DEPARTMENT OF COMMERCE

Bureau of Export Administration

15 CFR Parts 740, 743 and 774

[Docket No. 990625176–9176–01]

RIN 0694–AB86

Revisions to the Export Administration Regulations; Commerce Control List: Revision to Categories 1, 2, 3, 4, 5, 6, 7, and 9 Based on Wassenaar Arrangement Review

AGENCY: Bureau of Export Administration, Commerce.

ACTION: Final rule.

SUMMARY: The Bureau of Export Administration (BXA) maintains the Commerce Control List (CCL), which identifies those items subject to Department of Commerce export controls. This final rule revises certain entries controlled for national security reasons in Categories 1, 2, 3, 4, 5, 6, 7, and 9 to conform with changes in the Wassenaar Arrangement's List of Dual-Use Goods and Technologies maintained and agreed to by governments participating in the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies (Wassenaar Arrangement). The Wassenaar Arrangement controls strategic items with the objective of improving regional and international security and stability.

DATES: This rule is effective July 23, 1999.

FOR FURTHER INFORMATION CONTACT: For questions of technical nature, the following persons in the Office of Strategic Trade are available:

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SUPPLEMENTARY INFORMATION:

Background

In July 1996, the United States and thirty-two other countries gave final approval to the establishment of a new multilateral export control arrangement, called the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies (Wassenaar Arrangement). The Wassenaar Arrangement contributes to regional and international security and stability by promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies, thus preventing destabilizing accumulations of such items. Participating states have committed to exchange information on exports of dual-use goods and technologies to non-participating states for the purposes of enhancing transparency and assisting in developing common understandings of the risks associated with the transfers of these items.

On January 15, 1998, the Bureau of Export Administration (BXA) published an interim rule (63 FR 2452) fulfilling U.S. commitments to the Wassenaar Arrangement by implementing the Wassenaar Arrangement list of dual-use items and imposing reporting requirements for exports of certain items controlled under the Wassenaar Arrangement.

This final rule revises a number of national security controlled entries on the Commerce Control List (CCL) to conform with recent changes in the Wassenaar List of Dual-Use Goods and Technologies. Specifically, this rule makes the following amendments:

Category 1—Materials, Chemicals, Microorganisms, and Toxins

1C004—Amended by modifying controls on the elastic limit from 1,250 MPa to 880 MPa (1C004.b).

1C006—Amended by removing national security controls on hydrocarbon oils (1C006.a.1).

Category 2—Material Processing

2B001—Amended by modifying the note to 2B001.c to clarify that certain tool or cutter grinding machines are not controlled for national security reasons (decontrol note 2B001.c). In addition, the related controls section has been amended by adding a reference to refer to 1B101.d for cutting equipment designed or modified for removing prepregs and preforms controlled by 9A110 (2B001, related controls).

2B004—Amended by (1) revising the entry heading by removing national security controls on dies, molds and controls specially designed for certain hot isostatic presses (2B004, heading); and (2) revising the related controls section to by adding two new references, as follows: (a) for specially designed dies, molds and tooling refer to 1B001, 9B009, and ML18 of the Munitions List; and (b) in addition, see 1B101.d, 2B104, and 2B204 for controls on dies, molds and tooling (2B004, related controls).

2B005—Amended by correcting an editorial error (2B005.c).

2D001—Amended by modifying the entry heading to read ''software'', other than that controlled by 2D002, specially designed or modified for the ''development'', ''production'' or ''use'' of equipment controlled by 2A001 or 2B001 to 2B009 (2D001, heading). In addition, the related controls section is amended by clarifying that 2D001 controls software not covered by 2D101, that are specially designed or modified for the controllers of flow forming machines described in 2B109 (2D001, related controls).

2E003—Amended by (1) revising the related controls section by adding a reference to refer to 2E001, 2E002 and 2E101 for ''development'', ''production'' and ''use'' technology for equipment that are designed or modified for densification of carbon-carbon composites, structural composite rocket nozzles and reentry vehicle nose tips (2E003, related controls); and (2) revising the Deposition Techniques Table by (1) adding new ''resultant coatings'' technologies for diamond, boron nitride, and beryllium; and (2) updating the ''sensor window materials'' note by including diamond, gallium phosphide, sapphire, zirconium fluoride and hafnium fluoride and by removing potassium iodide, potassium fluoride, thallium bromide and thallium chlorobromide.

Category 3—Electronics

3A001—Amended by increasing the gate count from 300 to 3,000 for digital integrated circuits (3A001.a.11).

3A002—Amended by: (1) liberalizing controls for digital video magnetic tape recorders from 180 to 360 Mbits/s (3A002.a.2); (2) modifying the note to 3A002.a.2 by clarifying that 3A001.a.2 does not control digital video magnetic tape recorders specially designed for television recording using a signal format, which may include a compressed signal format, standardized or recommended by the ITU, the IEC, the SMPTE, the EBU or the IEEE for civil television applications (decontrol note to 3A002.a.2); and (3) modifying the note to 3A002.c.2 by clarifying that 3A002 does not control those ''dynamic signal analyzers'' using only constant percentage bandwidth filters (also known as octave or fractional octave filters) (clarification note to 3A002.c.2).

3B001—Amended by: (1) adding controls for molecular beam epitaxial growth equipment using solid sources

(3B001.a.3); (2) liberalizing controls for ion implantaters and adding a new term ''beam energy'' (3B001.b.1 and b.2); and (3) clarifying lithography equipment controls to include direct step on wafer equipment or step and scan (scanner) equipment, relaxing controls on the light source wavelength of lithography equipment from 400 nm to 350 nm and relaxing controls on minimum resolvable feature size on lithography equipment from 0.7 to 0.5 microns or less (3B001.f).

3C002—Amended by relaxing wavelength controls for positive resists for semiconductor lithography from 370 nm to 350 nm (3C002.a).

3E001—Amended by revising the note to 3E001 to indicate that 3E001 does not control integrated circuits using technology of 0.7 microns or more (decontrol note to 3E001).

3E002—Amended by adding new controls for substrates of silicon-on insulator (SOI) for integrated circuits in which the insulator is silicon dioxide (3E002.e) and substrates of silicon carbide for electronic components (3E002.f). In addition the related controls section is amended by adding a reference to refer to 3E001 for silicon-on-insulation technology for the ''development'' or ''production'' related to radiation hardening of integrated circuits (3E002, related controls).

Category 4—Computers

4A003—Amended by removing controls for 4A003.f (Equipment containing ''terminal interface equipment'' exceeding the limits in 5A001.b.3). This revision is consistent with consequential changes to 5A001 (i.e., the removal of equipment containing ''network access controllers'' or ''communication channel controllers''. In addition, to avoid possible confusion, the note to 4A003.g has been amended to clarify that ''network access controllers'' or ''communication channel controllers'' are not controlled by this entry (decontrol note to 4A003.g).

Table to Category 4—Amended by revising Note 5 to clarify that aggregation for CTP values do not apply to ''electronic assemblies'' described in 4A003.c (technical note 5 on CTP)

Category 5—Telecommunications, Part I

Several sections of Part I, Telecommunications have been removed creating a significant number of changes to the controls on telecommunication equipment. The majority of changes are identified in the following entries.

Note 1 to Category 5—Part 1—Telecommunications: Amended by removing the phrase ''materials'' (Note 1), as 5C001 was deleted from national security controls.

5A001—Amended by:

(1) removing controls on telecommunications equipment or systems containing any of the following:

—Employing digital techniques (5A001.b.1);

—Containing ''network access controllers'' or ''communication channel controllers'' (5A001.b.3);

—employing a laser (5A001.b.4);

—being radio equipment operating at input or output frequencies exceeding 31 GHz (5A001.b.5);

—being radio equipment employing Quadrature Amplitude Modulation (QAM) techniques or other digital modulation techniques and having a spectral efficiency exceeding 3 bit/sec/Hz (5A001.b.6);

(2) removing controls on ''stored program controlled'' switching equipment containing any of the following (5A001.c):

—common channel signalling (5A001.c.1);

—dynamic adaptive routing (5A001.c.2);

—being packet switches, circuit switches and routers (5A001.c.3);

—optical switches (5A001.c.4);

—employing ''Asynchronous Transfer Mode'' (ATM) techniques (5A001.c.5);

(3) modifying controls for optical fiber communication cables (5A001.d); removing controls on optical fiber cables and liberalizing controls on optical fibers from 50 m to 500 m (5A001.d.1); and removing controls for single mode operation (5A001.d.1.a); and

(4) adding a Nota Bene to 5A001.d.2 clarifying that you should review 8A002.a.3 for underwater umbilical cables and connectors therefor.

5B001—Amended by: (1) revising the entry heading to read ''test, inspection and production equipment, see list of items controlled''; (2) redesignating the former entry heading as 5B001.a and by removing the term ''materials''; (3) adding a note to 5B001.a specifying that 5B001.a does not control optical fiber characterization equipment not using semiconductor ''lasers'', formerly described in the Related Controls section. The format changes to the entry heading and to 5B001.a are consistent with the format revisions agreed to by the Wassenaar Arrangement. In addition, 5B001 is amended by creating a new 5B001.b. This new paragraph b adds national security controls for equipment and specially designed components or accessories therefor, specially designed for the ''development'' of certain telecommunication transmission or ''stored program controlled'' switching equipment.

5C001—Amended by removing national security controls for preforms of glass or of any other material optimized for the manufacturer of optical fibers controlled by 5A001.d.

5D001—Amended by: (1) removing controls for software for the use of digital cellular radio equipment or systems (5D001.c.1) and (2) creating a new 5D001.d. This new paragraph d adds national security controls for ''software'' specially designed or modified for the ''development'' of certain telecommunication transmission or ''stored program controlled'' switching equipment (5D001.d).

5E001—Amended by: (1) removing national security controls on certain technology for the ''development'' or ''use'' of laser communication techniques (5E001.b.4, 5E001.b.6, 5E001.b.8, and 5E001.b.9) and (2) creating a new 5E001.c. This new paragraph c adds national security controls for ''technology'' according to the General Technology Note for the ''development'' or ''production'' of certain telecommunication transmission or ''stored program controlled'' equipment functions or features (5E001.c).

Category 6—Sensors and Lasers

6A003—Amended by: (1) modifying the term intensifiers to read intensifier tubes (6A003.b.3); and (2) adding a note to 6A003.b.4 clarifying that 6A003.b.4 does not control imaging cameras incorporating linear ''focal plane arrays'' with twelve elements or fewer, not employing time-delay-and-integration within the element, designed for (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 (decontrol note to 6A003.b.4).

6A005—Amended by: (1) adding a note for excimer lasers, specially designed for lithography equipment (related controls); and (2) adding a new control for individual single-transverse mode semiconductor lasers (6A005.b.1).

6C002—Amended by relaxing controls on zinc cadmium telluride (6C005.b).

Category 7—Navigation and Avionics

Notes to Category 7A—Amended by revising the ''Note to Category 7A'' as ''Nota Bene (N.B.) 2'' and by revising the existing Nota Bene as ''N.B. 1'' (notes to Category 7 A).

