

CATEGORY 6 - SENSORS AND LASERS**A. "END ITEMS," "EQUIPMENT," "ACCESSORIES," "ATTACHMENTS," "PARTS," "COMPONENTS," AND "SYSTEMS"**

6A001 Acoustic systems, equipment and "components," as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

Reporting Requirements

See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End-User authorizations.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$3000; N/A for 6A001.a.1.b.1 object detection and location systems having a transmitting frequency below 5 kHz or a sound pressure level exceeding 210 dB (reference 1 µPa at 1 m) for equipment with an operating frequency in the band from 2 kHz to 30 kHz inclusive; 6A001.a.1.e, 6A001.a.2.a.1, a.2.a.2, 6A001.a.2.a.3, a.2.a.5, a.2.a.6, 6A001.a.2.b; processing equipment controlled by 6A001.a.2.c, and "specially designed" for real-time application with towed acoustic

hydrophone arrays; a.2.e.1, a.2.e.2; and bottom or bay cable systems controlled by 6A001.a.2.f and having processing equipment "specially designed" for real-time application with bottom or bay cable systems.

GBS: Yes for 6A001.a.1.b.4.

CIV: Yes for 6A001.a.1.b.4.

Special Conditions for STA

STA: License Exception STA may not be used to ship commodities in 6A001.a.1.b., 6A001.a.1.e or 6A001.a.2 (except .a.2.a.4) to any of the destinations listed in Country Group A:6 (See Supplement No.1 to part 740 of the EAR).

List of Items Controlled

Related Controls: See also [6A991](#)

Related Definitions: N/A

Items:

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

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

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

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

b. *Acoustic beacons, as follows:*

1. *Acoustic emergency beacons;*

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

a.1.a. Acoustic seabed survey equipment as follows:

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

a.1.a.1.a. Designed to take measurements at an angle exceeding 20° from the vertical;

a.1.a.1.b. Designed to measure seabed topography at seabed depths exceeding 600 m;

a.1.a.1.c. ‘Sounding resolution’ less than 2; and

a.1.a.1.d. ‘Enhancement’ of the depth “accuracy” through compensation for all the following:

a.1.a.1.d.1. Motion of the acoustic sensor;

a.1.a.1.d.2. In-water propagation from sensor to the seabed and back; and

a.1.a.1.d.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.

a.1.a.2. Underwater survey

equipment designed for seabed topographic mapping and having any of the following:

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

a.1.a.2.a. Having all of the following:

a.1.a.2.a.1. Designed or modified to operate at depths exceeding 300 m; and

a.1.a.2.a.2. ‘Sounding rate’ greater than 3,800 m/s; or

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

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

a.1.a.2.b.1. Designed or modified to operate at depths exceeding 100 m;

a.1.a.2.b.2. Designed to take measurements at an angle exceeding 20° from the vertical;

a.1.a.2.b.3. Having any of the following:

a.1.a.2.b.3.a. Operating frequency below 350 kHz; or

a.1.a.2.b.3.b. Designed to measure seabed topography at a range exceeding 200 m from the acoustic sensor; and

a.1.a.2.b.4. ‘Enhancement’ of the depth “accuracy” through compensation of

all of the following:

a.1.a.2.b.4.a. Motion of the acoustic sensor;

a.1.a.2.b.4.b. In-water propagation from sensor to the seabed and back; *and*

a.1.a.2.b.4.c. Sound speed at the sensor.

a.1.a.3. Side Scan Sonar (SSS) or Synthetic Aperture Sonar (SAS), designed for seabed imaging and having all of the following, and specially designed transmitting and receiving acoustic arrays therefor:

a.1.a.3.a. Designed or modified to operate at depths exceeding 500 m; *and*

a.1.a.3.b. An 'area coverage rate' of greater than 570 m²/s while operating at the maximum range that it can operate with an 'along track resolution' of less than 15 cm; *and*

a.1.a.3.c. An 'across track resolution' of less than 15 cm;

Technical Notes:

1. 'Area coverage rate' (m²/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).

a.1.b Systems or transmitting and receiving arrays, designed for object detection or location, having any of the following:

a.1.b.1. A transmitting frequency below 10 kHz;

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

a.1.b.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;

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

a.1.b.5. Designed to operate with an unambiguous display range exceeding 5,120 m; *or*

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

a.1.b.6.a. Dynamic compensation for pressure; *or*

a.1.b.6.b. Incorporating other than lead zirconate titanate as the transduction element;

a.1.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:

Notes:

1. The control status of acoustic projectors, including transducers, "specially designed" for other equipment is determined by the control status of the other equipment.

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

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

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

a.1.c.1.a. Not designed for continuous operation at 100% duty cycle and having a radiated 'free-field Source Level (SLRMS)' exceeding $(10\log(f) + 169.77)$ dB (reference 1 μ Pa at 1 m) where f is the frequency in Hertz of maximum Transmitting Voltage Response (TVR) below 10 kHz; or

a.1.c.1.b. Designed for continuous operation at 100% duty cycle and having a continuously radiated 'free-field Source Level (SLRMS)' at 100% duty cycle exceeding $(10\log(f) + 159.77)$ dB (reference 1 μ Pa at 1 m) where f is the frequency in Hertz of maximum Transmitting Voltage Response (TVR) below 10 kHz; or

Technical Note: The 'free-field Source Level (SL_{RMS})' is defined along the maximum response axis and in the far field of the acoustic projector. It can be obtained from the Transmitting Voltage Response using the following equation: $SL_{RMS} = (TVR + 20\log V_{RMS})$ dB (ref 1 μ 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.

a.1.c.2. [Reserved]

N.B. See 6A001.a.1.c.1 for items previously specified in 6A001.a.1.c.2.

a.1.c.3. Side-lobe suppression exceeding 22 dB;

a.1.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:

a.1.d.1. Detection range exceeding 1,000 m; and

a.1.d.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.

a.1.e. Active individual sonars, "specially designed" or modified to detect, locate and automatically classify swimmers or divers, having all of the following, and "specially designed" transmitting and receiving acoustic arrays therefor:

a.1.e.1. Detection range exceeding 530 m;

a.1.e.2. Determined position error of less than 15 m rms (root mean square) when measured at a range of 530 m; and

a.1.e.3. Transmitted pulse signal bandwidth exceeding 3 kHz;

N.B.: For diver detection systems "specially designed" or modified for military use, see the U.S. Munitions List in the International Traffic in Arms Regulations (ITAR) (22 CFR part 121).

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

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

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

a.2.a. Hydrophones having any of the following:

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

Technical Notes:

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

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

a.2.a.1. Incorporating continuous flexible sensing elements;

a.2.a.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;

a.2.a.3. Having any of the following sensing elements:

a.2.a.3.a. Optical fibers;

a.2.a.3.b. 'Piezoelectric polymer films' other than polyvinylidene-fluoride (PVDF) and its co-polymers {P(VDF-TrFE) and P(VDF-TFE)};

a.2.a.3.c. 'Flexible piezoelectric composites';

a.2.a.3.d. Lead-magnesium-niobate/lead-titanate (*i.e.*, Pb(Mg_{1/3}Nb_{2/3})O₃-PbTiO₃, or PMN-PT) piezoelectric single crystals grown from solid solution; *or*

a.2.a.3.e. Lead-indium-niobate/lead-magnesium niobate/lead-titanate (*i.e.*, Pb(In_{1/2}Nb_{1/2})O₃-Pb(Mg_{1/3}Nb_{2/3})O₃-PbTiO₃, or PIN-PMN-PT) piezoelectric single crystals grown from solid solution;

a.2.a.4. A 'hydrophone sensitivity' better than -180dB at any depth with no acceleration compensation;

a.2.a.5. Designed to operate at depths exceeding 35 m with acceleration compensation; *or*

a.2.a.6. Designed for operation at depths exceeding 1,000 m and having a 'hydrophone sensitivity' better than -230 dB below 4 kHz;

Technical Notes:

1. 'Piezoelectric polymer film' sensing elements consist of 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 fibers 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.

a.2.b. Towed acoustic hydrophone arrays having any of the following:

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

a.2.b.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;

a.2.b.2. Designed or ‘able to be modified’ to operate at depths exceeding 35m;

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.

a.2.b.3. Heading sensors controlled by 6A001.a.2.d;

a.2.b.4. Longitudinally reinforced array hoses;

a.2.b.5. An assembled array of less than 40 mm in diameter;

a.2.b.6. [Reserved];

a.2.b.7. Hydrophone characteristics controlled by 6A001.a.2.a; or

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

a.2.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;

a.2.d. Heading sensors having all of the following:

a.2.d.1. An “accuracy” of better than $\pm 0.5^\circ$; and

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

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

a.2.e. Bottom or bay-cable hydrophone arrays having any of the following:

a.2.e.1. Incorporating hydrophones controlled by 6A001.a.2.a;

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

a.2.e.2.a. Designed to operate at depths exceeding 35 m or having an adjustable or removal depth sensing device in order to operate at depths exceeding 35 m; *and*

a.2.e.2.b. Capable of being operationally interchanged with towed acoustic hydrophone array modules; *or*

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

a.2.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;

a.2.g. Accelerometer-based hydro-acoustic sensors having all of the following:

a.2.g.1. Composed of three accelerometers arranged along three distinct axes;

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

a.2.g.3. Designed to operate at depths greater than 35 meters; *and*

a.2.g.4. Operating frequency below 20 kHz;

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

Technical Notes:

I. Accelerometer-based hydro-acoustic

sensors are also known as vector sensors.

2. ‘Acceleration sensitivity’ is defined as twenty times the logarithm to the base 10 of the ratio of rms output voltage to a 1 V rms reference, when the hydro-acoustic sensor, without a preamplifier, is placed in a plane wave acoustic field with an rms acceleration of 1 g (i.e., 9.81 m/s²).

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:

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

b.1.a. Designed to operate at distances between the carrier and the sea bed exceeding 500 m; *or*

b.1.b. Having speed “accuracy” better than 1% of speed;

b.2. Doppler-velocity sonar log equipment having speed “accuracy” better than 1% of speed;

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

a. Measuring the depth of water;

b. Measuring the distance of submerged or buried objects; *or*

c. Fish finding.

Note 2: 6A001.b does not apply to equipment “specially designed” for installation on surface vessels.

c. [Reserved]

N.B.: For diver deterrent acoustic systems, see 8A002.r.

6A002 Optical sensors and equipment, and “components” therefor, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, MT, CC, RS, AT, UN

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
MT applies to optical detectors in 6A002.a.1, or a.3 that are “specially designed” or modified to protect “missiles” against nuclear effects (e.g., Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for “missiles”	MT Column 1
RS applies to 6A002.a.1, a.2, a.3 (except a.3.d.2.a and a.3.e for lead selenide based focal plane arrays (FPAs)), .c, and .f.	RS Column 1
CC applies to police-model infrared viewers in 6A002.c	CC Column 1
AT applies to entire entry	AT Column 1
UN applies to 6A002.a.1, a.2, a.3 and .c	See § 746.1(b) for UN controls

Reporting Requirements

See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End-User authorizations.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$500 for 6A002.f.
\$3000; except N/A for MT and for

6A002.a.1, a.2, a.3, .c, and .f.

