking, or otherwise assembling, 'arrays' so that the centres of the emitted light beams are on parallel paths.*

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

6A005 d. continued

a. An output energy exceeding 2 J per pulse and a "peak power" exceeding 5 kW; or
b. An average or CW output power exceeding 5 kW;

3. Carbon dioxide (CO_2) "lasers" having any of the following:
   a. A CW output power exceeding 15 kW;
   b. A pulsed output having a "pulse duration" exceeding 10 µs and having any of the following:
      1. An "average output power" exceeding 10 kW; or
      2. A "peak power" exceeding 100 kW; or
   c. A pulsed output having a "pulse duration" equal to or less than 10 µs and having any of the following:
      1. A pulse energy exceeding 5 J per pulse; or
      2. An "average output power" exceeding 2.5 kW;

4. Excimer "lasers", having any of the following:
   a. An output wavelength not exceeding 150 nm and having any of the following:
      1. An output energy exceeding 50 mJ per pulse; or
      2. An "average output power" exceeding 1 W;
   b. An output wavelength exceeding 150 nm but not exceeding 190 nm and having any of the following:
      1. An output energy exceeding 1.5 J per pulse; or
      2. An "average output power" exceeding 120 W;
   c. An output wavelength exceeding 190 nm but not exceeding 360 nm and having any of the following:
      1. An output energy exceeding 10 J per pulse; or
      2. An "average output power" exceeding 500 W; or
   d. An output wavelength exceeding 360 nm and having any of the following:
      1. An output energy exceeding 1.5 J per pulse; or
      2. An "average output power" exceeding 30 W;

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

5. "Chemical lasers", as follows:
   a. Hydrogen Fluoride (HF) "lasers";
   b. Deuterium Fluoride (DF) "lasers";
   c. "Transfer lasers", as follows:
      1. Oxygen Iodine (O_2-I) "lasers";
      2. Deuterium Fluoride-Carbon dioxide (DF-CO_2) "lasers";

6. 'Non-repetitive pulsed' Nd: glass "lasers" having any of the following:
   a. A "pulse duration" not exceeding 1 µs and an output energy exceeding 50 J per pulse; or
   b. A "pulse duration" exceeding 1 µs and an 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 specially designed for use with controlled "lasers";

f. Optical equipment, as follows:

N.B.: *For shared aperture optical elements, capable of operating in "Super-High Power Laser" ("SHPL") applications, see ML19.a.*

1. Dynamic wavefront (phase) measuring equipment capable of mapping at least 50 positions on a beam wavefront having any of the following:
   a. Frame rates equal to or more than 100 Hz and phase discrimination of at least 5% of the beam's wavelength; or
   b. Frame rates equal to or more than 1,000 Hz and phase discrimination of at least 20% of the beam's wavelength;

2. "Laser" diagnostic equipment capable of measuring "SHPL" system angular beam steering errors of equal to or less than 10 μrad;

3. Optical equipment and components specially designed for a phased-array "SHPL" system for coherent beam combination to an accuracy of lambda/10 at the designed wavelength, or 0.1 μm, whichever is the smaller;

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

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

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

a. "Magnetometers" and subsystems as follows:

6A006 a. continued

1. 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 "noise level" (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-magntometer "noise level" (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. Using optically pumped or nuclear precession (proton/Overhauser) "technology" having a "noise level" (sensitivity) lower (better) than 20 pT (rms) per square root Hz;

3. Using fluxgate "technology" having a "noise level" (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 "noise level" (sensitivity) lower (better) than any of the following:
   a. 0.05 nT (rms) per square root Hz at frequencies of less than 1 Hz;
   b. 1×10^{-3} nT (rms) per square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or
   c. 1×10^{-4} nT (rms) per square root Hz at frequencies exceeding 10 Hz;

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

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

c. "Magnetic gradiometers", as follows:

1. "Magnetic gradiometers" using multiple "magnetometers" specified in 6A006.a.;
2. Fibre optic "intrinsic magnetic gradiometers" having a magnetic gradient field "noise level" (sensitivity) lower (better) than 0.3 nT/m rms per square root Hz;
2. "Intrinsic magnetic gradiometers", using "technology" other than fibre-optic "technology", having a magnetic gradient field "noise level" (sensitivity) lower (better) than 0.015 nT/m rms per square root Hz;

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.