Category 9—Propulsion Systems, Space Vehicles and Related Equipment

Parenthetical note to Category 9A—Amended by redesignating the parenthetical phrase as a Nota Bene (N.B.).

Items placed under control will be subject to both national security (NS) and antiterrorism (AT) controls. (see ECCN 3E002.e and f.) These actions are taken in consultation with the Departments of State and Defense and pursuant to agreements reached in the Wassenaar Arrangement.

All items removed from national security (NS) controls as a result of the Wassenaar List of Dual-Use Goods and Technologies will continue to be controlled for antiterrorism (AT) reasons.

BXA is continuing a comprehensive review of the Commerce Control List (CCL) to account for items controlled by the Nuclear Suppliers Group (NSG), the Missile Technology Control Regime (MTCR), and the Australia Group (AG) and to correct errors unavoidably reprinted in this version of the CCL. The review will be based in large part upon the comments received and upon ongoing efforts to harmonize the CCL with the EU's control list.

Although the Export Administration Act (EAA) expired on August 20, 1994, the President invoked the International Emergency Economic Powers Act and continued in effect, to the extent permitted by law, the provisions of the EAA and the EAR in Executive Order 12924 of August 19, 1994, as extended by the President's notices of August 15, 1995 (60 FR 42767), August 14, 1996 (61 FR 42527), August 13, 1997 (62 FR 43629), and August 13, 1998 (63 FR 44121).

Saving Clause

Shipments of items removed from eligibility for export or reexport under a particular License Exception authorization or the designator NLR, as a result of this regulatory action, may continue to be exported or reexported under that License Exception authorization or designator until August 23, 1999. In addition, this rule revises the numbering and structure of certain entries on the Commerce Control List. For items under such entries and for October 21, 1999, BXA will accept license applications for items described either by the entries in effect immediately before July 23, 1999 or the entries described in this rule.

Rulemaking Requirements

1. This interim rule has been determined to be not significant for purposes of E.O. 12866.

2. Notwithstanding any other provision of law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with a collection of information, subject to the requirements of the Paperwork Reduction Act (PRA), unless that collection of information displays a currently valid OMB Control Number. This rule involves collections of information subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*) These collections has been approved by the Office of Management and Budget under control numbers 0694–0073, 0694–0086, and 0694–0088.

3. This rule does not contain policies with Federalism implications sufficient to warrant preparation of a Federalism assessment under Executive Order 12612.

4. The provisions of the Administrative Procedure Act (5 U.S.C. 553) requiring notice of proposed rulemaking, the opportunity for public participation, and a delay in effective date, are inapplicable because this regulation involves a military and foreign affairs function of the United States (Sec. 5 U.S.C. 553(a)(1)). Further, no other law requires that a notice of proposed rulemaking and an opportunity for public comment be given for this interim rule. Because a notice of proposed rulemaking and an opportunity for public comment are not required to be given for this rule under 5 U.S.C. or by any other law, the analytical requirements of the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) are not applicable.

List of Subjects

15 CFR Part 740

Administrative practice and procedure, Exports, Foreign trade, Reporting and recordkeeping requirements.

15 CFR Part 743

Administrative practice and procedure, Exports, Foreign trade, Reporting and recordkeeping requirements.

15 CFR Part 774

Exports, Foreign Trade.

Accordingly, parts 740, 743 and 774 of the Export Administration Regulations (15 CFR parts 730 through 799) are amended as follows:

1. The authority citation for part 740 is revised to read as follows:

Authority: 50 U.S.C. app. 2401 *et seq.*; 50 U.S.C. 1701 *et seq.*; E.O. 12924, 59 FR 43437, 3 CFR, 1994 Comp., p. 917; E.O. 13026, 61 FR 58767, 3 CFR, 1996 Comp., p. 228 and of Notice of August 13, 1998 (63 FR 44121, 3 CFR, 1998 Comp., p. 294.

2. The authority citation for part 743 is revised to read as follows:

Authority: 50 U.S.C. app. 2401 *et seq.*; 50 U.S.C. 1701 *et seq.*; E.O. 12924, 59 FR 43437, 3 CFR, 1994 Comp., p. 917; Notice of August 13, 1998, 63 FR 44121, 3 CFR, 1998 Comp., p. 294.

3. The authority citation for part 774 continues to read as follows:

Authority: 50 U.S.C. app. 2401 *et seq.*; 50 U.S.C. 1701 *et seq.*; 10 U.S.C. 720; 10 U.S.C. 7430(e); 18 U.S.C. 2510 *et seq.*; 22 U.S.C. 287c; 22 U.S.C. 3201 *et seq.*; 22 U.S.C. 6004; 30 U.S.C. 185(s), 185(u); 42 U.S.C. 2139a; 42 U.S.C. 6212; 43 U.S.C. 1354; 46 U.S.C. app. 466c; 50 U.S.C. app. 5; E.O. 12924, 59 FR 43437, 3 CFR, 1994 Comp., p. 917; Notice of August 15, 1995, 60 FR 42767, 3 CFR, 1995 Comp., p. 501; Notice of August 14, 1996, 61 FR 42527, 3 CFR, 1996 Comp., p. 298; Notice of August 13, 1997, 62 FR 43629, 3 CFR, 1997 Comp. p., 306; Notice of August 13, 1998, 63 FR 44121, 3 CFR, 1998 Comp., p. 294.

PART 740—[AMENDED]

4. Section 740.11 is amended:

a. By revising paragraph (a)(2);

b. By revising Supplement No. 1, as follows:

§ 740.11 Governments, international organizations, and international inspections under the Chemical Weapons Convention (GOV).

* * * * *

(a) * * *

(2) The following items controlled for national security (NS) reasons under Export Control Classification Numbers (ECCNs) identified on the Commerce Control List may not be exported or reexported under this License Exception to destinations other than Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom: 1C001, 1C012, 5A001.b.4, 6A001.a.2.a.1, 6A001.a.2.a.2, 6A001.a.2.a.7, 6A001.a.2.b, 6A001.a.2.e.1, 6A001.a.2.e.2, 6A002.a.1.c, 6A008.l.3., 6B008, 8A001.b., 8A001.d., 8A002.o.3.b., 9A011; and

(i) ''Composite'' structures or laminates controlled by 1A002.a., having an organic ''matrix'' and made from materials listed under 1C010.c. or 1C010.d.; and

(ii) ''Digital'' computers controlled by 4A003.b. and having a CTP exceeding 10,000 MTOPS; and

(iii) ''Electronic assemblies'' controlled by 4A003.c. and capable of enhancing performance by aggregation of ''computing elements'' so that the CTP of the aggregation exceeds 10,000 MTOPS; and

(iv) Processing equipment controlled by 6A001.a.2.c. and specially designed for real time application with towed acoustic hydrophone arrays; and

(v) Bottom or bay cable systems controlled by 6A001.a.2.e.3 and having processing equipment specially designed for real time application with bottom or bay cable systems; and

(vi) ''Software'', as follows:

(A) Controlled by 4D001, specially designed for the ''development'' or ''production'' for items controlled by 4A003.b or .c, as defined by paragraphs (a)(2)(ii) and (iii) of this section; and

(B) Controlled by 5D001.a, specially designed for items controlled by 5A001.b.4; and

(C) Controlled by 6D001 for items controlled by 6A008.l.3 or 6B008; and

(D) Controlled by 6D003.a; and

(E) Controlled by 7D003.a or 7D003.b; and

(F) Controlled by 8D001, specially designed for the ''development'' or ''production'' of equipment controlled by 8A001.b, 8A001.d, or 8A002.o.3.b; and

(G) Controlled by 9D001, specially designed for the ''development'' of equipment or ''technology'' controlled by 9A011, 9E003.a.1, or by 9E003.a.3, for items controlled by 1A002.a, as described in paragraph (a)(2)(i) of this section; and

(H) Controlled by 9D002 for ''software'' specially designed for the ''production'' of equipment controlled by 9A011; and

(I) Controlled by 9D004.a or .c.

* * * * *

Supplement No. 1 to § 740.11—Additional Restrictions On Use of License Exception GOV.

(a) Items for official use within national territory by agencies of the U.S. Government. License Exception GOV is available for all items consigned to and for the official use of any agency of a cooperating government within the territory of any cooperating government, except:

(1) Items identified on the Commerce Control List as controlled for national security (NS) reasons under Export Control Classification Numbers (ECCNs) as follows for export or reexport to destinations other than Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, or the United Kingdom: 1C001, 1C012, 5A001.b.4, 6A001.a.2.a.1, 6A001.a.2.a.2, 6A001.a.2.a.7, 6A001.a.2.b, 6A001.a.2.e.1, 6A001.a.2.e.2, 6A002.a.1.c, 6A008.l.3., 6B008, 8A001.b., 8A001.d., 8A002.o.3.b., 9A011; and

(i) ''Composite'' structures or laminates controlled by 1A002.a., having an organic ''matrix'' and made from materials listed under 1C010.c. or 1C010.d.; and

(ii) ''Digital'' computers controlled by 4A003.b. and having a CTP exceeding 10,000 MTOPS; and

(iii) ''Electronic assemblies'' controlled by 4A003.c. and capable of enhancing performance by aggregation of ''computing elements'' so that the CTP of the aggregation exceeds 10,000 MTOPS; and

(iv) Processing equipment controlled by 6A001.a.2.c. and specially designed for real time application with towed acoustic hydrophone arrays; and

(v) Bottom or bay cable systems controlled by 6A001.a.2.e.3 and having processing equipment specially designed for real time application with bottom or bay cable systems; and

(vi) ''Software'', as follows:

(A) Controlled by 4D001, specially designed for the ''development'' or ''production'' for items controlled by 4A003.b or .c, as defined by paragraphs (a)(1)(ii) and (iii) of this Supplement; and

(B) Controlled by 5D001.a, specially designed for items controlled by 5A001.b.4; and

(C) Controlled by 6D001 for items controlled by 6A008.l.3 or 6B008; and

(D) Controlled by 6D003.a; and

(E) Controlled by 7D003.a or 7D003.b; and

(F) Controlled by 8D001, specially designed for the ''development'' or ''production'' of equipment controlled by 8A001.b, 8A001.d, or 8A002.o.3.b; and

(G) Controlled by 9D001, specially designed for the ''development'' of equipment or ''technology'' controlled by 9A011, 9E003.a.1, or by 9E003.a.3, for items controlled by 1A002.a, as described in paragraph (a)(1)(i) of this Supplement; and

(H) Controlled by 9D002 for ''software'' specially designed for the ''production'' of equipment controlled by 9A011; and

(I) Controlled by 9D004.a or .c.; and

(vii) ''Technology'', as follows:

(A) Controlled by 5E001.a for items controlled by 5A001.b.4 or 5D001.a; and

(B) Controlled by 1E001 for items controlled by 1A002.a, 1C001, or 1C102 as described by paragraph (a)(1)(i) of this Supplement; and

(C) Controlled by 6E001 for the ''development'' of equipment or ''software'' in 6A001.a.2.a.1, 6A001.a.2.a.2, 6A001.a.2.a.7, 6A001.a.2.b, 6A001.a.2.c, 6A001.a.2, a.3, 6A002.a.1.c, 6A008.l.3, or 6B008, as described in paragraph (a)(1) of this Supplement; and

(D) Controlled by 6E002 for the ''production'' of equipment controlled by 6A001.a.2.a.1, 6A001.a.2.a.2, 6A001.a.2.a.7, 6A001.a.2.b, 6A001.a.2.c, 6A001.a.2.3, 6A002.a.1.c, 6A008.l.3, or 6B008, as described in paragraph (a)(1) of this Supplement; and

(E) Controlled by 8E001 for items controlled by 8A001.b, 8A002.o.3.b, or 8A001.d; and

(F) Controlled by 9E001 for items controlled by 9A011, 9D001, or 9D002; and

(G) Controlled by 9E002 for items controlled by 9A011; and

(H) Controlled by 9E003.a.1; and

(I) Controlled by 9E003.a.3 for items controlled by 1A002.a as described in paragraph (a)(1) of this Supplement;

(2) Items identified on the Commerce Control List as controlled for missile technology (MT), chemical and biological warfare (CB), or nuclear nonproliferation (NP) reasons;

(3) Regional stability items controlled under Export Control Classification Numbers (ECCNs) 6A002, 6A003, 6E001, 6E002, 7D001, 7E001, 7E002, and 7E101 as described in § 742.6(a)(1) of the EAR; or

(4) Encryption items controlled for EI reasons as described in the Commerce Control List.