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: (1) See USML Category XII(e) for infrared focal plane arrays, image intensifier tubes, and related parts and components, subject to the ITAR. (2) See USML Category XV(e) for space-qualified focal plane arrays subject to the ITAR. (3) See also ECCNs 6A102, 6A202, and 6A992. (4) See ECCN 0A919 for foreign-made military commodities that incorporate commodities described in 6A002. (5) Section 744.9 imposes a license requirement on commodities described in ECCN 6A002 if being exported, reexported, or transferred (in-country) for use by a military end-user or for incorporation into an item controlled by ECCN 0A919. (6) See USML Categories XII(e) and XV(e)(3) for read-out integrated circuits “subject to the ITAR.”

Related Definitions: N/A

Items:

a. Optical detectors as follows:

a.1. “Space-qualified” solid-state detectors as follows:

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

a.1.a. “Space-qualified” solid-state detectors having all of the following:

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

a.1.a.2. A response of less than 0.1% relative to the peak response at a wavelength exceeding 400 nm;

a.1.b. “Space-qualified” solid-state detectors having all of the following:

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

a.1.b.2. A response “time constant” of 95 ns or less;

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

a.1.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;

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

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

a. *A single metal anode; or*

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

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

a.2.a. Image intensifier tubes having all of the following:

a.2.a.1. A peak response in the

wavelength range exceeding 400 nm but not exceeding 1,050 nm;

a.2.a.2. Electron image amplification using any of the following:

a.2.a.2.a. A microchannel plate with a hole pitch (center-to-center spacing) of 12 μm or less; *or*

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

a.2.a.3. Any of the following photocathodes:

a.2.a.3.a. Multialkali photocathodes (e.g., S-20 and S-25) having a luminous sensitivity exceeding 350 μA/lm;

a.2.a.3.b. GaAs or GaInAs photocathodes; *or*

a.2.a.3.c. Other “III-V compound” semiconductor photocathodes having a maximum “radiant sensitivity” exceeding 10 mA/W;

a.2.b. Image intensifier tubes having all of the following:

a.2.b.1. A peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,800 nm;

a.2.b.2. Electron image amplification using any of the following:

a.2.b.2.a. A microchannel plate with a hole pitch (center-to-center spacing) of 12 μm or less; *or*

a.2.b.2.b. An electron sensing device with a non-binned pixel pitch of 500 μm

or less, "specially designed" or modified to achieve 'charge multiplication' other than by a microchannel plate; *and*

a.2.b.3. "III/V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes, having a maximum "radian sensitivity" exceeding 15 mA/W;

a.2.c. "Specially designed" "components" as follows:

a.2.c.1. Microchannel plates having a hole pitch (center-to-center spacing) of 12 μm or less;

a.2.c.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;

a.2.c.3. "III-V compound" semiconductor (e.g., GaAs or GaInAs) photocathodes and transferred electron photocathodes;

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

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

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

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

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

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

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

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

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

b. Pyroelectric detectors using any of the following:

b.1. Triglycine sulphate and variants;

b.2. Lead-lanthanum-zirconium titanate and variants;

b.3. Lithium tantalate;

b.4. Polyvinylidene fluoride and variants; *or*

b.5. Strontium barium niobate and variants.

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

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

c.2. Any of the following:

c.2.a. The response limiting mechanism is integral to or combined with the detector element; *or*

c.2.b. The "focal plane array" is only operable with the response limiting mechanism in place.

d. Thermopile arrays having less than

5,130 elements;

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

a.3.a. Non-“space-qualified” “focal plane arrays” having all of the following:

a.3.a.1. Individual elements with a peak response within the wavelength range exceeding 900 nm but not exceeding 1,050 nm; and

a.3.a.2. Any of the following:

a.3.a.2.a. A response “time constant” of less than 0.5 ns; or

a.3.a.2.b. “Specially designed” or modified to achieve ‘charge multiplication’ and having a maximum “radiant sensitivity” exceeding 10 mA/W;

a.3.b. Non-“space-qualified” “focal plane arrays” having all of the following:

a.3.b.1. Individual elements with a peak response in the wavelength range exceeding 1,050 nm but not exceeding 1,200 nm; and

a.3.b.2. Any of the following:

a.3.b.2.a. A response “time constant” of 95 ns or less; or

a.3.b.2.b. “Specially designed” or modified to achieve ‘charge multiplication’ and having a maximum “radiant sensitivity” exceeding 10 mA/W;

a.3.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 by 6A002.a.3.f.

a.3.d. Non-“space-qualified” linear (1-dimensional) “focal plane arrays” having all of the following:

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

a.3.d.2. Any of the following:

a.3.d.2.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

a.3.d.2.b. Signal processing in the detector elements;

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

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

a.3.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;

a.3.f. Non-“space-qualified” non-linear

(2-dimensional) infrared “focal plane arrays” based on ‘microbolometer’ material having individual elements with an unfiltered response in the wavelength range equal to or exceeding 8,000 nm but not exceeding 14,000 nm;

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

a.3.g. Non-“space-qualified” “focal plane arrays” having all of the following:

a.3.g.1. Individual detector elements with a peak response in the wavelength range exceeding 400 nm but not exceeding 900 nm;

a.3.g.2. “Specially designed” or modified to achieve ‘charge multiplication’ and having a maximum “radiant sensitivity” exceeding 10 mA/W for wavelengths exceeding 760 nm; and

a.3.g.3. Greater than 32 elements;

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

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

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

b.2.a. Providing output imaging data in digital format; and

b.2.b. Having any of the following characteristics:

b.2.b.1. “Space-qualified”; or

b.2.b.2. Designed for airborne operation, using other than silicon detectors, and having an IFOV of less than 2.5 mrad (milliradians);

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

a. Charge Coupled Devices (CCD) not designed or modified to achieve ‘charge multiplication’; or

b. Complementary Metal Oxide Semiconductor (CMOS) devices not designed or modified to achieve ‘charge multiplication’.

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

c.1. Image intensifier tubes having the characteristics listed in 6A002.a.2.a or 6A002.a.2.b;

c.2. “Focal plane arrays” having the characteristics listed in 6A002.a.3; or

c.3. Solid state detectors specified by 6A002.a.1;

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

Note: 6A002.c does not control equipment as follows, when incorporating other than GaAs or GaInAs photocathodes:

- a. Industrial or civilian intrusion alarm, traffic or industrial movement control or counting systems;
- b. Medical equipment;
- c. Industrial equipment used for inspection, sorting or analysis of the properties of materials;
- d. Flame detectors for industrial furnaces;
- e. Equipment “specially designed” for laboratory use.
- d. Special support “components” for optical sensors, as follows:
 - d.1. “Space-qualified” cryocoolers;
 - d.2. Non-“space-qualified” cryocoolers having a cooling source temperature below 218K (-55° C), as follows:
 - d.2.a. Closed cycle type with a specified Mean-Time-To-Failure (MTTF) or Mean-Time-Between-Failures (MTBF), exceeding 2,500 hours;
 - d.2.b. Joule-Thomson (JT) self-regulating minicoolers having bore (outside) diameters of less than 8 mm;
 - d.3. Optical sensing fibers specially fabricated either compositionally or structurally, or modified by coating, to be acoustically, thermally, inertially, electromagnetically or nuclear radiation sensitive.
- f. ‘Read-Out Integrated Circuits’ (‘ROIC’) “specially designed” for “focal plane arrays” specified by 6A002.a.3.

Note: 6A002.f does not apply to read-out integrated circuits “specially designed” for civil automotive applications.

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

6A003 Cameras, systems or equipment, and “components” therefor, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, NP, RS, AT, UN

Control(s)	Country Chart (See Supp. No. 1 to part 738)
NS applies to entire entry	NS Column 2
NP applies to cameras controlled by 6A003.a.3 or a.4 and to plug-ins in 6A003.a.6 for cameras controlled by 6A003.a.3 or a.4	NP Column 1
RS applies to 6A003.b.3, 6A003.b.4.a, 6A003.b.4.c and to items controlled in 6A003.b.4.b that have a frame rate greater than 60 Hz or that incorporate a focal plane array with more than 111,000 elements, or to items in 6A003.b.4.b when being exported or reexported to be embedded in a civil product.	RS Column 1

(But see § 742.6(a)(2)(iii) and (v) for certain exemptions)	
RS applies to items controlled in 6A003.b.4.b that have a frame rate of 60 Hz or less and that incorporate a focal plane array with not more than 111,000 elements if not being exported or reexported to be embedded in a civil product	RS Column 2
AT applies to entire entry	AT Column 1
UN applies to 6A003.b.3 and b.4	See § 746.1(b) for UN controls

License Requirement Note: Commodities that are not subject to the ITAR but are of the type described in USML Category XII(c) are controlled as cameras in ECCN 6A003 when they incorporate a camera controlled in this ECCN.

Reporting Requirements

See §743.3 of the EAR for thermal camera reporting for exports that are not authorized by an individually validated license of thermal imaging cameras controlled by ECCN 6A003.b.4.b to destinations in Country Group A:1 (see Supplement No. 1 to part 740), must be reported to BIS.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$1500, except N/A for 6A003.a.3 through a.6, b.1, b.3 and b.4

GBS: N/A

CIV: N/A

Special Conditions for STA

STA: License Exception STA may not be used to ship any commodity in 6A003.b.3 or b.4 to any of the destinations listed in Country Group A:6 (See Supplement No.1 to part 740 of the EAR).

List of Items Controlled

Related Controls: (1) See ECCNs [6E001](#) (“development”), [6E002](#) (“production”), and [6E201](#) (“use”) for technology for items controlled under this entry. (2) Also see ECCN [6A203](#). (3) See ECCN 0A919 for foreign made military commodities that incorporate cameras described in 6A003. (4) Section 744.9 imposes a license requirement on cameras described in 6A003 if being exported, reexported, or transferred (in-country) for use by a military end-user or for incorporation into a commodity controlled by ECCN 0A919. (5) See USML Category XII(c) and (e) for cameras subject to the ITAR.