6A007 Gravity meters (gravimeters) and gravity gradiometers, as follows:
N.B.: SEE ALSO 6A107.

a. Gravity meters designed or modified for ground use having a static accuracy of less (better) than 10 μgal;
Note: 6A007.a. does not control ground gravity meters of the quartz element (Worden) type.

b. Gravity meters designed for mobile platforms, having all of the following:
1. A static accuracy of less (better) than 0.7 mgal; and
2. An in-service (operational) accuracy of less (better) than 0.7 mgal having a time-to-steady-state registration of less than 2 minutes under any combination of attendant corrective compensations and motional influences;

c. Gravity gradiometers.

6A008 Radar systems, equipment and assemblies having any of the following characteristics, and specially designed components therefor:
N.B.: SEE ALSO 6A108.

Note: 6A008 does not control:
a. Secondary surveillance radar (SSR);
b. Civil AutomotiveRadar;
c. Displays or monitors used for air traffic control (ATC) having no more than 12 resolvable elements per mm;
d. Meteorological (weather) radar.

a. Operating at frequencies from 40 GHz to 230 GHz and having any of the following:
1. An average output power exceeding 100 mW; or
2. Locating accuracy of 1 m or less (better) in range and 0.2 degree or less (better) in azimuth;

b. Having a tunable bandwidth exceeding ± 6.25% of the 'centre operating frequency';
Technical Note:
The 'centre operating frequency' equals one half of the sum of the highest plus the lowest specified operating frequencies.

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

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

e. Incorporating "electronically steerable phased array antennae";

f. Capable of heightfinding non-cooperative targets;
Note: 6A008.f. does not control precision approach radar (PAR) equipment conforming to ICAO standards.

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

h. Employing processing of radar signals using any of the following:
   1. "Radar spread spectrum" techniques; or
   2. "Radar frequency agility" techniques;

i. Providing ground-based operation with a maximum "instrumented range" exceeding 185 km;
   Note: *6A008.i. does not control:*
      a. Fishing ground surveillance radar;
      b. Ground radar equipment specially designed for enroute air traffic control, provided that all the following conditions are met:
         1. It has a maximum "instrumented range" of 500 km or less;
         2. It is configured so that radar target data can be transmitted only one way from the radar site to one or more civil ATC centres;
         3. It contains no provisions for remote control of the radar scan rate from the enroute ATC centre; and
         4. It is to be permanently installed;
      c. Weather balloon tracking radars.

j. Being "laser" radar or Light Detection and Ranging (LIDAR) equipment, having any of the following:
   1. "Space-qualified"; or
   2. Employing coherent heterodyne or homodyne detection techniques and having an angular resolution of less (better) than 20 μrad (microradians);
   Note: *6A008.j. does not control LIDAR equipment specially designed for surveying or for meteorological observation.*

k. Having "signal processing" sub-systems using "pulse compression", with any of the following:
   1. A "pulse compression" ratio exceeding 150; or
   2. A pulse width of less than 200 ns; or

l. Having data processing sub-systems with any of the following:
   1. "Automatic target tracking" providing, at any antenna rotation, the predicted target position beyond the time of the next antenna beam passage;
      Note: 6A008.l.1. does not control conflict alert capability in ATC systems, or marine or harbour radar.
   2. Calculation of target velocity from primary radar having non-periodic (variable) scanning rates;
   3. Processing for automatic pattern recognition (feature extraction) and comparison with target characteristic data bases (waveforms or imagery) to identify or classify targets; or

6A008 l. continued

4. Superposition and correlation, or fusion, of target data from two or more "geographically dispersed" and "interconnected radar sensors" to enhance and discriminate targets.
   Note: *6A008.l.4. does not control systems, equipment and assemblies used for marine traffic control.*

6A102 Radiation hardened 'detectors', not controlled in 6A002, specially designed or modified for protecting against nuclear effects (e.g. electromagnetic pulse (EMP), X-rays, combined blast and thermal effects) and usable for "missiles", designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of 5×10^5 rads (silicon).
Technical Note:
In 6A102, a 'detector' is defined as a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material. This includes devices that sense by one time operation or failure.