(b) *Diplomatic and consular missions of a cooperating government.* License Exception GOV is available for all items consigned to and for the official use of a diplomatic or consular mission of a cooperating government located in any country in Country Group B (see Supplement No. 1 to part 740), except:

(1) Items identified on the Commerce Control List as controlled for national security (NS) reasons under Export Control Classification Numbers (ECCNs) as follows for export or reexport to destinations other than Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, or the United Kingdom: 1C001, 1C012, 5A001.b.4, 6A001.a.2.a.1, 6A001.a.2.a.2, 6A001.a.2.a.7, 6A001.a.2.b, 6A001.a.2.e.1, 6A001.a.2.e.2, 6A002.a.1.c, 6A008.l.3., 6B008, 8A001.b., 8A001.d., 8A002.o.3.b., 9A011; and

(i) ''Composite'' structures or laminates controlled by 1A002.a., having an organic ''matrix'' and made from materials listed under 1C010.c. or 1C010.d.; and

(ii) ''Digital'' computers controlled by 4A003.b. and having a CTP exceeding 10,000 MTOPS; and

(iii) ''Electronic assemblies'' controlled by 4A003.c. and capable of enhancing performance by aggregation of ''computing elements'' so that the CTP of the aggregation exceeds 10,000 MTOPS; and

(iv) Processing equipment controlled by 6A001.a.2.c. and specially designed for real time application with towed acoustic hydrophone arrays; and

(v) Bottom or bay cable systems controlled by 6A001.a.2.e.3 and having processing equipment specially designed for real time application with bottom or bay cable systems; and

(vi) ''Software'', as follows:

(A) Controlled by 4D001, specially designed for the ''development'' or ''production'' for items controlled by 4A003.b or .c, as defined by paragraphs (b)(1)(ii) or (iii) of this Supplement; and

(B) Controlled by 5D001.a, specially designed for items controlled by 5A001.b.4; and

(C) Controlled by 6D001 for items controlled by 6A008.l.3 or 6B008; and

(D) Controlled by 6D003.a; and

(E) Controlled by 7D003.a or 7D003.b; and

(F) Controlled by 8D001, specially designed for the ''development'' or ''production'' of equipment controlled by 8A001.b, 8A001.d, or 8A002.o.3.b; and

(G) Controlled by 9D001, specially designed for the ''development'' of equipment or ''technology'' controlled by 9A011, 9E003.a.1, or by 9E003.a.3, for items controlled by 1A002.a, as described in paragraph (b)(1)(i) of this Supplement; and

(H) Controlled by 9D002 for ''software'' specially designed for the ''production'' of equipment controlled by 9A011; and

(I) Controlled by 9D004.a or .c; and

(vii) ''Technology'', as follows:

(A) Controlled by 5E001.a for items controlled by 5A001.b.4 or 5D001.a; and

(B) Controlled by 1E001 for items controlled by 1A002.a, 1C001, or 1C102 as described by paragraph (b)(1) of this Supplement; and

(C) Controlled by 6E001 for the ''development'' of equipment or ''software'' in 6A001.a.2.a.1, 6A001.a.2.a.2, 6A001.a.2.a.7, 6A001.a.2.b, 6A001.a.2.c, 6A001.a.2.3, 6A002.a.1.c, 6A008.l.3, or 6B008, as described in paragraph (b)(1) of this Supplement; and

(D) Controlled by 6E002 for the ''production'' of equipment controlled by 6A001.a.2.a.1, 6A001.a.2.a.2, 6A001.a.2.a.7, 6A001.a.2.b, 6A001.a.2.c, 6A001.a.2.3, 6A002.a.1.c, 6A008.l.3, or 6B008, as described in paragraph (b)(1) of this Supplement; and

(E) Controlled by 8E001 for items controlled by 8A001.b, 8A002.o.3.b, or 8A001.d; and

(F) Controlled by 9E001 for items controlled by 9A011, 9D001, or 9D002; and

(G) Controlled by 9E002 for items controlled by 9A011; and

(H) Controlled by 9E003.a.1; and

(I) Controlled by 9E003.a.3 for items controlled by 1A002.a as described in paragraph (b)(1)(i) of this Supplement;

(2) Items identified on the Commerce Control List as controlled for missile technology (MT), chemical and biological warfare (CB), or nuclear nonproliferation (NP) reasons;

(3) Regional stability items controlled under Export Control Classification Numbers (ECCNs) 6A002, 6A003, 6E001, 6E002, 7D001, 7E001, 7E002, and 7E101 as described in § 742.6(a)(1) of the EAR; or

(4) Encryption items controlled for EI reasons as described in the Commerce Control List.

PART 743—[AMENDED]

5. Section 743.1 is amended by revising (c)(1) to read as follows:

§ 743.1 Wassenaar Arrangement.

* * * * * *

(c) *Items for which reports are required.* (1) You must submit reports to BXA under the provisions of this section only for exports of items controlled under the following ECCNs:

(i) *Category 1:* 1A002, 1C007.c and .d, 1C010.c and .d, 1D002, 1E001, 1E002.e, and 1E002.f.;

(ii) *Category 2:* 2B001.a or .b (certain items only; see Note to this paragraph) 2B001.d and .f, 2B003, 2D001, 2E001, and 2E002;

Note to paragraph (c)(1)(ii): The following are not controlled for NP reasons: turning machines controlled by 2B001.a with a capacity equal to or less than 35 mm diameter; bar machines (Swissturn), limited to machining only bar feed through, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks (machines may have drilling and/or milling capabilities for machining parts with diameters less than 42 mm); or milling machines controlled by 2B001.b with x-axis travel greater than two meters and overall ''positioning accuracy'' on the x-axis more (worse) than 0.030 mm. Therefore, exports of such items under License Exception GOV are subject to reporting requirements.

(iii) *Category 3:* 3A002.g.2, 3B001.a.2, 3D001, and 3E001;

(iv) *Category 4:* 4A001.a.2 and .b, 4A003.b and .c (see paragraph (c)(2) of this section), 4D001, 4D003.c, and 4E001;

(v) *Category 5:* 5A001.b.3, 5B001 (items specially designed for 5A001.b.3), 5D001.a and .b, and 5E001.a;

(vi) *Category 6:* 6A001.a.1.b, .a.2.c, .a.2.d, and .a.2.e; 6A002.b, 6A004.c and d, 6A006.g and h, 6A008.d, .h, and .k; 6D001, 6D003.a, 6E001, and 6E002;

(vii) *Category 8:* 8A001.c; 8A002.b, .h, .j, .o.3.a, and .p; 8D001, 8D002, 8E001, and 8E002.a; and

(viii) *Category 9:* 9B001.b, 9D001, 9D002, 9D004.a and .c, 9E001, 9E002, 9E003.a.1, 9E003.a.2, .a.3, .a.4, .a.5, .a.8, and .a.9.

* * * * *

PART 774—[AMENDED]

6. In Supplement No. 1 to part 774 (the Commerce Control List), Category 1—Materials, Chemicals, Microorganisms, and Toxins, Export Control Classification Numbers (ECCNs) are amended:

a. By revising the List of Items Controlled section for ECCNs 1C004 and 1C006; and

b. By adding a new ECCN 1C996, to read as follows:

1C004 Uranium titanium alloys or tungsten alloys with a ''matrix'' based on iron, nickel or copper, having all of the characteristics (see List of Items Controlled).

* * * * *

List of Items Controlled

Unit: Kilograms
Related Controls: N/A
Related Definitions: N/A
Items:

a. A density exceeding 17.5 g/cm^3;

b. An elastic limit exceeding 880 MPa;

c. An ultimate tensile strength exceeding 1,270 MPa; *and*

d. An elongation exceeding 8%.

1C006 Fluids and lubricating materials, as follows (see List of Items Controlled).

* * * * *

List of Items Controlled

Unit: Barrels (55 U.S. gallons/ 209 liters)
Related Controls: N/A
Related Definitions: N/A
Items:

a. Hydraulic fluids containing, as their principal ingredients, any of the following compounds or materials:

a.1. Synthetic or silahydrocarbon oils, having all of the following:

Note: For the purpose of 1C006.a.1, silahydrocarbon oils contain exclusively silicon, hydrogen and carbon.

a.1.a. A flash point exceeding 477 K (204° C);

a.1.b. A pour point at 239 K (−34° C) or less;

a.1.c. A viscosity index of 75 or more; *and*

a.1.d. A thermal stability at 616 K (343° C); *or*

a.2. Chlorofluorocarbons, having all of the following:

Note: For the purpose of 1C006.a.2, chlorofluorocarbons contain exclusively carbon, fluorine and chlorine.

a.2.a. No flash point;

a.2.b. An autogenous ignition temperature exceeding 977 K (704° C);

a.2.c. A pour point at 219 K (−54° C) or less;

a.2.d. A viscosity index of 80 or more; *and*

a.2.e. A boiling point at 473 K (200° C) or higher;

b. Lubricating materials containing, as their principal ingredients, any of the following compounds or materials:

b.1. Phenylene or alkylphenylene ethers or thio-ethers, or their mixtures, containing more than two ether or thio-ether functions or mixtures thereof; *or*

b.2. Fluorinated silicone fluids with a kinematic viscosity of less than 5,000 mm^2/s (5,000 centistokes) measured at 298 K (25° C);

c. Damping or flotation fluids with a purity exceeding 99.8%, containing less than 25 particles of 200 μm or larger in size per 100 ml and made from at least 85% of any of the following compounds or materials:

c.1. Dibromotetrafluoroethane;

c.2. Polychlorotrifluoroethylene (oily and waxy modifications only); *or*

c.3. Polybromotrifluoroethylene;

d. Fluorocarbon electronic cooling fluids, having all of the following characteristics:

d.1. Containing 85% by weight or more of any of the following, or mixtures thereof:

d.1.a. Monomeric forms of perfluoropolyalkylether-triazines or perfluoroaliphatic-ethers;
d.1.b. Perfluoroalkylamines;
d.1.c. Perfluorocycloalkanes; *or*
d.1.d. Perfluoroalkanes;
d.2. Density at 298 K (25° C) of 1.5 g/ml or more;
d.3. In a liquid state at 273 K (0° C); *and*
d.4. Containing 60% or more by weight of fluorine.