Related Definitions: N/A

Items:

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

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.*

a.1. [Reserved]

a.2. [Reserved]

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

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

a.5. Electronic cameras having all of the following:

a.5.a. An electronic shutter speed (gating capability) of less than 1µs per full frame; and

a.5.b. A read out time allowing a framing

rate of more than 125 full frames per second;

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

a.6.a. “Specially designed” for instrumentation cameras which have modular structures and that are controlled by 6A003.a; *and*

a.6.b. Enabling these cameras to meet the characteristics specified by 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.

b.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:

b.1.a. Having any of the following:

b.1.a.1. More than 4×10^6 “active pixels” per solid state array for monochrome (black and white) cameras;

b.1.a.2. More than 4×10^6 “active pixels” per solid state array for color cameras incorporating three solid state arrays; *or*

b.1.a.3. More than 12×10^6 “active pixels” for solid state array color cameras incorporating one solid state array; *and*

b.1.b. Having any of the following:

b.1.b.1. Optical mirrors controlled by 6A004.a.;

b.1.b.2. Optical control equipment

controlled by 6A004.d.; *or*

b.1.b.3. The capability for annotating internally generated ‘camera tracking data’;

Technical Notes:

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

2. For the 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.

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

b.2.a. A peak response in the wavelength range exceeding 10 nm, but not exceeding 30,000 nm;

b.2.b. Linear detector arrays with more than 8,192 elements per array; *and*

b.2.c. Mechanical scanning in one direction;

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); *or*

c. Medical equipment.

b.3. Imaging cameras incorporating image intensifier tubes having the characteristics listed in 6A002.a.2.a or 6A002.a.2.b;

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

b.4.a. Incorporating “focal plane arrays” controlled by 6A002.a.3.a to 6A002.a.3.e;

b.4.b. Incorporating “focal plane arrays” controlled by 6A002.a.3.f; or

b.4.c. Incorporating “focal plane arrays” controlled by 6A002.a.3.g;

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 analog or digital signal once power is supplied.

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

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

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

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

d. Equipment “specially designed” for laboratory use; or

e. Medical equipment.

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

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

b. Having all of the following:

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

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

3. Not incorporating a ‘direct view’ display; and

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

4. Having any of the following:

a. No facility to obtain a viewable image of the detected field-of-view; or

b. The camera is designed for a single kind of application and designed not to be user modified; or

Technical Note:

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

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

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

c. The camera is “specially designed” for installation into a civilian passenger land

vehicle and having all of the following:

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

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

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

b. A “specially designed”, authorized maintenance test facility; and

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

Note: When necessary, details of the items will be provided, upon request, to the Bureau of Industry and Security in order to ascertain compliance with the conditions described in Note 3.b.4 and Note 3.c in this Note to 6A003.b.4.b.

Note 4: 6A003.b.4.c does not apply to ‘imaging cameras’ having any of the following characteristics:

a. Having all of the following:

1. Where the camera is “specially designed” for installation as an integrated component into indoor and wall-plug-operated systems or equipment, limited by design for a single kind of application, as follows:

a. Industrial process monitoring, quality control, or analysis of the properties of materials;

b. Laboratory equipment “specially designed” for scientific research;

c. Medical equipment;

d. Financial fraud detection equipment; and

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

a. The system(s) or equipment for which it was intended; or

b. A “specially designed,” authorized maintenance facility; and

3. Incorporates an active mechanism that forces the camera not to function when it is removed from the system(s) or equipment for which it was intended;

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

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

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

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

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

c. A “specially designed”, authorized maintenance test facility; and

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

intended;

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

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

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

3. Not "specially designed" or modified for underwater use; or

d. Having all of the following:

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

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

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

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

Note: When necessary, details of the item will be provided, upon request, to the Bureau of Industry and Security in order to ascertain compliance with the conditions described in Note 4 above.

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

6A004 Optical equipment and "components," as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

Reporting Requirements

See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End-User authorizations.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$3000

GBS: Yes for 6A004.a.1, a.2, a.4, .b, d.2, and .f.

CIV: Yes for 6A004.a.1, a.2, a.4, .b, d.2, and .f.

Special Conditions for STA

STA: Paragraph (c)(2) of License Exception STA may not be used to ship any commodity in 6A004.c or .d to any of the destinations listed in Country Group A:6 (See Supplement No.1 to part 740 of the EAR).

List of Items Controlled

Related Controls: (1) For optical mirrors or 'aspheric optical elements' "specially designed" for lithography "equipment," see ECCN 3B001. (2) See USML Category XII(e) for gimbals "subject to the ITAR." (3) See also 6A994.

Related Definitions: 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.

Items:

- a. Optical mirrors (reflectors) as follows:

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

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

- a.1.a. Having all the following:

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

a.1.a.2. More than 200 actuators; *or*

a.1.b. A Laser Induced Damage Threshold (LIDT) being any of the following:

a.1.b.1. Greater than 1 kW/cm² using a “CW laser”; *or*

a.1.b.2. Greater than 2 J/cm² using 20 ns “laser” pulses at 20 Hz repetition rate;

Technical Notes:

1. ‘Deformable mirrors’ are mirrors having any of the following:

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

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

2. ‘Deformable mirrors’ are also known as adaptive optic mirrors.

a.2. Lightweight monolithic mirrors having an average “equivalent density” of less than 30 kg/m² and a total mass exceeding 10 kg;

a.3. Lightweight “composite” or foam mirror structures having an average “equivalent density” of less than 30 kg/m² and a total mass exceeding 2 kg;

Note: 6A004.a.2 and 6A004.a.3 do not apply to mirrors “specially designed” to direct solar radiation for terrestrial heliostat installations.

a.4. Mirrors specially designed for beam steering mirror stages specified in 6A004.d.2.a with a flatness of $\lambda/10$ or better (λ is equal to 633 nm) and having any of the following:

a.4.a. Diameter or major axis length greater than or equal to 100 mm; *or*

a.4.b. Having all of the following:

a.4.b.1. Diameter or major axis length greater than 50 mm but less than 100 mm; *and*

a.4.b.2. A Laser Induced Damage Threshold (LIDT) being any of the following:

a.4.b.2.a. Greater than 10 kW/cm² using a “CW laser”; *or*

a.4.b.2.b. Greater than 20 J/cm² using 20 ns “laser” pulses at 20 Hz repetition rate;

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

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:

- b.1. Exceeding 100 cm³ in volume; *or*
- b.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:
 - c.1. “Components” lightweighted to less than 20% “equivalent density” compared with a solid blank of the same aperture and thickness;
 - c.2. Raw substrates, processed substrates having surface coatings (single-layer or multi-layer, metallic or dielectric, conducting, semiconducting or insulating) or having protective films;
 - c.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;
 - c.4. “Components” manufactured from “composite” materials having a coefficient of linear thermal expansion equal to or less than 5 x 10⁻⁶ in any coordinate direction;
- d. Optical control equipment as follows:
 - d.1. Equipment “specially designed” to maintain the surface figure or orientation of the “space-qualified” “components” controlled by 6A004.c.1 or 6A004.c.3;
 - d.2. Steering, tracking, stabilisation and resonator alignment equipment as follows:
 - d.2.a. Beam steering mirror stages designed to carry mirrors having diameter or major axis length greater than 50 mm and having all of the following, and specially designed electronic control equipment therefor:

d.2.a.1. A maximum angular travel of ±26 mrad or more;

d.2.a.2. A mechanical resonant frequency of 500 Hz or more; *and*

d.2.a.3. An angular “accuracy” of 10 µrad (microradians) or less (better);

d.2.b. Resonator alignment equipment having bandwidths equal to or more than 100 Hz and an “accuracy” of 10 µrad or less (better);

d.3. Gimbals having all of the following:

d.3.a. A maximum slew exceeding 5°;

d.3.b. A bandwidth of 100 Hz or more;

d.3.c. Angular pointing errors of 200 µrad (microradians) or less; *and*

d.3.d. Having any of the following:

d.3.d.1. Exceeding 0.15 m but not exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 2 rad (radians)/s²; *or*

d.3.d.2. Exceeding 1 m in diameter or major axis length and capable of angular accelerations exceeding 0.5 rad (radians)/s²;

d.4. [Reserved]

e. ‘Aspheric optical elements’ having all of the following:

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

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

e.3. Coefficient of linear thermal

expansion's absolute magnitude less than $3 \times 10^{-6}/K$ at $25^\circ C$;

Technical Note:

1. [See Related Definitions section of this ECCN]

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

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

a. Largest optical-aperture dimension less than 1 m and focal length to aperture ratio equal to or greater than 4.5:1;

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

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

d. Fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than $2.5 \times 10^{-6}/K$ at $25^\circ C$; or

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

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

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

f.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.

6A005 "Lasers," "components" and optical equipment, as follows (see List of Items Controlled), excluding items that are subject to the export licensing authority of the Nuclear Regulatory Commission (see 10 CFR part 110).

License Requirements

Reason for Control: NS, NP, AT

Control(s)	Country Chart (See Supp. No. I to part 738)
NS applies to entire entry	NS Column 2
NP applies to lasers controlled by 6A005.a.2, a.3, a.4, b.2.b, b.3, b.4, b.6.c, c.1.b, c.2.b, d.2, d.3.c, or d.4.c that meet or exceed the technical parameters described in 6A205	NP Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A for NP items

\$3000 for all other items

GBS: Neodymium-doped (other than glass) "lasers" controlled by 6A005.b.6.d.2 (except 6A005.b.6.d.2.b) that have an output wavelength exceeding 1,000 nm, but not exceeding 1,100 nm, and an average or CW output power not exceeding 2kW, and operate in a pulse-excited, non- "Q-switched" multiple-transverse mode, or in a continuously excited, multiple-transverse mode; Dye and Liquid Lasers controlled by

6A005.c.1, c.2 and c.3, except for a pulsed single longitudinal mode oscillator having an average output power exceeding 1 W and a repetition rate exceeding 1 kHz if the “pulse duration” is less than 100 ns; CO “lasers” controlled by 6A005.d.2 having a CW maximum rated single or multimode output power not exceeding 10 kW; CO₂ or CO/CO₂ “lasers” controlled by 6A005.d.3 having an output wavelength in the range from 9,000 to 11,000 nm and having a pulsed output not exceeding 2 J per pulse and a maximum rated average single or multimode output power not exceeding 5 kW; and CO₂ “lasers” controlled by 6A005.d.3 that operate in CW multiple-transverse mode, and having a CW output power not exceeding 15kW.

CIV: Neodymium-doped (other than glass) “lasers” controlled by 6A005.b.6.d.2 (except 6A005.b.6.d.2.b) that have an output wavelength exceeding 1,000 nm, but not exceeding 1,100 nm, and an average or CW output power not exceeding 2kW, and operate in a pulse-excited, non-“Q-switched” multiple-transverse mode, or in a continuously excited, multiple-transverse mode; Dye and Liquid Lasers controlled by 6A005.c.1, c.2 and c.3, except for a pulsed single longitudinal mode oscillator having an average output power exceeding 1 W and a repetition rate exceeding 1 kHz if the “pulse duration” is less than 100 ns; CO “lasers” controlled by 6A005.d.2 having a CW maximum rated single or multimode output power not exceeding 10 kW; CO₂ or CO/CO₂ “lasers” controlled by 6A005.d.3

having an output wavelength in the range from 9,000 to 11,000 nm and having a pulsed output not exceeding 2 J per pulse and a maximum rated average single or multimode output power not exceeding 5 kW; and CO₂ “lasers” controlled by 6A005.d.3 that operate in CW multiple-transverse mode, and having a CW output power not exceeding 15kW.