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

a. Gravity meters, not controlled in 6A007.b, designed or modified for airborne or marine use, and having a static or operational accuracy of 7×10^{-6} m/s^2 (0.7 milligal) or less (better), and having a time-to-steady-state registration of two minutes or less;
b. Specially designed components for gravity meters specified in 6A007.b or 6A107.a. and gravity gradiometers specified in 6A007.c.

6A108 Radar systems and tracking systems, not controlled in entry 6A008, as follows:

a. Radar and laser radar systems designed or modified for use in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104;
   Note: *6A108.a. includes the following:*
   a. Terrain contour mapping equipment;
   b. Imaging sensor equipment;
   c. Scene mapping and correlation (both digital and analogue) equipment;
   d. Doppler navigation radar equipment.

b. Precision tracking systems, usable for 'missiles', as follows:
   1. Tracking systems which use a code translator in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of in-flight position and velocity;
   2. Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:

6A108 b. continued

a. Angular resolution better than 3 milliradians;
b. Range of 30 km or greater with a range resolution better than 10 m rms;
c. Velocity resolution better than 3 m/s.

Technical Note:

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

6A202 Photomultiplier tubes having both of the following characteristics:
a. Photocathode area of greater than 20 cm^2; and
b. Anode pulse rise time of less than 1 ns.

6A203 Cameras and components, not controlled in 6A003, as follows:

a. Mechanical rotating mirror cameras, as follows, and specially designed components therefor:
   1. Framing cameras with recording rates greater than 225,000 frames per second;
   2. Streak cameras with writing speeds greater than 0.5 mm per microsecond;

   Note: In 6A203.a. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors and bearings.
b. Electronic streak cameras, electronic framing cameras, tubes and devices, as follows:
   1. Electronic streak cameras capable of 50 ns or less time resolution;
   2. Streak tubes for cameras specified in 6A203.b.1.;
   3. Electronic (or electronically shuttered) framing cameras capable of 50 ns or less frame exposure time;
   4. Framing tubes and solid-state imaging devices for use with cameras specified in 6A203.b.3., as follows:
      a. Proximity focused image intensifier tubes having the photocathode deposited on a transparent conductive coating to decrease photocathode sheet resistance;
      b. Gate silicon intensifier target (SIT) videcon tubes, where a fast system allows gating the photoelectrons from the photocathode before they impinge on the SIT plate;
      c. Kerr or Pockels cell electro-optical shuttering;
      d. Other framing tubes and solid-state imaging devices having a fast-image gating time of less than 50 ns specially designed for cameras specified in 6A203.b.3.;
c. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 50×10^3 Gy(silicon) (5×10^6 rad (silicon)) without operational degradation.

   Technical Note:

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

6A205 "Lasers", "laser" amplifiers and oscillators, not controlled in 0B001.g.5., 0B001.h.6. and 6A005; as follows:

a. Argon ion "lasers" having both of the following characteristics:
   1. Operating at wavelengths between 400 nm and 515 nm; and
   2. An average output power greater than 40 W;

b. Tunable pulsed single-mode dye laser oscillators having all of the following characteristics:
   1. Operating at wavelengths between 300 nm and 800 nm;
   2. An average output power greater than 1 W;
   3. A repetition rate greater than 1 kHz; and
   4. Pulse width less than 100 ns;

c. Tunable pulsed dye laser amplifiers and oscillators, having all of the following characteristics:
   1. Operating at wavelengths between 300 nm and 800 nm;
   2. An average output power greater than 30 W;
   3. A repetition rate greater than 1 kHz; and
   4. Pulse width less than 100 ns;

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

d. Pulsed carbon dioxide "lasers" having all of the following characteristics:
   1. Operating at wavelengths between 9,000 nm and 11,000 nm;
   2. A repetition rate greater than 250 Hz;
   3. An average output power greater than 500 W; and
   4. Pulse width of less than 200 ns;

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

f. Neodymium-doped (other than glass) "lasers" with an output wavelength between 1000 and 1100 nm having either of the following:
   1. Pulse-excited and Q-switched with a pulse duration equal to or more than 1 ns and having either of the following:
      a. A single–transverse mode output with an average output power greater than 40W; or
      b. A multiple-transverse mode output having an average power greater than 50 W;

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

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

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

6A226 Pressure sensors, as follows:

a. Manganin gauges for pressures greater than 10 GPa;

b. Quartz pressure transducers for pressures greater than 10 GPa.