Technical Note: For the purpose of 1C006:

a. Flash point is determined using the Cleveland Open Cup Method described in ASTM D–92 or national equivalents;
b. Pour point is determined using the method described in ASTM D–97 or national equivalents;
c. Viscosity index is determined using the method describe in ASTM D–2270 or national equivalents;
d. Thermal stability is determined by the following test procedure or national equivalents:
Twenty ml of the fluid under test is placed in a 46 ml type 317 stainless steel chamber containing one each of 12.5 mm (nominal) diameter balls of M–10 tool steel, 52100 steel and naval bronze (60% Cu, 39% Zn, 0.75% Sn);
The chamber is purged with nitrogen, sealed at atmospheric pressure and the temperature raised to and maintained at 644 ± 6 K (371 ± 6° C) for six hours;
The specimen will be considered thermally stable if, on completion of the above procedure, all of the following conditions are met:
1. The loss in weight of each ball is less than 10 mg/mm ^{2} of ball surface;
2. The change in original viscosity as determined at 311 K (38° C) is less than 25%; *and*
3. The total acid or base number is less than 0.40;
e. Autogenous ignition temperature is determined using the method described in ASTM E–659 or national equivalents.

1C996 Hydraulic fluids containing synthetic hydrocarbon oils, having all the following characteristics (see List of Items Controlled).

License Requirements

Reason for Control: *AT*

Control(s)	*Country Chart*
AT applies to entire entry	AT Column 1

License Exceptions

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

List of Items Controlled

Unit: Barrels (55 U.S. gallons/209 liters)
Related Controls: N/A
Related Definitions: N/A
Items:
a. A flash point exceeding 477 K (204° C);
b. A pour point at 239 K (-34° C) or less;
c. A viscosity index of 75 or more; *and*
d. A thermal stability at 616 K (343° C).

7. In Supplement No. 1 to part 774 (the Commerce Control List), Category 2—Materials Processing, Export Control Classification Numbers (ECCNs) are amended:
a. By revising ECCN 2B001;
b. By revising the entry heading and the List of Items Controlled section for ECCN 2B004;
c. By revising the List of Items Controlled section for ECCN 2B005;
d. By revising the entry heading and the List of Items Controlled for ECCN 2D001; and
e. By revising the List of Items Controlled section for ECCN 2E003, to read as follows:

2B001 Machine tools (see List of Items Controlled) and any combination thereof, for removing (or cutting) metals, ceramics or ''composites'', which, according to the manufacturer's technical specification, can be equipped with electronic devices for ''numerical control''.

License Requirements

Reason for Control: NS, NP, AT

Control(s)	*Country Chart*
NS applies to entire entry	NS Column 2
NP applies to 2B001.a,b,c, and d, EXCEPT:(1) turning machines under 2B001.a with a capacity equal to or less than 35 mm diameter; (2) bar machines (Swissturn), limited to machining only bar feed through, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks. (Machines may have drilling and/or milling capabilities for machining parts with diameters less than 42 mm); or (3) milling machines under 2B001.b. with x-axis travel greater than two meters and overall ''positioning accuracy'' on the x-axis more (worse) than 0.030 mm.	NP Column 1
AT applies to entire entry	AT Column 1

License Requirement Notes: See § 743.1 of the EAR for reporting requirements for exports under License Exceptions.

License Exceptions

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

List of Items Controlled

Unit: Equipment in number; parts and accessories in $ value
Related Controls: (1) See also 2B290 and 2B991; (2) See also 1B101.d for cutting equipment designed or modified for removing prepregs and preforms controlled by 9A110.
Related Definitions: N/A
Items:
a. Machine tools for turning, having all of the following characteristics:
a.1. Positioning accuracy with ''all compensations available'' of less (better) than 6 μm along any linear axis; *and*
a.2. Two or more axes which can be coordinated simultaneously for ''contouring control'';

Note: 2B001.a does not control turning machines specially designed for the production of contact lenses.

b. Machine tools for milling, having any of the following characteristics:
b.1.a. Positioning accuracy with ''all compensations available'' of less (better) than 6 μm along any linear axis; *and*
b.1.b. Three linear axes plus one rotary axis which can be coordinated simultaneously for ''contouring control'';
b.2. Five or more axes which can be coordinated simultaneously for ''contouring control''; *or*
b.3. A positioning accuracy for jig boring machines, with ''all compensations available'', of less (better) than 4 μm along any linear axis;
c. Machine tools for grinding, having any of the following characteristics:
c.1.a. Positioning accuracy with ''all compensations available'' of less (better) than 4 μm along any linear axis; *and*
c.1.b. Three or more axes which can be coordinated simultaneously for ''contouring control''; *or*
c.2. Five or more axes which can be coordinated simultaneously for ''contouring control'';

Notes: 2B001.c does not control grinding machines, as follows:

1. Cylindrical external, internal, and external-internal grinding machines having all the following characteristics:
a. Limited to cylindrical grinding; *and*
b. Limited to a maximum workpiece capacity of 150 mm outside diameter or length.
2. Machines designed specifically as jig grinders having any of following characteristics:

a. The c-axis is used to maintain the grinding wheel normal to the work surface; *or*

b. The a-axis is configured to grind barrel cams.

3. Tool or cutter grinding machines limited to the production of tools or cutters.

4. Crank shaft or cam shaft grinding machines.

5. Surface grinders.

d. Electrical discharge machines (EDM) of the non-wire type which have two or more rotary axes which can be coordinated simultaneously for ''contouring control'';

e. Machine tools for removing metals, ceramics or ''composites'':

e.1. By means of:

e.1.a. Water or other liquid jets, including those employing abrasive additives;

e.1.b. Electron beam; *or*

e.1.c. ''Laser'' beam; *and*

e.2. Having two or more rotary axes which:

e.2.a. Can be coordinated simultaneously for ''contouring control''; *and*

e.2.b. Have a positioning accuracy of less (better) than 0.003°;

f. Deep-hole-drilling machines and turning machines modified for deep-hole-drilling, having a maximum depth-of-bore capability exceeding 5,000 mm and specially designed components therefor.

2B004 Hot ''isostatic presses'', having all of the following characteristics described in the List of Items Controlled, and specially designed components, and accessories therefor.

* * * * *

List of Items Controlled

Unit: Equipment in number; parts and accessories in $ value

Related Controls: (1) See also 2B104 and 2B204. (2) For specially designed dies, molds and tooling, see 1B003, 9B009 and ML18 (22 CFR part 121). (3) In addition, see 1B101.d, 2B104 and 2B204 for controls on dies, molds and tooling.

Related Definitions: N/A

Items:

a. A controlled thermal environment within the closed cavity and possessing a chamber cavity with an inside diameter of 406 mm or more; *and*

b. Any of the following:

b.1. A maximum working pressure exceeding 207 MPa;

b.2. A controlled thermal environment exceeding 1,773 K (1,500° C); *or*

b.3. A facility for hydrocarbon impregnation and removal of resultant gaseous degradation products.

Technical Note: The inside chamber dimension is that of the chamber in which both the working temperature and the working pressure are achieved and does not include fixtures. That dimension will be the smaller of either the inside diameter of the pressure chamber or the inside diameter of the insulated furnace chamber, depending on which of the two chambers is located inside the other.

2B005 Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications for non-electronic substrates, by processes shown in the Table and associated Notes following 2E003.f, and specially designed automated handling, positioning, manipulation and control components therefor.

* * * * *

List of Items Controlled

Unit: $ value

Related Controls: (1) This entry does not control chemical vapor deposition, cathodic arc, sputter deposition, ion plating or ion implantation equipment specially designed for cutting or machining tools. (2) Vapor deposition equipment for the production of filamentary materials are controlled by 1B001 or 1B101. (3) Chemical Vapor Deposition furnaces designed or modified for densification of carbon-carbon composites are controlled by 2B104.

Related Definitions: N/A

Items:

a. ''Stored program controlled'' chemical vapor deposition (CVD) production equipment having all of the following:

a.1. Process modified for one of the following:

a.1.a. Pulsating CVD;

a.1.b. Controlled nucleation thermal deposition (CNTD); *or*

a.1.c. Plasma enhanced or plasma assisted CVD; *and*

a.2. Any of the following:

a.2.a. Incorporating high vacuum (equal to or less than 0.01 Pa) rotating seals; *or*

a.2.b. Incorporating *in situ* coating thickness control;

b. ''Stored program controlled'' ion implantation production equipment having beam currents of 5 mA or more;

c. ''Stored program controlled'' electron beam physical vapor (EB–PVD) production equipment incorporating power systems rated for over 80 kW, having any of the following:

c.1. A liquid pool level ''laser'' control system which regulates precisely the ingots feed rate; or

c.2. A computer controlled rate monitor operating on the principle of photo-luminescence of the ionized atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;

d. ''Stored program controlled'' plasma spraying production equipment having any of the following characteristics:

d.1. Operating at reduced pressure controlled atmosphere (equal or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0.01 Pa prior to the spraying process; *or*

d.2. Incorporating *in situ* coating thickness control;

e. ''Stored program controlled'' sputter deposition production equipment capable of current densities of 0.1 mA/mm^2 or higher at a deposition rate 15 μm/h or more;

f. ''Stored program controlled'' cathodic arc deposition equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;

g. ''Stored program controlled'' ion plating production equipment allowing for the *in situ* measurement of any of the following:

g.1. Coating thickness on the substrate and rate control; or

g.2. Optical characteristics.

2D001 ''Software'', other than that controlled by 2D002, specially designed or modified for the ''development'', ''production'' or ''use'' of equipment controlled by 2A001 or 2B001 to 2B009.

* * * * *

List of Items Controlled

Unit: N/A

Related Controls: This entry controls software, not covered by 2D101, that are specially designed or modified for the controllers of flow forming machines specified by 2B109.

Related Definitions: N/A

Items:

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

2E003 Other ''technology'', as follows (see List of Items Controlled).

* * * * *

List of Items Controlled

Unit: N/A

Related Controls: See 2E001, 2E002, and 2E101 for ''development'' and ''use'' technology for equipment that are designed or modified for densification of carbon-carbon composites, structural composite rocket nozzles and reentry vehicle nose tips.