List of Items Controlled

Related Controls (1) See ECCN [6D001](#) for “software” for items controlled under this entry. (2) See ECCNs [6E001](#) (“development”), [6E002](#) (“production”), and [6E201](#) (“use”) for technology for items controlled under this entry. (3) Also see ECCNs [6A205](#) and [6A995](#). (4) See ECCN 3B001 for excimer “lasers” “specially designed” for lithography equipment. (5) “Lasers” “specially designed” or prepared for use in isotope separation are subject to the export licensing authority of the Nuclear Regulatory Commission (see 10 CFR part 110). (6) See USML Category XII(b) and (e) for laser systems or lasers subject to the ITAR. (7) See USML Category XVIII for certain laser-based directed energy weapon systems, equipment, and components subject to the ITAR.

Related Definitions: (1) ‘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, see 6A005.a.6.b.1 and 6A005.b.6; (2) ‘Non-repetitive pulsed’ refers to “lasers” that produce either a single output pulse or that have a time interval between pulses exceeding one minute, see Note 2 of 6A005 and 6A005.d.6.

Items:

Note:

1. Pulsed “lasers” include those that run in a continuous wave (CW) mode with pulses superimposed.

2. Excimer, semiconductor, chemical, CO, CO₂, and ‘non-repetitive pulsed’ Nd:glass “lasers” are only specified by 6A005.d.

Technical Note: ‘Non-repetitive pulsed’ refers to “lasers” that produce either a single output pulse or that have a time interval between pulses exceeding one minute.

3. 6A005 includes fiber “lasers”.

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.

5. 6A005 does not control “lasers” as follows:

a. Ruby with output energy below 20 J;

b. Nitrogen;

c. Krypton.

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

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

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

Note: 6A005.a.2 does not control Argon “lasers” having an output power equal to or less than 50 W.

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

a.3.a. Single transverse mode output and output power exceeding 50 W; or

a.3.b. Multiple transverse mode output and output power exceeding 150 W;

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

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

a.5.a. Single transverse mode output and output power exceeding 50 W; or

a.5.b. Multiple transverse mode output and output power exceeding 80 W;

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

a.6.a. Single transverse mode output and output power exceeding 500 W; or

a.6.b. Multiple transverse mode output and any of the following:

a.6.b.1. ‘Wall-plug efficiency’ exceeding 18% and output power exceeding 500 W; or

a.6.b.2. Output power exceeding 2 kW;

Note 1: 6A005.a.6.b does not control multiple transverse mode, industrial “lasers” with output power exceeding 2kW and not exceeding 6 kW with a total mass greater than 1,200 kg. For the purpose of this note, total

mass includes all “components” required to operate the “laser,” e.g., “laser,” power supply, heat exchanger, but excludes external optics for beam conditioning or delivery.

Note 2: 6A005.a.6.b does not apply to multiple transverse mode, industrial “lasers” having any of the following:

- a. *Output power exceeding 500 W but not exceeding 1 kW and having all of the following:*
 1. *Beam Parameter Product (BPP) exceeding 0.7 mm•mrad; and*
 2. *‘Brightness’ not exceeding 1024 W/(mm•mrad)²;*
- b. *Output power exceeding 1 kW but not exceeding 1.6 kW and having a BPP exceeding 1.25 mm•mrad;*
- c. *Output power exceeding 1.6 kW but not exceeding 2.5 kW and having a BPP exceeding 1.7 mm•mrad;*
- d. *Output power exceeding 2.5 kW but not exceeding 3.3 kW and having a BPP exceeding 2.5 mm•mrad;*
- e. *Output power exceeding 3.3 kW but not exceeding 4 kW and having a BPP exceeding 3.5 mm•mrad;*
- f. *Output power exceeding 4 kW but not exceeding 5 kW and having a BPP exceeding 5 mm•mrad;*
- g. *Output power exceeding 5 kW but not exceeding 6 kW and having a BPP exceeding 7.2 mm•mrad;*
- h. *Output power exceeding 6 kW but not exceeding 8 kW and having a BPP exceeding 12 mm•mrad; or*
- i. *Output power exceeding 8 kW but not exceeding 10 kW and having a BPP exceeding 24 mm•mrad;*

Technical Note: For the purpose of 6A005.a.6.b, Note 2 (a)(2), ‘brightness’ is defined as the output power of the “laser” divided by the squared Beam Parameter Product (BPP), i.e., $(\text{output power})/\text{BPP}^2$.

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

a.7.a. Single transverse mode and output power exceeding 50 W; *or*

a.7.b. Multiple transverse mode and output power exceeding 80 W;

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

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

a.9.a. Single transverse mode and output power exceeding 1 W; *or*

a.9.b. Multiple transverse mode output and output power exceeding 120 W; *or*

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

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

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

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

b.1.b. “Average output power” exceeding 1 W;

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

b.2.a. Output energy exceeding 1.5 J per pulse and “peak power” exceeding 30 W; *or*

b.2.b. “Average output power” exceeding 30 W;

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

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

b.3.a. Single transverse mode output and any of the following:

b.3.a.1. Output energy exceeding 1.5 J per pulse and “peak power” exceeding 50 W; or

b.3.a.2. “Average output power” exceeding 50 W; or

b.3.b. Multiple transverse mode output and any of the following:

b.3.b.1. Output energy exceeding 1.5 J per pulse and “peak power” exceeding 150 W; or

b.3.b.2. “Average output power” exceeding 150 W;

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

b.4.a. “Pulse duration” less than 1 ps and any of the following:

b.4.a.1. Output energy exceeding 0.005 J per pulse and “peak power” exceeding 5 GW; or

b.4.a.2. “Average output power” exceeding 20 W; or

b.4.b. “Pulse duration” equal to or exceeding 1 ps and any of the following:

b.4.b.1. Output energy exceeding 1.5 J per pulse and “peak power” exceeding 30 W; or

b.4.b.2. “Average output power” exceeding 30 W;

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

b.5.a. “Pulse duration” less than 1 ps and any of the following:

b.5.a.1. Output energy exceeding 0.005 J per pulse and “peak power” exceeding 5 GW; or

b.5.a.2. Single transverse mode output and “average output power” exceeding 20 W;

b.5.b. “Pulse duration” equal to or exceeding 1 ps and not exceeding 1 μs and any of the following:

b.5.b.1. Output energy exceeding 0.5 J per pulse and “peak power” exceeding 50 W;

b.5.b.2. Single transverse mode output and “average output power” exceeding 20 W; or

b.5.b.3. Multiple transverse mode output and “average output power” exceeding 50 W; or

b.5.c. “Pulse duration” exceeding 1 μs and any of the following:

b.5.c.1. Output energy exceeding 2 J per pulse and “peak power” exceeding 50 W;

b.5.c.2. Single transverse mode output and “average output power” exceeding 50 W; or

b.5.c.3. Multiple transverse mode output and “average output power” exceeding 80 W.

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

b.6.a. “Pulse duration” of less than 1 ps, and any of the following:

b.6.a.1. Output “peak power” exceeding 2 GW per pulse;

b.6.a.2. “Average output power” exceeding 30 W; or

b.6.a.3. Output energy exceeding 0.002 J per pulse;

b.6.b. “Pulse duration” equal to or exceeding 1 ps and less than 1 ns, and any of the following:

b.6.b.1. Output “peak power” exceeding 5 GW per pulse;

b.6.b.2. “Average output power” exceeding 50 W; or

b.6.b.3. Output energy exceeding 0.1 J per pulse;

b.6.c. “Pulse duration” equal to or exceeding 1 ns but not exceeding 1 μs and any of the following:

b.6.c.1. Single transverse mode output and any of the following:

b.6.c.1.a. “Peak power” exceeding 100 MW;

b.6.c.1.b. “Average output power” exceeding 20 W limited by design to a maximum pulse repetition frequency less than or equal to 1 kHz;

b.6.c.1.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;

b.6.c.1.d. “Average output power” exceeding 150 W and capable of operating at a pulse repetition frequency greater than 1 kHz; or

b.6.c.1.e. Output energy exceeding 2 J per pulse; or

b.6.c.2. Multiple transverse mode output and any of the following:

b.6.c.2.a. “Peak power” exceeding 400 MW;

b.6.c.2.b. ‘Wall-plug efficiency’ exceeding 18% and “average output power” exceeding 500 W;

b.6.c.2.c. “Average output power” exceeding 2 kW; or

b.6.c.2.d. Output energy exceeding 4 J per pulse; or

b.6.d. “Pulse duration” exceeding 1 μs and any of the following:

b.6.d.1. Single transverse mode output and any of the following:

b.6.d.1.a. “Peak power” exceeding 500 kW;

b.6.d.1.b. ‘Wall-plug efficiency’ exceeding 12% and “average output power” exceeding 100 W; or

b.6.d.1.c. “Average output power” exceeding 150 W; or

b.6.d.2. Multiple transverse mode output and any of the following:

b.6.d.2.a. “Peak power” exceeding 1 MW;

b.6.d.2.b. ‘Wall-plug efficiency’ exceeding 18% and “average output power” exceeding 500 W; *or*

b.6.d.2.c. “Average output power” exceeding 2 kW;

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

b.7.a. “Pulse duration” not exceeding 1 μ s and any of the following:

b.7.a.1. Output energy exceeding 0.5 J per pulse and “peak power” exceeding 50 W;

b.7.a.2. Single transverse mode output and “average output power” exceeding 20 W; *or*

b.7.a.3. Multiple transverse mode output and “average output power” exceeding 50 W; *or*

b.7.b. “Pulse duration” exceeding 1 μ s and any of the following:

b.7.b.1. Output energy exceeding 2 J per pulse and “peak power” exceeding 50 W;

b.7.b.2. Single transverse mode output and “average output power” exceeding 50 W; *or*

b.7.b.3. Multiple transverse mode output and “average output power” exceeding 80 W;

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

following:

b.8.a. Output energy exceeding 100 mJ per pulse and “peak power” exceeding 1 W; *or*

b.8.b. “Average output power” exceeding 1 W;

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

b.9.a. Single transverse mode and any of the following:

b.9.a.1. Output energy exceeding 100 mJ per pulse and “peak power” exceeding 1 W; *or*

b.9.a.2. “Average output power” exceeding 1 W;

b.9.b. Multiple transverse mode and any of the following:

b.9.b.1. Output energy exceeding 100 mJ per pulse and “peak power” exceeding 10 kW; *or*

b.9.b.2. “Average output power” exceeding 120 W; *or*

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

b.10.a. Output energy exceeding 100 mJ per pulse and “peak power” exceeding 1 W; *or*

b.10.b. “Average output power” exceeding 1 W;

c. “Tunable” lasers having any of the following:

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

c.1.a. Output energy exceeding 50 mJ

per pulse and “peak power” exceeding 1 W; or

c.1.b. Average or CW output power exceeding 1W;

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:

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

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

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

c.2.a. Output energy exceeding 1 J per pulse and “peak power” exceeding 20 W; or

c.2.b. Average or CW output power exceeding 20 W; or

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

c.3.a. Output energy exceeding 50 mJ per pulse and “peak power” exceeding 1 W; or

c.3.b. Average or CW output power exceeding 1 W;

d. Other “lasers”, not controlled by 6A005.a., 6A005.b, or 6A005.c as follows:

d.1. Semiconductor “lasers” as follows:

Note:

1. 6A005.d.1 includes semiconductor “lasers” having optical output connectors (e.g., fiber optic pigtails).