6B Test, Inspection and Production Equipment

6B004 Optical equipment, as follows:

a. Equipment for measuring absolute reflectance to an accuracy of ± 0.1% of the reflectance value;

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

Note: *6B004 does not control microscopes.*

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

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

N.B.: SEE ALSO 6B108.

6B108 Systems, not controlled in 6B008, specially designed for radar cross section measurement usable for 'missiles' and their subsystems.

Technical Note:

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

6C Materials

6C002 Optical sensor materials, as follows:

a. Elemental tellurium (Te) of purity levels of 99.9995% or more;

b. Single crystals (including epitaxial wafers) of any of the following:
   1. Cadmium zinc telluride (CdZnTe), with zinc content of less than 6% by 'mole fraction';
   2. Cadmium telluride (CdTe) of any purity level; or
   3. Mercury cadmium telluride (HgCdTe) of any purity level.

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

6C004 Optical materials, as follows:

a. Zinc selenide (ZnSe) and zinc sulphide (ZnS) "substrate blanks" produced by the chemical vapour deposition process, having any of the following:
   1. A volume greater than 100 cm^3; or
   2. A diameter greater than 80 mm having a thickness of 20 mm or more;

b. Boules of the following electro-optic materials:
   1. Potassium titanyl arsenate (KTA);
   2. Silver gallium selenide ($AgGaSe_2$);
   3. Thallium arsenic selenide (Tl_3AsSe_3, also known as TAS);

c. Non-linear optical materials, having all of the following:
   1. Third order susceptibility (chi 3) of 10^{-6} m^2/V^2 or more; and
   2. A response time of less than 1 ms;

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

e. Glass, including fused silica, phosphate glass, fluorophosphate glass, zirconium fluoride (ZrF_4) and hafnium fluoride (HfF_4), having all of the following:
   1. A hydroxyl ion (OH-) concentration of less than 5 ppm;
   2. Integrated metallic purity levels of less than 1 ppm; and
   3. High homogeneity (index of refraction variance) less than 5×10^{-6};

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

6C005 Synthetic crystalline "laser" host material in unfinished form, as follows:
a. Titanium doped sapphire;
b. Alexandrite.

6D Software

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

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

6D003 Other "software", as follows:

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

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

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

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

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

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

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

d. 1. Air Traffic Control "software" application "programs" hosted on general purpose computers located at Air Traffic Control centres and capable of any of the following:
   a. Processing and displaying more than 150 simultaneous "system tracks"; or
   b. Accepting radar target data from more than four primary radars;

2. "Software" for the design or "production" of radomes which:
   a. Are specially designed to protect the "electronically steerable phased array antennae" specified in 6A008.e.; and
   b. Result in an antenna pattern having an 'average side lobe level' more than 40 dB below the peak of the main beam level.

6D003 d. continued

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

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

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

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

6E Technology

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

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

6E003 Other "technology", as follows:

a. 1. Optical surface coating and treatment "technology" "required" to achieve uniformity of 99.5% or better for optical coatings 500 mm or more in diameter or major axis length and with a total loss (absorption and scatter) of less than 5×10^{-3};
N.B.: *See also 2E003.f.*

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

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

6E101 "Technology" according to the General Technology Note for the "use" of equipment or "software" specified in 6A002, 6A007.b. and c., 6A008, 6A102, 6A107, 6A108, 6B108, 6D102 or 6D103.
Note: *6E101 only specifies "technology" for equipment specified in 6A008 when it is designed for airborne applications and is usable in "missiles".*

6E201 "Technology" according to the General Technology Note for the "use" of equipment specified in 6A003, 6A005.a.1.c., 6A005.a.2.a., 6A005.c.1.b., 6A005.c.2.c.2., 6A005.c.2.d.2.b., 6A202, 6A203, 6A205, 6A225 or 6A226.