Related Definitions: N/A

Items:

a. ''Technology'' for the ''development'' of interactive graphics as an integrated part in ''numerical control'' units for preparation or modification of part programs;

b. ''Technology'' for metal-working manufacturing processes, as follows:

b.1. ''Technology'' for the design of tools, dies or fixtures specially designed for any of the following processes:

b.1.a. ''Superplastic forming'';

b.1.b. ''Diffusion bonding''; *or*

b.1.c. ''Direct-acting hydraulic pressing'';

b.2. Technical data consisting of process methods or parameters as listed below used to control:

b.2.a. ''Superplastic forming'' of aluminum alloys, titanium alloys or ''superalloys'':

b.2.a.1. Surface preparation;

b.2.a.2. Strain rate;

b.2.a.3. Temperature;

b.2.a.4. Pressure;

b.2.b. ''Diffusion bonding'' of ''superalloys'' or titanium alloys:

b.2.b.1. Surface preparation;

b.2.b.2. Temperature;

b.2.b.3. Pressure;

b.2.c. ''Direct-acting hydraulic pressing'' of aluminum alloys or titanium alloys:

b.2.c.1. Pressure;

b.2.c.2. Cycle time;

b.2.d. ''Hot isostatic densification'' of titanium alloys, aluminum alloys or ''superalloys'':

b.2.d.1. Temperature;

b.2.d.2. Pressure;

b.2.d.3. Cycle time;

c. ''Technology'' for the ''development'' or ''production'' of hydraulic stretch-forming machines and dies therefor, for the manufacture of airframe structures;

d. ''Technology'' for the ''development'' of generators of machine tool instructions (e.g., part programs) from design data residing inside ''numerical control'' units;

e. ''Technology for the development'' of integration ''software'' for incorporation of expert systems for advanced decision support of shop floor operations into ''numerical control'' units;

f. ''Technology'' for the application of inorganic overlay coatings or inorganic surface modification coatings (specified in column 3 of the following table) to non-electronic substrates (specified in column 2 of the following table), by processes specified in column 1 of the following table and defined in the Technical Note.

N.B. This table should be read to control the technology of a particular 'Coating Process' only when the 'Resultant Coating' in column 3 is in a paragraph directly across from the relevant 'Substrate' under column 2. For example, Chemical Vapor Deposition (CVD) coating process technical data are controlled for the application of 'silicides' to 'Carbon-carbon, Ceramic and Metal ''matrix'' ''composites'' substrates, but are not controlled for the application of 'silicides' to 'Cemented tungsten carbide (16), Silicon carbide (18)' substrates. In the second case, the 'Resultant Coating' is not listed in the paragraph under column 3 directly across from the paragraph under column 2 listing 'Cemented tungsten carbide (16), Silicon carbide (18)'.

8. In Supplement No. 1 to part 774 (the Commerce Control List), Category 2—Material Processing is amended by revising the Materials Processing Table in Category 2E to read as follows:

CATEGORY 2E.—MATERIALS PROCESSING TABLE; DEPOSITION TECHNIQUES

1. Coating process (1) [1]	2. Substrate	3. Resultant coating
A. Chemical Vapor Deposition (CVD)	''Superalloys''	Aluminides for internal passages Silicides Carbides Dielectric layers (15) Diamond Diamond-like carbon (17)
	Ceramics (19) and Low-expansion glasses (14).	Silicides Carbides Refractory metals, Mixtures thereof (4) Dielectric layers (15)
	Carbon-carbon, Ceramic, and Metal ''matrix'' ''composites''.	Aluminides Alloyed aluminides (2) Boron nitride Carbides Tungsten Mixtures thereof (4) Dielectric layers (15)
	Cemented tungsten carbide (16), Silicon Carbide (18).	Dielectric Players (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15) Diamond Diamond-like carbon (17)
	Beryllium and Beryllium alloys	Dielectric layers (15) Diamond Diamond-like carbon (17)
	Sensor window materials (9)	
B. Thermal Evaportation Physical Vapor 1. Physical Vapor Deposition (PVD): Deposition (TE-PVD) Electron-Beam (EB–PVD).	''Superalloys''	Alloyed silicides Alloyed aluminides (2) McrAlX (5) Modified zirconia (12) Silicides Aluminides Mixtures thereof (4)
	Ceramics (19) and Low-expansion glasses (14).	Dielectric layers (15)
	Corrosion resistant steel (7)	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)

CATEGORY 2E.—MATERIALS PROCESSING TABLE; DEPOSITION TECHNIQUES—Continued

1. Coating process (1) [1]	2. Substrate	3. Resultant coating
	Carbon-carbon, Ceramic and Metal ''matrix'' ''composites''.	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Cemented tungsten carbide (16), Silicon carbide (18).	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15) Borides Beryllium
	Sensor window materials (9)	Dielectric layers (15)
	Titanium alloys (13)	Borides Nitrides
2. Ion assisted resistive heating. Physical Vapor Deposition (PVD) (Ion Plating).	Ceramics (19) and Low-expansion glasses (14).	Dielectric layers (15) Diamond-like carbon (17)
	Carbon-carbon, Ceramic and Metal ''matrix'' ''composites''.	Dielectric layers (15)
	Cemented tungsten carbide (16), Silicon carbide.	Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon (17)
3. Physical Vapor Deposition (PVD): ''Laser'' Vaporization.	Ceramics (19) and Low-expansion glasses (14).	Silicides Dielectric layers (15) Diamond-like carbon (17)
	Carbon-carbon, Ceramic and Metal ''matrix'' ''composites''.	Dielectric layers (15)
	Cemented tungsten carbide (16), Silicon carbide.	Dielectric layers (15)
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon
4. Physical Vapor Deposition (PVD): Cathodic Arc Discharge.	''Superalloys''	Alloyed silicides Alloyed Aluminides (2) MCrAlX (5)
	Polymers (11) and Organic ''matrix'' ''composites''.	Borides Carbides Nitrides Diamond-like carbon (17)
C. Pack cementation (see A above for out-of-pack cementation) (10).	Carbon-carbon, Ceramic and Metal ''matrix'' ''composites''.	Silicides Carbides Mixtures thereof (4)
	Titanium alloys (13)	Silicides Aluminides Alloyed aluminides (2)
	Refractory metals and alloys (8)	Silicides Oxides
D. Plasma spraying	''Superalloys''	MCrAlX (5) Modified zirconia (12) Mixtures thereof (4) Abradable Nickel-Graphite Abradable materials containing Ni-Cr-Al Abradable Al-Si-Polyester Alloyed aluminides (2)
	Aluminum alloys (6)	MCrAlX (5) Modified zirconia (12) Silicides Mixtures thereof (4)
	Refractory metals and alloys (8), Carbides, Corrosion resistant steel (7).	Aluminides Silicides MCrAlX (5) Modified zirconia (12) Mixtures thereof (4)

CATEGORY 2E.—MATERIALS PROCESSING TABLE; DEPOSITION TECHNIQUES—Continued

1. Coating process (1) [1]	2. Substrate	3. Resultant coating
	Titanium alloys (13)	Carbides Aluminides Silicides Alloyed aluminides (2)
	Abradable, Nickel-Graphite	Abradable materials containing Ni-Cr-Al Abradable Al-Si-Polyester
E. Slurry Deposition	Refractory metals and alloys (8)	Fused silicides Fused aluminides except for resistance heating elements
	Carbon-carbon, Ceramic and Metal ''matrix'' ''composites''.	Silicides Carbides Mixtures thereof (4)
F. Sputter Deposition	''Superalloys''	Alloyed silicides Alloyed aluminides (2) Noble metal modified aluminides (3) McrAlX (5) Modified zirconia (12) Platinum Mixtures thereof (4)
	Ceramics and Low-expansion glasses (14)	Silicides Platinum Mixtures thereof (4) Dielectric layers (15) Diamond-like carbon (17)
	Titanium alloys (13)	Borides Nitrides Oxides Silicides Aluminides Alloyed aluminides (2) Carbides
	Carbon-carbon, Ceramic and Metal ''matrix'' ''Composites''.	Silicides Carbides Refractory metals Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Cemented tungsten carbide (16), Silicon carbide (18).	Carbides Tungsten Mixtures thereof (4) Dielectric layers (15) Boron nitride
	Molybdenum and Molybdenum alloys	Dielectric layers (15)
	Beryllium and Beryllium alloys	Borides Dielectric layers (15) Beryllium
	Sensor window materials (9)	Dielectric layers (15) Diamond-like carbon (17)
	Refractory metals and alloys (8)	Aluminides Silicides Oxides Carbides
G. Ion Implantation	High temperature bearing steels	Additions of Chromium, Tantalum, or Niobium (Columbium)
	Titanium alloys (13)	Borides Nitrides
	Beryllium and Beryllium alloys	Borides
	Cemented tungsten carbide (16)	Carbides Nitrides

[1] The numbers in parenthesis refer to the Notes following this Table.

Notes to Table on Deposition Techniques

1. The term 'coating process' includes coating repair and refurbishing as well as original coating.

2. The term 'alloyed aluminide coating' includes single or multiple-step coatings in which an element or elements are deposited prior to or during application of the aluminide coating, even if these elements are deposited by another coating process. It does not, however, include the multiple use of single-step pack cementation processes to achieve alloyed aluminides.

3. The term 'noble metal modified aluminide' coating includes multiple-step coatings in which the noble metal or noble metals are laid down by some other coating process prior to application of the aluminide coating.

4. The term 'mixtures thereof' includes infiltrated material, graded compositions, co-deposits and multilayer deposits and are obtained by one or more of the coating processes specified in the Table.

5. MCrAlX refers to a coating alloy where M equals cobalt, iron, nickel or combinations thereof and X equals hafnium, yttrium, silicon, tantalum in any amount or other intentional additions over 0.01 weight

percent in various proportions and combinations, except:

a. CoCrAlY coatings which contain less than 22 weight percent of chromium, less than 7 weight percent of aluminum and less than 2 weight percent of yttrium;

b. CoCrAlY coatings which contain 22 to 24 weight percent of chromium, 10 to 12 weight percent of aluminum and 0.5 to 0.7 weight percent of yttrium; *or*

c. NiCrAlY coatings which contain 21 to 23 weight percent of chromium, 10 to 12 weight percent of aluminum and 0.9 to 1.1 weight percent of yttrium.

6. The term 'aluminum alloys' refers to alloys having an ultimate tensile strength of 190 MPa or more measured at 293 K (20° C).

7. The term 'corrosion resistant steel' refers to AISI (American Iron and Steel Institute) 300 series or equivalent national standard steels.

8. 'Refractory metals and alloys' include the following metals and their alloys: niobium (columbium), molybdenum, tungsten and tantalum.

9. 'Sensor window materials', as follows: alumina, silicon, germanium, zinc sulphide, zinc selenide, gallium arsenide, diamond, gallium phosphide, sapphire and the following metal halides: sensor window materials of more than 40 mm diameter for zirconium fluoride and hafnium fluoride.

10. ''Technology'' for single-step pack cementation of solid airfoils is not controlled by this Category.

11. 'Polymers', as follows: polyimide, polyester, polysulfide, polycarbonates and polyurethanes.