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

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

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

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

d.1.b. Individual, multiple-transverse mode semiconductor “lasers” having any of the following:

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

d.1.b.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

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

d.1.c. Individual semiconductor “laser” ‘bars’ having any of the following:

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

d.1.c.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

d.1.c.3. Wavelength equal to or greater than 1,900 nm and average or CW output

power, exceeding 10 W;

d.1.d. Semiconductor “laser” ‘stacked arrays’ (two dimensional arrays) having any of the following:

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

d.1.d.1.a. Average or CW total output power less than 3 kW and having average or CW output ‘power density’ greater than 500 W/cm²;

d.1.d.1.b. Average or CW total output power equal to or exceeding 3 kW but less than or equal to 5 kW, and having average or CW output ‘power density’ greater than 350W/cm²;

d.1.d.1.c. Average or CW total output power exceeding 5 kW;

d.1.d.1.d. Peak pulsed ‘power density’ exceeding 2,500 W/cm²; or

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

d.1.d.1.e. Spatially coherent average or CW total output power, greater than 150 W;

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

d.1.d.2.a. Average or CW total output power less than 250 W and average or CW output ‘power density’ greater than 150 W/cm²;

d.1.d.2.b. Average or CW total output power equal to or exceeding 250 W but less than or equal to 500 W, and having average or CW output ‘power density’ greater

than 50W/cm²;

d.1.d.2.c. Average or CW total output power exceeding 500 W;

d.1.d.2.d. Peak pulsed ‘power density’ exceeding 500 W/cm²; or

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

d.1.d.2.e. Spatially coherent average or CW total output power, exceeding 15 W;

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

d.1.d.3.a. Average or CW output ‘power density’ greater than 50 W/cm²;

d.1.d.3.b. Average or CW output power greater than 10 W; or

d.1.d.3.c. Spatially coherent average or CW total output power, exceeding 1.5 W; or

d.1.d.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’.

d.1.e. Semiconductor “laser” ‘stacked arrays’, other than those specified by 6.A005.d.1.d., having all of the following:

d.1.e.1. “Specially designed” or modified to be combined with other ‘stacked arrays’ to form a larger ‘stacked array’; and

d.1.e.2. Integrated connections,

common for both electronics and cooling;

Note 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.

Note 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.

Note 3: 6A005.d.1.e does not apply to modular assemblies of single ‘bars’ designed to be fabricated into end to end stacked linear arrays.

Technical Notes:

1. Semiconductor “lasers” are commonly called “laser” diodes.

2. A ‘bar’ (also called a semiconductor “laser” ‘bar’, a “laser” diode ‘bar’ or diode ‘bar’) consists of multiple semiconductor “lasers” in a one dimensional array.

3. A ‘stacked array’ consists of multiple ‘bars’ forming a two dimensional array of semiconductor “lasers”.

d.2. Carbon monoxide (CO) “lasers” having any of the following:

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

d.2.b. Average or CW output power, exceeding 5 kW;

d.3. Carbon dioxide (CO₂) “lasers” having any of the following:

d.3.a. CW output power exceeding 15 kW;

d.3.b. Pulsed output with “pulse duration” exceeding 10 µs and any of the following:

d.3.b.1. “Average output power” exceeding 10 kW; or

d.3.b.2. “Peak power” exceeding 100 kW; or

d.3.c. Pulsed output with a “pulse duration” equal to or less than 10 µs and any of the following:

d.3.c.1. Pulse energy exceeding 5 J per pulse; or

d.3.c.2. “Average output power” exceeding 2.5 kW;

d.4. Excimer “lasers” having any of the following:

d.4.a. Output wavelength not exceeding 150 nm and any of the following:

d.4.a.1. Output energy exceeding 50 mJ per pulse; or

d.4.a.2. “Average output power” exceeding 1 W;

d.4.b. Output wavelength exceeding 150 nm but not exceeding 190 nm and any of the following:

d.4.b.1. Output energy exceeding 1.5 J per pulse; or

d.4.b.2. “Average output power” exceeding 120 W;

d.4.c. Output wavelength exceeding 190 nm but not exceeding 360 nm and any of the following:

d.4.c.1. Output energy exceeding

10 J per pulse; or

d.4.c.2. “Average output power” exceeding 500 W; or

d.4.d. Output wavelength exceeding 360 nm and any of the following:

d.4.d.1. Output energy exceeding 1.5 J per pulse; or

d.4.d.2. “Average output power” exceeding 30 W;

Note: For excimer “lasers” “specially designed” for lithography equipment, see 3B001.

d.5. “Chemical lasers” as follows:

d.5.a. Hydrogen Fluoride (HF) “lasers”;

d.5.b. Deuterium Fluoride (DF) “lasers”;

d.5.c. ‘Transfer lasers’ as follows:

d.5.c.1. Oxygen Iodine (O₂-I) “lasers”;

d.5.c.2. Deuterium Fluoride-Carbon dioxide (DF-CO₂) “lasers”;

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

d.6. ‘Non-repetitive pulsed’ Neodymium (Nd) glass “lasers” having any of the following:

d.6.a. A “pulse duration” not exceeding 1 µs and output energy exceeding 50 J per pulse; or

d.6.b. A “pulse duration” exceeding 1 µs and output energy exceeding 100 J per pulse;

e. “Components” as follows:

e.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.

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

Note to 6A005.e.2: Fiber combiners and MLDs are specified by 6A005.e.3.

e.3. Fiber “laser” “components” as follows:

e.3.a. Multimode to multimode fused tapered fiber combiners having all of the following:

e.3.a.1. An insertion loss better (less) than or equal to 0.3 dB maintained at a rated total average or CW output power (excluding output power transmitted through the single mode core if present) exceeding 1,000 W; and

e.3.a.2. Number of input fibers equal to or greater than 3;

e.3.b. Single mode to multimode fused tapered fiber combiners having all of the following:

e.3.b.1. An insertion loss better (less) than 0.5 dB maintained at a rated total average or CW output power exceeding 4,600 W;

e.3.b.2. Number of input fibers equal to or greater than 3; and

e.3.b.3. Having any of the following:

e.3.b.3.a. A Beam Parameter Product (BPP) measured at the output not exceeding 1.5 mm mrad for a number of input fibers less than or equal to 5; *or*

e.3.b.3.b. A BPP measured at the output not exceeding 2.5 mm mrad for a number of input fibers greater than 5;

e.3.c. MLDs having all of the following:

e.3.c.1. Designed for spectral or coherent beam combination of 5 or more fiber “lasers;” *and*

e.3.c.2. CW “Laser” Induced Damage Threshold (LIDT) greater than or equal to 10 kW/cm²;

f. Optical equipment as follows:

N.B.: For shared aperture optical elements, capable of operating in “Super-High Power Laser” (“SHPL”) applications, see the U.S. Munitions List (22 CFR part 121).

f.1. [Reserved]

N.B.: For items previously specified by 6A005.f.1, see 6A004.f.

f.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);

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

f.3.a. An “accuracy” of 0.1 μm or less, for wavelengths greater than 1 μm; *or*

f.3.b. An “accuracy” of $\lambda/10$ or less (better) at the designed wavelength, for wavelengths equal to or less than 1 μm;

f.4. Projection telescopes “specially designed” for use with “SHPL” systems;

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

g.1. CW “laser” output power greater than or equal to 20 mW;

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

g.3. “Laser” wavelengths equal to or exceeding 1,000 nm but not exceeding 2,000 nm;

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

g.5. Optical Signal to Noise ratio equal or exceeding to 10³.

Technical Note: ‘Laser acoustic detection equipment’ is sometimes referred to as a “Laser” Microphone or Particle Flow Detection Microphone.

6A006 “Magnetometers”, “magnetic gradiometers”, “intrinsic magnetic gradiometers”, underwater electric field sensors, “compensation systems”, and “specially designed” “components” therefor, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
NS applies to entire entry	NS Column 2

AT applies to entire entry	AT Column 1
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Reporting Requirements

See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End-User authorizations.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$1500, N/A for 6A006.a.1; “Magnetometers” and subsystems defined in 6A006.a.2 using optically pumped or nuclear precession (proton/Overhauser) having a ‘sensitivity’ lower (better) than 2 pT (rms) per square root Hz; and 6A006.d, and 6A006.e.

GBS: N/A

CIV: N/A

Special Conditions for STA

STA: License Exception STA may not be used to ship any commodity in: 6A006.a.1; or 6A006.a.2; or 6A006.c.1 “Magnetic gradiometers” using multiple “magnetometers” specified by 6A006.a.1 or 6.A006.a.2; or 6A006.d or .e (only for underwater receivers incorporating magnetometers specified in 6A006.a.1 or 6A006.a.2) to any of the destinations listed in Country Group A:6 (See Supplement No.1 to part 740 of the EAR).

List of Items Controlled

Related Controls: See also [6A996](#). This entry does not control instruments “specially designed” for fishery applications or biomagnetic measurements for medical diagnostics.

Related Definitions: N/A

Items:

a. “Magnetometers” and subsystems, as follows:

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

a.1.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

a.1.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;

a.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;

a.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;

a.4. Induction coil “magnetometers” having a ‘sensitivity’ lower (better) than any of the following:

a.4.a. 0.05 nT (rms)/square root Hz at frequencies of less than 1 Hz;

a.4.b. 1×10^{-3} nT (rms)/square root Hz at frequencies of 1 Hz or more but not exceeding 10 Hz; or

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

- a.5. Fiber 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:
 - c.1. “Magnetic gradiometers” using multiple “magnetometers” controlled by 6A006.a;
 - c.2. Fiber optic “intrinsic magnetic gradiometers” having a magnetic gradient field ‘sensitivity’ lower (better) than 0.3 nT/m (rms) per square root Hz;
 - c.3. “Intrinsic magnetic gradiometers”, using “technology” other than fiber-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 and underwater electric field sensors resulting in a performance equal to or better than the control parameters of 6A006.a, 6A006.b, and 6A006.c; and
- e. Underwater electromagnetic receivers incorporating magnetic field sensors specified by 6A006.a or underwater electric field sensors specified by 6A006.b.

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

6A007 Gravity meters (gravimeters) and gravity gradiometers, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, MT, AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
NS applies to entire entry	NS Column 2
MT applies to 6A007.b and .c when the accuracies in 6A007.b.1 and b.2 are met or exceeded.	MT Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$3000; N/A for MT

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: Related Controls: (1) See USML Category XII(d) for certain gravity meters (gravimeters) and gravity gradiometers subject to the ITAR. (2) See also ECCNs [6A107](#), [6A997](#), and 7A611.

Related Definitions: N/A

Items:

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

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

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

- b.1. A static “accuracy” of less (better) than 0.7 mGal; and

- b.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 (see List of Items Controlled), and “specially designed” “components” therefor.