12. 'Modified zirconia' refers to additions of other metal oxides, (e.g., calcia, magnesia, yttria, hafnia, rare earth oxides) to zirconia in order to stabilize certain crystallographic phases and phase compositions. Thermal barrier coatings made of zirconia, modified with calcia or magnesia by mixing or fusion, are not controlled.

13. 'Titanium alloys' refers only to aerospace alloys having an ultimate tensile strength of 900 MPa or more measured at 293 K (20° C).

14. 'Low-expansion glasses' refers to glasses which have a coefficient of thermal expansion of 1 x 10^{-7} K^{-1} or less measured at 293 K (20° C).

15. 'Dielectric layers' are coatings constructed of multi-layers of insulator materials in which the interference properties of a design composed of materials of various refractive indices are used to reflect, transmit or absorb various wavelength bands. Dielectric layers refers to more than four dielectric layers or dielectric/metal ''composite'' layers.

16. 'Cemented tungsten carbide' does not include cutting and forming tool materials consisting of tungsten carbide/(cobalt, nickel), titanium carbide/(cobalt, nickel), chromium carbide/nickel-chromium and chromium carbide/nickel.

17. ''Technology'' specially designed to deposit diamond-like carbon on any of the following is not controlled: magnetic disk drives and heads, polycarbonate eyeglasses, equipment for the manufacture of disposals, bakery equipment, valves for faucets, acoustic diaphragms for speakers, engine parts for automobiles, cutting tools, punching-pressing dies, high quality lenses designed for cameras or telescopes, office automation equipment, microphones or medical devices.

18. 'Silicon carbide' does not include cutting and forming tool materials.

19. Ceramic substrates, as used in this entry, does not include ceramic materials containing 5% by weight, or greater, clay or cement content, either as separate constituents or in combination.

Technical Note to Table on Deposition Techniques: Processes specified in Column 1 of the Table are defined as follows:

a. Chemical Vapor Deposition (CVD) is an overlay coating or surface modification coating process wherein a metal, alloy, ''composite'', dielectric or ceramic is deposited upon a heated substrate. Gaseous reactants are decomposed or combined in the vicinity of a substrate resulting in the deposition of the desired elemental, alloy or compound material on the substrate. Energy for this decomposition or chemical reaction process may be provided by the heat of the substrate, a glow discharge plasma, or ''laser'' irradiation.

Note 1: CVD includes the following processes: directed gas flow out-of-pack deposition, pulsating CVD, controlled nucleation thermal decomposition (CNTD), plasma enhanced or plasma assisted CVD processes.

Note 2: Pack denotes a substrate immersed in a powder mixture.

Note 3: The gaseous reactants used in the out-of-pack process are produced using the same basic reactions and parameters as the pack cementation process, except that the substrate to be coated is not in contact with the powder mixture.

b. Thermal Evaporation-Physical Vapor Deposition (TE–PVD) is an overlay coating process conducted in a vacuum with a pressure less than 0.1 Pa wherein a source of thermal energy is used to vaporize the coating material. This process results in the condensation, or deposition, of the evaporated species onto appropriately positioned substrates. The addition of gases to the vacuum chamber during the coating process to synthesize compound coatings is an ordinary modification of the process. The use of ion or electron beams, or plasma, to activate or assist the coating's deposition is also a common modification in this technique. The use of monitors to provide in-process measurement of optical characteristics and thickness of coatings can be a feature of these processes. Specific TE–PVD processes are as follows:

1. Electron Beam PVD uses an electron beam to heat and evaporate the material which forms the coating;

2. Ion Assisted Resistive Heating PVD employs electrically resistive heating sources in combination with impinging ion beam(s) to produce a controlled and uniform flux of evaporated coating species;

3. ''Laser'' Vaporization uses either pulsed or continuous wave ''laser'' beams to vaporize the material which forms the coating;

4. Cathodic Arc Deposition employs a consumable cathode of the material which forms the coating and has an arc discharge established on the surface by a momentary contact of a ground trigger. Controlled motion of arcing erodes the cathode surface creating a highly ionized plasma. The anode can be either a cone attached to the periphery of the cathode, through an insulator, or the chamber. Substrate biasing is used for non line-of-sight deposition.

Note: This definition does not include random cathodic arc deposition with non-biased substrates.

5. Ion Plating is a special modification of a general TE–PVD process in which a plasma or an ion source is used to ionize the species to be deposited, and a negative bias is applied to the substrate in order to facilitate the extraction of the species from the plasma. The introduction of reactive species, evaporation of solids within the process chamber, and the use of monitors to provide in-process measurement of optical characteristics and thicknesses of coatings are ordinary modifications of the process.

c. Pack Cementation is a surface modification coating or overlay coating process wherein a substrate is immersed in a powder mixture (a pack), that consists of:

1. The metallic powders that are to be deposited (usually aluminum, chromium, silicon or combinations thereof);

2. An activator (normally a halide salt); *and*

3. An inert powder, most frequently alumina.

Note: The substrate and powder mixture is contained within a retort which is heated to between 1,030 K (757 °C) to 1,375 K (1,102 °C) for sufficient time to deposit the coating.

d. Plasma Spraying is an overlay coating process wherein a gun (spray torch) which produces and controls a plasma accepts powder or wire coating materials, melts them and propels them towards a substrate, whereon an integrally bonded coating is formed. Plasma spraying constitutes either low pressure plasma spraying or high velocity plasma spraying.

Note 1: Low pressure means less than ambient atmospheric pressure.

Note 2: High velocity refers to nozzle-exit gas velocity exceeding 750 m/s calculated at 293 K (20 °C) at 0.1 MPa.

e. Slurry Deposition is a surface modification coating or overlay coating process wherein a metallic or ceramic powder with an organic binder is suspended in a liquid and is applied to a substrate by either spraying, dipping or painting, subsequent air or oven drying, and heat treatment to obtain the desired coating.

f. Sputter Deposition is an overlay coating process based on a momentum transfer phenomenon, wherein positive ions are accelerated by an electric field towards the surface of a target (coating material). The kinetic energy of the impacting ions is sufficient to cause target surface atoms to be released and deposited on an appropriately positioned substrate.

Note 1: The Table refers only to triode, magnetron or reactive sputter deposition which is used to increase adhesion of the coating and rate of deposition and to radio

frequency (RF) augmented sputter deposition used to permit vaporization of non-metallic coating materials.

Note 2: Low-energy ion beams (less than 5 keV) can be used to activate the deposition.

g. Ion Implantation is a surface modification coating process in which the element to be alloyed is ionized, accelerated through a potential gradient and implanted into the surface region of the substrate. This includes processes in which ion implantation is performed simultaneously with electron beam physical vapor deposition or sputter deposition.

Accompanying Technical Information to Table on Deposition Techniques:

1. ''Technology'' for pretreatments of the substrates listed in the Table, as follows:
a. Chemical stripping and cleaning bath cycle parameters, as follows:
1. Bath composition;
a. For the removal of old or defective coatings corrosion product or foreign deposits;
b. For preparation of virgin substrates;
2. Time in bath;
3. Temperature of bath;
4. Number and sequences of wash cycles;
b. Visual and macroscopic criteria for acceptance of the cleaned part;
c. Heat treatment cycle parameters, as follows:
1. Atmosphere parameters, as follows:
a. Composition of the atmosphere;
b. Pressure of the atmosphere;
2. Temperature for heat treatment;
3. Time of heat treatment;
d. Substrate surface preparation parameters, as follows:
1. Grit blasting parameters, as follows:
a. Grit composition;
b. Grit size and shape;
c. Grit velocity;
2. Time and sequence of cleaning cycle after grit blast;
3. Surface finish parameters;
4. Application of binders to promote adhesion;
e. Masking technique parameters, as follows:
1. Material of mask;
2. Location of mask;
2. ''Technology'' for in situ quality assurance techniques for evaluation of the coating processes listed in the Table, as follows:
a. Atmosphere parameters, as follows:
1. Composition of the atmosphere;
2. Pressure of the atmosphere;
b. Time parameters;
c. Temperature parameters;
d. Thickness parameters;
e. Index of refraction parameters;
f. Control of composition;
3. ''Technology'' for post deposition treatments of the coated substrates listed in the Table, as follows:
a. Shot peening parameters, as follows:
1. Shot composition;
2. Shot size;
3. Shot velocity;
b. Post shot peening cleaning parameters;
c. Heat treatment cycle parameters, as follows:
1. Atmosphere parameters, as follows:
a. Composition of the atmosphere;
b. Pressure of the atmosphere;
2. Time-temperature cycles;
d. Post heat treatment visual and macroscopic criteria for acceptance of the coated substrates;
4. ''Technology'' for quality assurance techniques for the evaluation of the coated substrates listed in the Table, as follows:
a. Statistical sampling criteria;
b. Microscopic criteria for:
1. Magnification;
2. Coating thickness, uniformity;
3. Coating integrity;
4. Coating composition;
5. Coating and substrates bonding;
6. Microstructural uniformity.
c. Criteria for optical properties assessment (measured as a function of wavelength):
1. Reflectance;
2. Transmission;
3. Absorption;
4. Scatter;
5. ''Technology'' and parameters related to specific coating and surface modification processes listed in the Table, as follows:
a. For Chemical Vapor Deposition (CVD):
1. Coating source composition and formulation;
2. Carrier gas composition;
3. Substrate temperature;
4. Time-temperature-pressure cycles;
5. Gas control and part manipulation;
b. For Thermal Evaporation-Physical Vapor Deposition (PVD):
1. Ingot or coating material source composition;
2. Substrate temperature;
3. Reactive gas composition;
4. Ingot feed rate or material vaporization rate;
5. Time-temperature-pressure cycles;
6. Beam and part manipulation;
7. ''Laser'' parameters, as follows:
a. Wave length;
b. Power density;
c. Pulse length;
d. Repetition ratio;
e. Source;
c. For Pack Cementation:
1. Pack composition and formulation;
2. Carrier gas composition;
3. Time-temperature-pressure cycles;
d. For Plasma Spraying:
1. Powder composition, preparation and size distributions;
2. Feed gas composition and parameters;
3. Substrate temperature;
4. Gun power parameters;
5. Spray distance;
6. Spray angle;
7. Cover gas composition, pressure and flow rates;
8. Gun control and part manipulation;
e. For Sputter Deposition:
1. Target composition and fabrication;
2. Geometrical positioning of part and target;
3. Reactive gas composition;
4. Electrical bias;
5. Time-temperature-pressure cycles;
6. Triode power;
7. Part manipulation;
f. For Ion Implantation:
1. Beam control and part manipulation;
2. Ion source design details;
3. Control techniques for ion beam and deposition rate parameters;
4. Time-temperature-pressure cycles.
g. For Ion Plating:
1. Beam control and part manipulation;
2. Ion source design details;
3. Control techniques for ion beam and deposition rate parameters;
4. Time-temperature-pressure cycles;
5. Coating material feed rate and vaporization rate;
6. Substrate temperature;
7. Substrate bias parameters.