License Requirements

Reason for Control: NS, MT, RS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
MT applies to items that are designed for airborne applications and that are usable in systems controlled for MT reasons	MT Column 1
RS applies to 6A008.j.1	RS Column 1
AT applies to entire entry	AT Column 1

Reporting Requirements

See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End-User authorizations.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$5000; N/A for MT and for 6A008.j.1.

GBS: Yes, for 6A008.b, .c, and l.1 only

CIV: Yes, for 6A008.b, .c, and l.1 only

STA: License Exception STA may not be used to ship any commodity in 6A008.d, 6A008.h or 6A008.k to any of the destinations listed in Country Group A:6 (See Supplement No.1 to part 740 of the EAR).

List of Items Controlled

Related Controls: (1) See also ECCNs [6A108](#) and [6A998](#). ECCN [6A998](#) controls, inter alia, the Light Detection and Ranging (LIDAR) equipment excluded by the note to paragraph j of this ECCN ([6A008](#)). (2) See USML Category XII(b) for certain LIDAR, Laser Detection and Ranging (LADAR), or range-gated systems subject to the ITAR.

Related Definitions: N/A

Items:

Note: 6A008 does not control:

- Secondary surveillance radar (SSR);
- Civil Automotive Radar;
- Displays or monitors used for air traffic control (ATC);
- Meteorological (weather) radar;
- Precision Approach Radar (PAR) equipment conforming to ICAO standards and employing electronically steerable linear (1-dimensional) arrays or mechanically positioned passive antennas.

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

a.1. An average output power exceeding 100 mW; or

a.2. Locating “accuracy” of 1 m or less

Special Conditions for STA

(better) in range and 0.2 degree or less (better) in azimuth;

b. A tunable bandwidth exceeding $\pm 6.25\%$ of the ‘center operating frequency’;

Technical Note: The ‘center operating frequency’ equals one half of the sum of the highest plus the lowest specified operating frequencies.

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

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

e. Incorporating electronically scanned array antennae;

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

f. Capable of heightfinding non-cooperative targets;

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

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

h.1. “Radar spread spectrum” techniques; or

h.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 en route air traffic control, and having all of the following:

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

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

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

4. Permanently installed;

c. Weather balloon tracking radars.

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

j.1. “Space-qualified”;

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

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

Note 1: LIDAR equipment “specially designed” for surveying is only specified by 6A008.j.3.

Note 2: 6A008.j does not apply to LIDAR equipment “specially designed” for

meteorological observation.

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

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

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

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

b = 0.013 = factor of depth dependent error

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

d = depth

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

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

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

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

Note: 6A008.k.2 does not apply to two dimensional ‘marine radar’ or ‘vessel traffic service’ radar, having all of the following:

a. “Pulse compression” ratio not exceeding 150;

b. Compressed pulse width of greater than 30 ns;

c. Single and rotating mechanically scanned antenna;

d. Peak output power not exceeding 250 W; and

e. Not capable of “frequency hopping”.

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

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

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

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

l.2. [Reserved]

l.3. [Reserved]

l.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.

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

N.B.: See also the U.S. Munitions List (22 CFR part 121).

Note: 6A008.l does not apply to systems, equipment and assemblies designed for ‘vessel traffic services’.

Technical Notes:

1. For the purposes of 6A008, ‘marine radar’ is a radar that is used to navigate safely at sea, inland waterways or near-shore environments.

2. For the purposes of 6A008, ‘vessel traffic service’ is a vessel traffic monitoring and control service similar to air traffic control for “aircraft.”

6A102 Radiation hardened detectors, other than those 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 dose of 5×10^5 rads (silicon).

License Requirements

Reason for Control: MT, AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: In this entry, 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.

Items:

The list of items controlled is contained in the ECCN heading.

6A103 Radomes designed to withstand a combined thermal shock greater than 100 cal/sq cm accompanied by a peak over pressure of greater than 50 kPa, usable in protecting “missiles” against nuclear effects (e.g., Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for “missiles”. (These items are “subject to the ITAR.” See 22 CFR parts 120 through 130.)

6A107 Gravity meters (gravimeters) or gravity gradiometers, other than those controlled by 6A007, designed or modified for airborne or marine use, as follows, (see List of Items Controlled) and “specially designed” “parts” and “components” therefor.

License Requirements

Reason for Control: MT, AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: See USML Category XII(d) for certain gravity meters (gravimeters) or gravity gradiometers subject to the ITAR. See also ECCN 7A611.

Related Definitions: ‘Time to steady-state registration’ (also referred to as the gravity meter’s response time) is the time over which the disturbing effects of platform-induced acceleration (high frequency noise) are reduced.

Items:

- a. Gravity meters having all the following:
 - a.1. A static or operational accuracy equal to or less (better) than 0.7 milligal (mgal); *and*
 - a.2. A ‘time to steady-state registration’ of two minutes or less.
- b. Gravity gradiometers.

6A108 Radar systems and tracking systems, other than those controlled by 6A008, as follows (see List of Items Controlled).

License Requirements

Reason for Control: MT, AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: (1) This entry does not control airborne civil weather radar conforming to international standards for civil weather radars provided that they do not incorporate any of the following: (a) Phased array antennas; (b) Frequency agility; (c) Spread spectrum; or (d) Signal processing “specially designed” for the tracking of vehicles. (2) Items in [6A108.a](#) that are “specially designed” or modified for “missiles” or for items on the U.S. Munitions List are “subject to the ITAR” (see 22 CFR parts 120 through 130).

Related Definitions: Laser radar systems are defined as those that embody specialized transmission, scanning, receiving and signal processing techniques for utilization of lasers for echo ranging, direction finding and discrimination of targets by location, radial speed and body reflection characteristics.

Items:

- a. Radar and laser radar systems designed or modified for use in “missiles”;

Note: [6A108.a](#) includes the following:

- a. Terrain contour mapping equipment;
- b. Imaging sensor equipment;
- c. Scene mapping and correlation (both digital and analog) equipment;
- d. Doppler navigation radar equipment.

b. Precision tracking systems, usable for rockets, missiles, or unmanned aerial vehicles capable of achieving a “range” equal to or greater than 300 km, as follows:

- b.1. Tracking systems which use a code translator installed on the rocket or unmanned

aerial vehicle in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of in-flight position and velocity;

b.2. Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:

b.2.a. Angular resolution better than 1.5 milliradians;

b.2.b. Range of 30 km or greater with a range resolution better than 10 m rms;

b.2.c. Velocity resolution better than 3 m/s.

6A202 Photomultiplier tubes having both of the following characteristics (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: See ECCNs [6E001](#) (“development”), [6E002](#) (“production”), and [6E201](#) (“use”) for technology for items controlled under this entry.

Related Definitions: N/A

Items:

a. Photocathode area of greater than 20 cm²; and

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

6A203 High-speed cameras, imaging devices and “components” therefor, other than those controlled by 6A003 (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: (1) See ECCNs [6E001](#) (“development”), [6E002](#) (“production”), and [6E201](#) (“use”) for technology for items controlled under this entry. (2) Also see ECCN [6A003.a.3](#) and [a.4](#).

Related Definitions: N/A

Items:

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

a.1. Streak cameras with writing speeds greater than 0.5 mm/μs;

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

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

a.4. Plug-ins, “specially designed” for use with streak cameras having modular structures, that enable the performance characteristics described in 6A203.a.1 or .a.2;

a.5. Synchronizing electronics units, and rotor assemblies consisting of turbines, mirrors and bearings, that are “specially designed” for cameras described in 6A203.a.1.

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

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

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

b.3. Framing tubes, and solid-state imaging devices, that have a fast image gating (shutter) time of 50 ns or less and are “specially designed” for cameras described in 6A203.b.1 or .b.2;

b.4. Plug-ins, “specially designed” for use with framing cameras having modular structures, that enable the performance characteristics described in 6A203.b.1 or .b.2;

b.5. Synchronizing electronic units, and rotor assemblies consisting of turbines, mirrors and bearings, that are “specially designed” for cameras described in 6A203.b.1 or .b.2.

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

c.1. Solid-state cameras, or electron tube cameras, with a fast image gating (shutter) time

of 50 ns or less;

c.2. Solid-state imaging devices, and image intensifiers tubes, that have a fast image gating (shutter) time of 50 ns or less and are “specially designed” for cameras described in 6A203.c.1;

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

c.4. Plug-ins, “specially designed” for use with cameras having modular structures, that enable the performance characteristics described in 6A203.c.1.

Technical Note: *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.*

d. Radiation-hardened TV cameras, or lenses therefor, “specially designed” or rated as radiation hardened to withstand a total radiation dose greater than 5×10^4 Gy (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.*

6A205 “Lasers,” “laser” amplifiers and oscillators, other than those controlled by 6A005 (see List of Items Controlled), excluding items that are subject to the export licensing authority of the Nuclear Regulatory Commission (see 10 CFR part 110).

License Requirements

Reason for Control: NP, AT

Control(s)	Country Chart (See)
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	<i>Supp. No. 1 to part 738)</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)*LVS:* N/A*GBS:* N/A*CIV:* N/A**List of Items Controlled**

Related Controls: (1) See ECCNs [6E001](#) (“development”), [6E002](#) (“production”), and [6E201](#) (“use”) for technology for items controlled under this entry. (2) Also see ECCNs [6A005](#) and [6A995](#). (3) See ECCN [6A005.a.2](#) for additional controls on argon ion lasers; See ECCN [6A005.b.6.c](#) for additional controls on neodymium-doped lasers. (4) “Lasers” “specially designed” or prepared for use in isotope separation are subject to the export licensing authority of the Nuclear Regulatory Commission (see 10 CFR part 110).

Related Definitions: N/A*Items:*

a. Copper vapor lasers having both of the following characteristics:

a.1. Operating at wavelengths between 500 nm and 600 nm; *and*

a.2. An average output power equal to or greater than 30 W;

b. Argon ion “lasers” having both of the following characteristics:

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

b.2. An average output power greater than 40 W;

c. Neodymium-doped (other than glass) lasers with an output wavelength between 1000 nm and 1100 nm having either of the following:

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

c.1.a. A single-transverse mode output with an average output power greater than 40 W; *or*

c.1.b. A multiple-transverse mode output with an average output power greater than 50 W; *or*

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

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

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

d.2. An average output greater than 1 W;

d.3. A repetition rate greater than 1 kHz; *and*

d.4. Pulse width less than 100 ns;

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

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

e.2. An average output greater than 30 W;

e.3. A repetition rate greater than 1 kHz; *and*

e.4. Pulse width less than 100 ns;

Note to 6A205.e: 6A205.e does not control single mode oscillators.

f. Alexandrite lasers having all of the following characteristics:

- f.1. Operating at wavelengths between 720 nm and 800 nm;
- f.2. A bandwidth of 0.005 nm or less;
- f.3. A repetition rate greater than 125 Hz; *and*
- f.4. An average output power greater than 30 W;

g. Pulsed carbon dioxide “lasers” having all of the following characteristics:

- g.1. Operating at wavelengths between 9,000 nm and 11,000 nm;
- g.2. A repetition rate greater than 250 Hz;
- g.3. An average output power greater than 500 W; *and*
- g.4. Pulse width of less than 200 ns;

Note to 6A205.g: 6A205.g does not control the higher power (typically 1 kW to 5 kW) industrial CO₂ lasers used in applications such as cutting and welding, as these latter lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.

h. Pulsed excimer lasers (XeF, XeCl, KrF) having all of the following characteristics:

- h.1. Operating at wavelengths between 240 nm and 360 nm;
- h.2. A repetition rate greater than 250 Hz; *and*
- h.3. An average output power greater than 500 W;

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

j. Pulsed carbon monoxide lasers having all of the following characteristics:

- j.1. Operating at wavelengths between 5,000 and 6,000 nm;
- j.2. A repetition rate greater than 250 Hz;
- j.3. An average output power greater than 200 W; *and*
- j.4. Pulse width of less than 200 ns.

Note to ECCN 6A205.j: 6A205.j does not control the higher power (typically 1 kW to 5 kW) industrial CO lasers used in applications such as cutting and welding, because such lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.

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

License Requirements

Reason for Control: NP, AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: See ECCNs [6E001](#) (“development”), [6E002](#) (“production”), and [6E201](#) (“use”) for technology for items controlled under this entry.

Related Definitions: N/A

ECCN Controls: 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).

Items:

The list of items controlled is contained in the ECCN heading.

6A226 Pressure sensors, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

Control(s)	Country Chart (See Supp. No. I to part 738)
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: See ECCNs [6E001](#) (“development”), [6E002](#) (“production”), and [6E201](#) (“use”) for technology for items controlled under this entry.

Related Definitions: N/A

Items:

a. Shock pressure gauges capable of measuring pressures greater than 10 GPa (100 kilobars), including gauges made with manganin, ytterbium, and polyvinylidene difluoride (PVBF, PVF₂);

b. Quartz pressure transducers for pressures greater than 10 GPa (100 kilobars).

6A611 Acoustic systems and equipment, radar, and “parts,” “components,” “accessories,” and “attachments” “specially designed” therefor, “specially designed” for a military application that are not enumerated in any USML category or other ECCN are controlled by ECCN 3A611. Military fire control, laser, imaging, and guidance equipment that are not enumerated in any USML category or ECCN are controlled by ECCN 7A611.

6A991 Marine or terrestrial acoustic equipment, n.e.s., capable of detecting or locating underwater objects or features or positioning surface vessels or underwater vehicles; and “specially designed” “parts” and “components,” n.e.s.

License Requirements

Reason for Control: AT, Foreign policy

Control(s)	Country Chart (See Supp. No. I to part 738)
AT applies to entire entry	AT Column 2
Russian industry sector	See § 746.5 for specific sanctions apply to entire entry.

List Based License Exceptions (See Part 740 for

a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

The list of items controlled is contained in the ECCN heading.

6A992 Optical Sensors, not controlled by 6A002, as follows (see List of Items Controlled).

License Requirements

Reason for Control: AT, RS

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
AT applies to entire entry	AT Column 1
RS applies to entire entry.	A license is required for items controlled by this entry for export or reexport to Iraq or transfer within Iraq for regional stability reasons. The Commerce Country Chart is not designed to determine RS license requirements for this entry. See §§742.6 and 746.3 of the EAR for additional information.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

a. Image intensifier tubes and “specially designed” “components” therefor, as follows:

a.1. Image intensifier tubes having all the following:

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

a.1.b. A microchannel plate for electron image amplification with a hole pitch (center-to-center spacing) of less than 25 micrometers; *and*

a.1.c. Having any of the following:

a.1.c.1. An S-20, S-25 or multialkali photocathode; *or*

a.1.c.2. A GaAs or GaInAs photocathode;

a.2. “Specially designed” microchannel plates having both of the following characteristics:

a.2.a. 15,000 or more hollow tubes per plate; *and*

a.2.b. Hole pitch (center-to-center spacing) of less than 25 micrometers.

b. Direct view imaging equipment operating in the visible or infrared spectrum, incorporating image intensifier tubes having the characteristics listed in 6A992.a.1.

6A993 Cameras, not controlled by 6A003 or 6A203, as follows (see List of Items

Controlled).

License Requirements

Reason for Control: AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: (1) See ECCN 0A919 for foreign made military commodities that incorporate cameras described in 6A993.a that meet the criteria specified in Note 3.a to 6A003.b.4.b (i.e., having a maximum frame rate equal to or less than 9 Hz). (2) Section 744.9 imposes license requirements on cameras described in 6A993.a as a result of meeting the criteria specified in Note 3.a to 6A003.b.4.b (i.e., having a maximum frame rate equal to or less than 9 Hz) if being exported, reexported, or transferred (in-country) for use by a military end-user or for incorporation into a commodity controlled by ECCN 0A919.

Related Definitions: N/A

Items:

a. Cameras that meet the criteria of Note 3 to 6A003.b.4.

b. [Reserved]

6A994 Optics, not controlled by 6A004, as follows (see List of Items Controlled).

License Requirements

Reason for Control: AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

a. Optical filters:

a.1. For wavelengths longer than 250 nm, comprised of multi-layer optical coatings and having either of the following:

a.1.a. Bandwidths equal to or less than 1 nm Full Width Half Intensity (FWHI) and peak transmission of 90% or more; *or*

a.1.b. Bandwidths equal to or less than 0.1 nm FWHI and peak transmission of 50% or more;

Note: 6A994 does not control optical filters with fixed air gaps or Lyot-type filters.

a.2. For wavelengths longer than 250 nm, and having all of the following:

a.2.a. Tunable over a spectral range of 500 nm or more;

a.2.b. Instantaneous optical bandpass of 1.25 nm or less;

a.2.c. Wavelength resettable within 0.1 ms to an accuracy of 1 nm or better within the tunable spectral range; *and*

a.2.d. A single peak transmission of 91% or more;

a.3. Optical opacity switches (filters) with a field of view of 30° or wider and a response time equal to or less than 1 ns;

b. “Fluoride fiber” cable, or optical fibers therefor, having an attenuation of less than 4 dB/km in the wavelength range exceeding 1,000 nm but not exceeding 3,000 nm.

6A995 “Lasers” as follows (see List of Items Controlled).

License Requirements

Reason for Control: AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

a. Carbon dioxide (CO₂) “lasers” having any of the following:

a.1. A CW output power exceeding 10 kW;

a.2. A pulsed output with a “pulse duration” exceeding 10 microseconds; *and*

a.2.a. An average output power exceeding 10 kW; *or*

a.2.b. A pulsed “peak power” exceeding 100 kW; *or*

a.3. A pulsed output with a “pulse duration” equal to or less than 10 microseconds; *and*

a.3.a. A pulse energy exceeding 5 J per pulse and “peak power” exceeding 2.5 kW; *or*

a.3.b. An average output power exceeding 2.5 kW;

b. Semiconductor lasers, as follows:

b.1. Individual, single-transverse mode semiconductor “lasers” having:

b.1.a. An average output power exceeding 100 mW; *or*

b.1.b. A wavelength exceeding 1,050 nm;

b.2. Individual, multiple-transverse mode semiconductor “lasers”, or arrays of individual semiconductor “lasers”, having a wavelength exceeding 1,050 nm;

c. Ruby “lasers” having an output energy exceeding 20 J per pulse;

d. Non-“tunable” “pulsed lasers” having an output wavelength exceeding 975 nm but not exceeding 1,150 nm and having any of the following:

d.1. A “pulse duration” equal to or exceeding 1 ns but not exceeding 1 μs, and having any of the

following:

d.1.a. A single transverse mode output and having any of the following:

d.1.a.1. A ‘wall-plug efficiency’ exceeding 12% and an “average output power” exceeding 10 W and capable of operating at a pulse repetition frequency greater than 1kHz; *or*

d.1.a.2. An “average output power” exceeding 20 W; *or*

d.1.b. A multiple transverse mode output and having any of the following:

d.1.b.1. A ‘wall-plug efficiency’ exceeding 18% and an “average output power” exceeding 30W;

d.1.b.2. A “peak power” exceeding 200 MW; *or*

d.1.b.3. An “average output power” exceeding 50 W; *or*

d.2. A “pulse duration” exceeding 1 μ s and having any of the following:

d.2.a. A single transverse mode output and having any of the following:

d.2.a.1. A ‘wall-plug efficiency’ exceeding 12% and an “average output power” exceeding 10 W and capable of operating at a pulse repetition frequency greater than 1 kHz; *or*

d.2.a.2. An “average output power” exceeding 20 W; *or*

d.2.b. A multiple transverse mode output and having any of the following:

d.2.b.1. A ‘wall-plug efficiency’ exceeding 18% and an “average output power” exceeding 30 W; *or*

d.2.b.2. An “average output power” exceeding 500 W;

e. Non-“tunable” continuous wave “(CW) lasers”, having an output wavelength exceeding 975 nm but not exceeding 1,150nm and having any of the following:

e.1. A single transverse mode output and having any of the following:

e.1.a. A ‘wall-plug efficiency’ exceeding 12% and an “average output power” exceeding 10 W and capable of operating at a pulse repetition frequency greater than 1 kHz; *or*

e.1.b. An “average output power” exceeding 50 W; *or*

e.2. A multiple transverse mode output and having any of the following:

e.2.a. A ‘wall-plug efficiency’ exceeding 18% and an “average output power” exceeding 30 W; *or*

e.2.b. An “average output power” exceeding 500 W;

Note: 6A995.e.2.b does not control multiple transverse mode, industrial “lasers” with output power less than or equal to 2kW with a total mass greater than 1,200kg. 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.

f. Non-“tunable” “lasers”, having a wavelength exceeding 1,400 nm, but not exceeding 1555 nm and having any of the following:

f.1. An output energy exceeding 100 mJ per pulse and a pulsed “peak power” exceeding 1 W; *or*

f.2. An average or CW output power exceeding 1 W;

g. Free electron “lasers.”

6A996 “Magnetometers” not controlled by ECCN 6A006, “Superconductive” electromagnetic sensors, and “specially designed” “components” therefor, as follows (see List of Items Controlled).

License Requirements

Reason for Control: AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

a. “Magnetometers”, n.e.s., having a ‘sensitivity’ lower (better) than 1.0 nT (rms) per square root Hz.

Technical Note: For the purposes of 6A996, ‘sensitivity’ (noise level) is the root mean square of the device-limited noise floor which is the lowest signal that can be measured.

b. “Superconductive” electromagnetic sensors, “components” manufactured from “superconductive” materials:

b.1. Designed for operation at temperatures below the “critical temperature” of at least one of their “superconductive” constituents (including Josephson effect devices or “superconductive” quantum interference devices (SQUIDS));

b.2. Designed for sensing electromagnetic field variations at frequencies of 1 KHz or less; *and*

b.3. Having any of the following characteristics:

b.3.a. Incorporating thin-film SQUIDS with a minimum feature size of less than 2 μ m and with associated input and output coupling circuits;

b.3.b. Designed to operate with a magnetic field slew rate exceeding 1×10^6 magnetic flux quanta per second;

b.3.c. Designed to function without magnetic shielding in the earth’s ambient magnetic field; *or*

b.3.d. Having a temperature coefficient less (smaller) than 0.1 magnetic flux quantum/K.