9. In Supplement No. 1 to part 774 (the Commerce Control List), Category 3—Electronics, Export Control Classification Numbers (ECCNs), are amended:

a. By revising the List of Items Controlled section for ECCNs 3A001, 3A002, 3A991, 3B001, 3B991, 3C002 and 3E001;

b. By adding a new ECCN 3C992;

c. By revising the License Exceptions section and the List of Items Controlled section for 3E002, to read as follows:

3A001 Electronic components, as follows (see List of Items Controlled).

* * * * *

List of Items Controlled

Unit: Number
Related Controls: See also 3A101, 3A201, and 3A991
Related Definitions: For the purposes of integrated circuits in 3A001.a.1, 5 x 10^3 Gy(Si) = 5 x 10^5 Rads (Si); 5 x 10^6 Gy (Si)/s = 5 x 10^8 Rads (Si)/s.
Items:
a. General purpose integrated circuits, as follows:

Note 1: The control status of wafers (finished or unfinished), in which the function has been determined, is to be evaluated against the parameters of 3A001.a.

Note 2: Integrated circuits include the following types:
''Monolithic integrated circuits'';
''Hybrid integrated circuits'';
''Multichip integrated circuits'';
''Film type integrated circuits'', including silicon-on-sapphire integrated circuits;
''Optical integrated circuits''.

a.1. Integrated circuits, designed or rated as radiation hardened to withstand any of the following:

a.1.a. A total dose of 5 x 10^3 Gy (Si), or higher; *or*

a.1.b. A dose rate upset of 5 x 10^6 Gy (Si)/s, or higher;

a.2. Integrated circuits described in 3A001.a.3 to 3A001.a.10 or 3A001.a.12, electrical erasable programmable read-only memories (EEPROMs), flash memories and static random-access memories (SRAMs), having any of the following:

a.2.a. Rated for operation at an ambient temperature above 398 K (125° C);

a.2.b. Rated for operation at an ambient temperature below 218 K (−55° C); *or*

a.2.c. Rated for operation over the entire ambient temperature range from 218 K (−55° C) to 398 K (125° C);

Note: 3A001.a.2 does not apply to integrated circuits for civil automobiles or railway train applications.

a.3. ''Microprocessor microcircuits'', ''micro-computer microcircuits'' and microcontroller microcircuits, having any of the following characteristics:

Note: 3A001.a.3 includes digital signal processors, digital array processors and digital coprocessors.

a.3.a. A ''composite theoretical performance'' (''CTP'') of 260 million theoretical operations per second (Mtops) or more and an arithmetic logic unit with an access width of 32 bit or more;

a.3.b. Manufactured from a compound semiconductor and operating at a clock frequency exceeding 40 MHz; *or*

a.3.c. More than one data or instruction bus or serial communication port for external interconnection in a parallel processor with a transfer rate exceeding 2.5 Mbyte/s;

a.4. Storage integrated circuits manufactured from a compound semiconductor;

a.5. Analog-to-digital and digital-to-analog converter integrated circuits, as follows:

a.5.a. Analog-to-digital converters having any of the following:

a.5.a.1. A resolution of 8 bit or more, but less than 12 bit, with a total conversion time to maximum resolution of less than 10 ns;

a.5.a.2. A resolution of 12 bit with a total conversion time to maximum resolution of less than 200 ns; *or*

a.5.a.3. A resolution of more than 12 bit with a total conversion time to maximum resolution of less than 2 μs;

a.5.b. Digital-to-analog converters with a resolution of 12 bit or more, and a ''settling time'' of less than 10 ns;

a.6. Electro-optical and ''optical integrated circuits'' designed for ''signal processing'' having all of the following:

a.6.a. One or more than one internal ''laser'' diode;

a.6.b. One or more than one internal light detecting element; *and*

a.6.c. Optical waveguides;

a.7. Field programmable gate arrays having any of the following:

a.7.a. An equivalent usable gate count of more than 30,000 (2 input gates); *or*

a.7.b. A typical ''basic gate propagation delay time'' of less than 0.4 ns;

a.8. Field programmable logic arrays having any of the following:

a.8.a. An equivalent usable gate count of more than 30,000 (2 input gates); *or*

a.8.b. A toggle frequency exceeding 133 MHz;

a.9. Neural network integrated circuits;

a.10. Custom integrated circuits for which the function is unknown, or the control status of the equipment in which the integrated circuits will be used is unknown to the manufacturer, having any of the following:

a.10.a. More than 208 terminals;

a.10.b. A typical ''basic gate propagation delay time'' of less than 0.35 ns; or

a.10.c. An operating frequency exceeding 3 GHz;

a.11. Digital integrated circuits, other than those described in 3A001.a.3 to 3A001.a.10 and 3A001.a.12, based upon any compound semiconductor and having any of the following:

a.11.a. An equivalent gate count of more than 3,000 (2 input gates); *or*

a.11.b. A toggle frequency exceeding 1.2 GHz;

a.12. Fast Fourier Transform (FFT) processors having any of the following:

a.12.a. A rated execution time for a 1,024 point complex FFT of less than 1 ms;

a.12.b. A rated execution time for an N-point complex FFT of other than 1,024 points of less than $N \log_2 N$ /10,240 ms, where N is the number of points; *or*

a.12.c. A butterfly throughput of more than 5.12 MHz;

b. Microwave or millimeter wave components, as follows:

b.1. Electronic vacuum tubes and cathodes, as follows:

Note: 3A001.b.1 does not control tubes designed or rated to operate in the ITU allocated bands at frequencies not exceeding 31 GHz.

b.1.a. Traveling wave tubes, pulsed or continuous wave, as follows:

b.1.a.1. Operating at frequencies higher than 31 GHz;

b.1.a.2. Having a cathode heater element with a turn on time to rated RF power of less than 3 seconds;

b.1.a.3. Coupled cavity tubes, or derivatives thereof, with an ''instantaneous bandwidth'' of more than 7% or a peak power exceeding 2.5 kW;

b.1.a.4. Helix tubes, or derivatives thereof, with any of the following characteristics:

b.1.a.4.a. An ''instantaneous bandwidth'' of more than one octave, and average power (expressed in kW) times frequency (expressed in GHz) of more than 0.5;

b.1.a.4.b. An ''instantaneous bandwidth'' of one octave or less, and average power (expressed in kW) times frequency (expressed in GHz) of more than 1; *or*

b.1.a.4.c. Being ''space qualified'';

b.1.b. Crossed-field amplifier tubes with a gain of more than 17 dB;

b.1.c. Impregnated cathodes designed for electronic tubes, with any of the following:

b.1.c.1. A turn on time to rated emission of less than 3 seconds; *or*

b.1.c.2. Producing a continuous emission current density at rated operating conditions exceeding 5 A/cm^2;

b.2. Microwave integrated circuits or modules having all of the following:

b.2.a. Containing ''monolithic integrated circuits''; and

b.2.b. Operating at frequencies above 3 GHz;

Note: 3A001.b.2 does not control circuits or modules for equipment designed or rated to operate in the ITU allocated bands at frequencies not exceeding 31 GHz.

b.3. Microwave transistors rated for operation at frequencies exceeding 31 GHz;

b.4. Microwave solid state amplifiers, having any of the following:

b.4.a. Operating frequencies exceeding 10.5 GHz and an ''instantaneous bandwidth'' of more than half an octave; *or*

b.4.b. Operating frequencies exceeding 31 GHz;

b.5. Electronically or magnetically tunable band-pass or band-stop filters having more than 5 tunable resonators capable of tuning across a 1.5:1 frequency band (F_{max}/F_{min}) in less than 10 μs having any of the following:

b.5.a. A band-pass bandwidth of more than 0.5% of center frequency; *or*

b.5.b. A band-stop bandwidth of less than 0.5% of center frequency;

b.6. Microwave ''assemblies'' capable of operating at frequencies exceeding 31 GHz;

b.7. Mixers and converters designed to extend the frequency range of equipment described in 3A002.c, 3A002.e or 3A002.f beyond the limits stated therein;

b.8. Microwave power amplifiers containing tubes controlled by 3A001.b and having all of the following:

b.8.a. Operating frequencies above 3 GHz;

b.8.b. An average output power density exceeding 80 W/kg; *and*

b.8.c. A volume of less than 400 cm^3;

Note: 3A001.b.8 does not control equipment designed or rated for operation in an ITU allocated band.

c. Acoustic wave devices, as follows, and specially designed components therefor:

c.1. Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices (i.e., ''signal processing'' devices employing elastic waves in materials), having any of the following:

c.1.a. A carrier frequency exceeding 2.5 GHz;

c.1.b. A carrier frequency exceeding 1 GHz, but not exceeding 2.5 GHz, and having any of the following:

c.1.b.1. A frequency side-lobe rejection exceeding 55 dB;

c.1.b.2. A product of the maximum delay time and the bandwidth (time in μs and bandwidth in MHz) of more than 100;

c.1.b.3. A bandwidth greater than 250 MHz; *or*

c.1.b.4. A dispersive delay of more than 10 μs; *or*

c.1.c. A carrier frequency of 1 GHz or less, having any of the following:

c.1.c.1. A product of the maximum delay time and the bandwidth (time in μs and bandwidth in MHz) of more than 100;

c.1.c.2. A dispersive delay of more than 10 μs; *or*

c.1.c.3. A frequency side-lobe rejection exceeding 55 dB and a bandwidth greater than 50 MHz;

c.2. Bulk (volume) acoustic wave devices (i.e., ''signal processing'' devices employing elastic waves) that permit the direct processing of signals at frequencies exceeding 1 GHz;

c.3. Acoustic-optic ''signal processing'' devices employing interaction between acoustic waves (bulk wave or surface wave) and light waves that permit the direct processing of signals or images, including spectral analysis, correlation or convolution;

d. Electronic devices and circuits containing components, manufactured from ''superconductive'' materials specially designed for operation at temperatures below the ''critical temperature'' of at least one of the ''superconductive'' constituents, with any of the following:

d.1. Electromagnetic amplification:

d.1.a. At frequencies equal to or less than 31 GHz with a noise figure of less than 0.5 dB; *or*

d.1.b. At frequencies exceeding 31 GHz;

d.2. Current switching for digital circuits using ''superconductive'' gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10^{-14}J; *or*

d.3. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;

e. High energy devices, as follows:

e.1. Batteries and photovoltaic arrays, as follows:

Note: 3A001.e.1 does not control batteries with volumes equal to or less than 27 cm^3 (e.g., standard C-cells or R14 batteries).

e.1.a. Primary cells and batteries having an energy density exceeding 480 Wh/kg and rated for operation in the temperature range from below 243 K (−30° C) to above 343 K (70° C);

e.1.b. Rechargeable cells and batteries having an energy density exceeding 150 Wh/kg after 75 charge/discharge cycles at a discharge current equal to C/5 hours (C being the nominal capacity in ampere hours) when operating in the temperature range from below 253 K (−20° C) to above 333 K (60° C);