6A997 Gravity meters (gravimeters) for ground use, n.e.s., as follows (see List of Items Controlled).

License Requirements

Reason for Control: AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

a. Having a static accuracy of less (better) than 100 microgal; or

b. Being of the quartz element (Worden) type.

6A998 Radar systems, equipment and major “components,” n.e.s., and “specially designed” “components” therefor, as follows (see List of Items Controlled).

License Requirements

Reason for Control: RS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
RS applies to 6A998.b	RS Column 1
RS applies to 6A998.c	RS Column 2
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

a. Airborne radar equipment, n.e.s., and “specially designed” “components” therefor.

b. “Space-qualified”“laser” radar or Light Detection and Ranging (LIDAR) equipment “specially designed” for surveying or for meteorological observation.

c. Millimeter wave enhanced vision radar imaging systems “specially designed” for rotary wing aircraft and having all of the following:

c.1. Operates at a frequency of 94 GHz;

c.2. An average output power of less than 20 mW;

c.3. Radar beam width of 1 degree; and

c.4. Operating range equal to or greater than 1500 m.

6A999 Specific processing equipment, as follows (see List of Items Controlled).

License Requirements

Reason for Control: RS AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
RS applies to 6A999.c	RS Column 2
AT applies to entire entry	A license is required for items controlled by this entry to North Korea for anti-terrorism reasons. The Commerce Country Chart is not designed to determine AT licensing requirements for this entry. See §742.19 of the EAR for additional information.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: See also [6A203](#)

Related Definitions: N/A

Items:

- a. Seismic detection equipment not controlled in paragraph c.
- b. Radiation hardened TV cameras, n.e.s.
- c. Seismic intrusion detection systems that detect, classify and determine the bearing on the source of a detected signal.

B. TEST, INSPECTION AND “PRODUCTION EQUIPMENT”

6B004 Optical equipment as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$5000
GBS: Yes for 6B004.b
CIV: Yes for 6B004.b

List of Items Controlled

Related Controls: This entry does not control microscopes.

Related Definitions: N/A

Items:

- a. Equipment for measuring absolute reflectance to an “accuracy” of equal to or better than 0.1% of the reflectance value;
- b. Equipment other than optical surface scattering measurement equipment, having an unobscured aperture of more than 10 cm, “specially designed” for the non-contact optical measurement of a non-planar optical surface figure (profile) to an “accuracy” of 2 nm or less (better) against the required profile.

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

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$5000
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: N/A
Related Definitions: N/A
Items:

The list of items controlled is contained in the

ECCN heading.

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

License Requirements

Reason for Control: NS, MT, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

Reporting Requirements

See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End-User authorizations.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

Special Conditions for STA

STA: License Exception STA may not be used to ship any commodity in this entry to any of the destinations listed in Country Group A:6 (See Supplement No.1 to part 740 of the EAR).

List of Items Controlled

Related Controls: See also [6B108](#)
Related Definitions: N/A
Items:

The list of items controlled is contained in the ECCN heading.

6B108 Systems, other than those controlled by 6B008, “specially designed” for radar cross section measurement usable for rockets, missiles, or unmanned aerial vehicles capable of achieving a “range” equal to or greater than 300 km and their subsystems.

License Requirements

Reason for Control: MT, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: N/A
Related Definitions: N/A
Items:

The list of items controlled is contained in the ECCN heading.

6B619 Test, inspection, and production “equipment” and related commodities “specially designed” for the “development,” “production,” repair, overhaul, or

refurbishing of commodities enumerated or otherwise described in USML Category XVIII (see List of Items Controlled)

License Requirements

Reason for Control: NS, RS, AT, UN

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 1
RS applies to entire entry	RS Column 1
AT applies to entire entry	AT Column 1
UN applies to entire entry	See § 746.1(b) for UN controls

License Exceptions

LVS: \$1500

GBS: N/A

CIV: N/A

Special Conditions for STA

STA: Paragraph (c)(2) of License Exception STA (§ 740.20(c)(2) of the EAR) may not be used for any item in 6B619.

List of Items Controlled

Related Controls: “Parts,” “components,” “accessories,” “attachments,” and associated systems or “equipment” “specially designed” for defense articles enumerated or otherwise described in paragraphs (a) or (b) of USML Category XVIII are subject to the ITAR (see 22 CFR § 121.1, Category XVIII(e)).

Related Definitions: N/A

Items:

- a. Tooling, templates, jigs, mandrels, molds, dies, fixtures, alignment mechanisms, and test “equipment” not enumerated or otherwise

described in USML Category XVIII and not elsewhere specified on the USML that are “specially designed” for the “development,” “production,” repair, overhaul, or refurbishing of commodities controlled by USML Category XVIII.

b. through w. [Reserved]

x. “Parts,” “components,” “accessories,” and “attachments” “specially designed” for a commodity subject to control under paragraph .a of this ECCN and not enumerated or otherwise described in USML Category XVIII and not elsewhere specified on the USML.

6B995 Equipment, including tools, dies, fixtures or gauges, and other “specially designed” “parts,” “components” and “accessories” therefor, “specially designed” or modified for any of the following (see List of Items Controlled).

License Requirements

Reason for Control: AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

- a. For the manufacture or inspection of:

- a.1. Free electron “laser” magnet wigglers;
- a.2. Free electron “laser” photo injectors;
- b. For the adjustment, to required tolerances, of the longitudinal magnetic field of free electron “lasers”.

C. “MATERIALS”

6C002 Optical sensor materials as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$3000
GBS: N/A
CIV: N/A

List of Items Controlled

Related Controls: See also [6C992](#)

Related Definitions: N/A

Items:

- a. Elemental tellurium (Te) of purity levels of 99.9995% or more;
- b. Single crystals (including epitaxial wafers) of any of the following:
 - b.1. Cadmium zinc telluride (CdZnTe), with zinc content less than 6% by ‘mole fraction’;

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

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

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

6C004 Optical materials as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$1500
GBS: Yes for 6C004.a and .e
CIV: Yes for 6C004.a and .e

List of Items Controlled

Related Controls: See also [6C992](#)

Related Definitions: N/A

Items:

- a. Zinc selenide (ZnSe) and zinc sulphide (ZnS) “substrate blanks”, produced by the chemical vapor deposition process and having any of the following:
 - a.1. A volume greater than 100 cm³; *or*
 - a.2. A diameter greater than 80 mm and a

thickness of 20 mm or more;

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

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

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

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

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

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

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

c.1. Having all of the following:

c.1.a. Dynamic (also known as nonstationary) third order nonlinear susceptibility ($\chi^{(3)}$, chi 3) of $10^{-6} \text{ m}^2/\text{V}^2$ or more; *and*

c.1.b. Response time of less than 1 ms; *or*

c.2. Second order nonlinear susceptibility ($\chi^{(2)}$, chi 2) of $3.3 \times 10^{-11} \text{ m/V}$ or more;

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

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

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

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

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

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

6C005 “Laser” materials as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No. 1 to part 738)</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: \$1500

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: N/A

Items:

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

a.1. Titanium doped sapphire;

a.2. [Reserved]

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

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

b.1.a. Average core diameter equal to or greater than 25 μm ; *and*

b.1.b. Core ‘Numerical Aperture’ (‘NA’) less than 0.065; *or*

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

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

b.2.a. Average core diameter equal to or greater than 20 μm ; *and*

b.2.b. Core ‘NA’ less than 0.1.

Technical Notes:

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

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

6C992 Optical sensing fibers not controlled by 6A002.d.3 that are modified structurally to have a ‘beat length’ of less than 500 mm (high birefringence) or optical sensor materials not described in 6C002.b and having a zinc content of equal to or more than 6% by ‘mole fraction.’

License Requirements

Reason for Control: AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: ‘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. 2) ‘Beat length’ is the distance over which two orthogonally polarized signals, initially in phase, must pass in order to achieve a 2 Pi radian(s) phase difference.

Items:

The list of items controlled is contained in the ECCN heading.

6C994 Optical materials, as follows (see List of Items Controlled).

License Requirements

Reason for Control: AT

Control(s)	Country Chart (See Supp. No. 1 to part 738)
AT applies to entire entry	AT Column 1

List Based License Exceptions (See Part 740 for a description of all license exceptions)

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Related Controls: N/A

Related Definitions: 1) ‘Fluoride fibers’ are fibers manufactured from bulk fluoride compounds. 2) ‘Optical fiber preforms’ are bars, ingots, or rods of glass, plastic or other materials that have been specially processed for use in fabricating optical fibers. The characteristics of the preform determine the basic parameters of the resultant drawn optical fibers.

Items:

a. Low optical absorption materials, as follows:

a.1. Bulk fluoride compounds containing ingredients with a purity of 99.999% or better; *or*

Note: 6C994.a.1 controls fluorides of zirconium or aluminum and variants.

a.2. Bulk fluoride glass made from compounds controlled by 6C004.e.1;

b. ‘Optical fiber preforms’ made from bulk fluoride compounds containing ingredients with a purity of 99.999% or better, “specially designed” for the manufacture of ‘fluoride fibers’ controlled by 6A994.b.

D. “SOFTWARE”

6D001 “Software” “specially designed” for the “development” or “production” of equipment controlled by 6A004, 6A005, 6A008 or 6B008.

License Requirements

Reason for Control: NS, MT, RS, AT

<i>Control(s)</i>	<i>Country Chart (See Supp. No.)</i>
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	<i>I to part 738)</i>
NS applies to “software” for equipment controlled by 6A004, 6A005, 6A008 or 6B008.	NS Column 1
MT applies to “software” for equipment controlled by 6A008 or 6B008 for MT reasons.	MT Column 1
RS applies to “software” for equipment controlled by 6A008.j.1	RS Column 1
AT applies to entire entry	AT Column 1

Reporting Requirements

See § 743.1 of the EAR for reporting requirements for exports under License Exceptions, and Validated End-User authorizations.

List Based License Exceptions (See Part 740 for a description of all license exceptions)

CIV: N/A

TSR: Yes, except for the following:

- (1) Items controlled for MT reasons;
- (2) “Software” “specially designed” for the “development” or “production” of “space qualified” “laser” radar or Light Detection and Ranging (LIDAR) equipment defined in 6A008.j.1; or
- (3) Exports or reexports to destinations outside of those countries listed in Country Group A:5 (See Supplement No. 1 to part 740 of the EAR) of “software” “specially designed” for the “development” or “production” of equipment controlled by 6A004.c or d, 6A008.d, h, k or 6B008.

Special Conditions for STA

STA: License Exception STA may not be used to ship or transmit “software”