Technical Note: Energy density is obtained by multiplying the average power in watts (average voltage in volts times average current in amperes) by the duration of the discharge in hours to 75% of the open circuit voltage divided by the total mass of the cell (or battery) in kg.

e.1.c. ''Space qualified'' and radiation hardened photovoltaic arrays with a specific power exceeding 160 W/m^2 at an operating temperature of 301 K (28° C) under a tungsten illumination of 1 kW/m^2 at 2,800 K (2,527° C);

e.2. High energy storage capacitors, as follows:

N.B.: See also 3A201.a.

e.2.a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) having all of the following:

e.2.a.1. A voltage rating equal to or more than 5 kV;

e.2.a.2. An energy density equal to or more than 250 J/kg; *and*

e.2.a.3. A total energy equal to or more than 25 kJ;

e.2.b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) having all of the following:

e.2.b.1. A voltage rating equal to or more than 5 kV;

e.2.b.2. An energy density equal to or more than 50 J/kg;

e.2.b.3. A total energy equal to or more than 100 J; *and*

e.2.b.4. A charge/discharge cycle life equal to or more than 10,000;

e.3. ''Superconductive'' electromagnets and solenoids specially designed to be fully charged or discharged in less than one second, having all of the following:

N.B.: See also 3A201.b.

e.3.a. Energy delivered during the discharge exceeding 10 kJ in the first second;

e.3.b. Inner diameter of the current carrying windings of more than 250 mm; *and*

e.3.c. Rated for a magnetic induction of more than 8 T or ''overall current density'' in the winding of more than 300 A/mm^2;

Note: 3A001.e.3 does not control ''superconductive'' electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

f. Rotary input type shaft absolute position encoders having any of the following:

f.1. A resolution of better than 1 part in 265,000 (18 bit resolution) of full scale; *or*

f.2. An accuracy better than ±2.5 seconds of arc.

3A002 General purpose electronic equipment, as follows (see List of Items Controlled).

* * * * *

List of Items Controlled

Unit: Number

Related Controls: See also 3A202 and 3A992

Related Definitions: N/A

Items:

a. Recording equipment, as follows, and specially designed test tape therefor:

a.1. Analog instrumentation magnetic tape recorders, including those permitting the recording of digital signals (e.g., using a high density digital recording (HDDR) module), having any of the following:

a.1.a. A bandwidth exceeding 4 MHz per electronic channel or track;

a.1.b. A bandwidth exceeding 2 MHz per electronic channel or track and having more than 42 tracks; *or*

a.1.c. A time displacement (base) error, measured in accordance with applicable IRIG or EIA documents, of less than ±0.1 μs;

Note: Analog magnetic tape recorders specially designed for civilian video purposes are not considered to be instrumentation tape recorders.

a.2. Digital video magnetic tape recorders having a maximum digital interface transfer rate exceeding 360 Mbit/s;

Note: 3A002.a.2 does not control digital video magnetic tape recorders specially designed for television recording using a signal format, which may include a compressed signal format, standardized or recommended by the ITU, the IEC, the SMPTE, the EBU or the IEEE for civil television applications.

a.3. Digital instrumentation magnetic tape data recorders employing helical scan techniques or fixed head techniques, having any of the following:

a.3.a. A maximum digital interface transfer rate exceeding 175 Mbit/s; *or*

a.3.b. Being ''space qualified'';

Note: 3A002.a.3 does not control analog magnetic tape recorders equipped with

HDDR conversion electronics and configured to record only digital data.

a.4. Equipment, having a maximum digital interface transfer rate exceeding 175 Mbit/s, designed to convert digital video magnetic tape recorders for use as digital instrumentation data recorders;

a.5. Waveform digitizers and transient recorders having all of the following:

N.B.: See also 3A202.

a.5.a. Digitizing rates equal to or more than 200 million samples per second and a resolution of 10 bits or more; *and*

a.5.b. A continuous throughput of 2 Gbit/s or more;

Technical Note: For those instruments with a parallel bus architecture, the continuous throughput rate is the highest word rate multiplied by the number of bits in a word. Continuous throughput is the fastest data rate the instrument can output to mass storage without the loss of any information while sustaining the sampling rate and analog-to-digital conversion.

b. ''Frequency synthesizer'', ''assemblies'' having a ''frequency switching time'' from one selected frequency to another of less than 1 ms;

c. ''Signal analyzers'', as follows:

c.1. ''Signal analyzers'' capable of analyzing frequencies exceeding 31 GHz;

c.2. ''Dynamic signal analyzers'' having a ''real-time bandwidth'' exceeding 25.6 kHz;

Note: 3A002.c.2 does not control those ''dynamic signal analyzers'' using only constant percentage bandwidth filters (also known as octave or fractional octave filters).

Technical Note: Constant percentage bandwidth filters are also known as octave or fractional octave filters.

d. Frequency synthesized signal generators producing output frequencies, the accuracy and short term and long term stability of which are controlled, derived from or disciplined by the internal master frequency, and having any of the following:

d.1. A maximum synthesized frequency exceeding 31 GHz;

d.2. A ''frequency switching time'' from one selected frequency to another of less than 1 ms; *or*

d.3. A single sideband (SSB) phase noise better than $-(126 + 20 \log_{10}F - 20 \log_{10}f)$ in dBc/Hz, where F is the off-set from the operating frequency in Hz and f is the operating frequency in MHz;

Note: 3A002.d does not control equipment in which the output frequency is either produced by the addition or subtraction of two or more crystal oscillator frequencies, or by an addition or subtraction followed by a multiplication of the result.

e. Network analyzers with a maximum operating frequency exceeding 40 GHz;

f. Microwave test receivers having all of the following:

f.1. A maximum operating frequency exceeding 40 GHz; *and*

f.2. Being capable of measuring amplitude and phase simultaneously;

g. Atomic frequency standards having any of the following:

g.1. Long-term stability (aging) less (better) than 1×10^{-11}/month; *or*

g.2. Being ''space qualified''.

Note: 3A002.g.1 does not control non-''space qualified'' rubidium standards.

3A991 Electronic devices and components not controlled by 3A001.

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List of Items Controlled

Unit: Equipment in number
Related Controls: N/A
Related Definitions: N/A
Items:

a. ''Microprocessor microcircuits'', ''microcomputer microcircuits'', and microcontroller microcircuits having a clock frequency exceeding 25 MHz;

b. Storage integrated circuits, as follows:

b.1. Electrical erasable programmable read-only memories (EEPROMs) with a storage capacity;

b.1.a. Exceeding 16 Mbits per package for flash memory types; *or*

b.1.b. Exceeding either of the following limits for all other EEPROM types:

b.1.b.1. Exceeding 1 Mbit per package; *or*

b.1.b.2. Exceeding 256 kbit per package and a maximum access time of less than 80 ns;

b.2. Static random access memories (SRAMs) with a storage capacity:

b.2.a. Exceeding 1 Mbit per package; *or*

b.2.b. Exceeding 256 kbit per package and a maximum access time of less than 25 ns;

c. Field programmable logic arrays having either of the following:

c.1. An equivalent gate count of more than 5000 (2 input gates); *or*

c.2. A toggle frequency exceeding 100 MHz;

d. Custom integrated circuits for which either the function is unknown, or the control status of the equipment in which the integrated circuits will be used is unknown to the manufacturer, having any of the following:

d.1. More than 144 terminals; *or*

d.2. A typical ''basic propagation delay time'' of less than 0.4 ns.

e. Travelling wave tubes, pulsed or continuous wave, as follows:

e.1. Coupled cavity tubes, or derivatives thereof;

e.2. Helix tubes, or derivatives thereof, with any of the following:

e.2.a.1. An ''instantaneous bandwidth'' of half an octave or more; *and*

e.2.a.2. The product of the rated average output power (expressed in kW) and the maximum operating frequency (expressed in GHz) of more than 0.2;

e.2.b.1 An ''instantaneous bandwidth'' of less than half an octave; *and*

e.2.b.2. The product of the rated average output power (expressed in kW) and the maximum operating frequency (expressed in GHz) of more than 0.4;

f. Flexible waveguides designed for use at frequencies exceeding 40 GHz;

g. Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices (i.e., ''signal processing'' devices employing elastic waves in materials), having either of the following:

g.1. A carrier frequency exceeding 1 GHz; *or*

g.2. A carrier frequency of 1 GHz or less; *and*

g.2.a. A frequency side-lobe rejection exceeding 55 dB;

g.2.b. A product of the maximum delay time and bandwidth (time in microseconds and bandwidth in MHz) of more than 100; *or*

g.2.c. A dispersive delay of more than 10 microseconds.

h. Batteries, as follows:

Note: 3A991.h does not control batteries with volumes equal to or less than 26 cm^3 (e.g., standard C-cells or UM–2 batteries).

h.1. Primary cells and batteries having an energy density exceeding 350 Wh/kg and rated for operation in the temperature range from below 243 K ($-30°$ C) to above 343 K (70° C);

h.2. Rechargeable cells and batteries having an energy density exceeding 150 Wh/kg after 75 charge/discharge cycles at a discharge current equal to C/5 hours (C being the nominal capacity in ampere hours) when operating in the temperature range from below 253 K ($-20°$ C) to above 333 K (60° C);

Technical Note: Energy density is obtained by multiplying the average power in watts (average voltage in volts times average current in amperes) by the duration of the discharge in hours to 75 percent of the open circuit voltage divided by the total mass of the cell (or battery) in kg.

i. ''Superconductive'' electromagnets or solenoids specially designed to be fully charged or discharged in less than one minute, having all of the following:

Note: 3A991.i does not control ''superconductive'' electromagnets or solenoids designed for Magnetic Resonance Imaging (MRI) medical equipment.

i.1. Maximum energy delivered during the discharge divided by the

duration of the discharge of more than 500 kJ per minute;

i.2. Inner diameter of the current carrying windings of more than 250 mm; *and*

i.3. Rated for a magnetic induction of more than 8T or ''overall current density'' in the winding of more than 300 A/mm.^{2}

j. Circuits or systems for electromagnetic energy storage, containing components manufactured from ''superconductive'' materials specially designed for operation at temperatures below the ''critical temperature'' of at least one of their ''superconductive'' constituents, having all of the following:

j.1. Resonant operating frequencies exceeding 1 MHz;

j.2. A stored energy density of 1 MJ/M^3 or more; *and*

j.3. A discharge time of less than 1 ms;

k. Hydrogen/hydrogen-isotope thyratrons of ceramic-metal construction and rate for a peak current of 500 A or more;

l. Digital integrated circuits based on any compound semiconductor having an equivalent gate count of more than 300 (2 input gates).

3B001 Equipment for the manufacturing of semiconductor devices or materials and specially designed components and accessories therefor.

* * * * *

List of Items Controlled

Unit: Number
Related Controls: See also 3B991
Related Definitions: N/A
Items:

a. ''Stored program controlled'' equipment designed for epitaxial growth, as follows:

a.1. Equipment capable of producing a layer thickness uniform to less than ± 2.5% across a distance of 75 mm or more;

a.2. Metal organic chemical vapor deposition (MOCVD) reactors specially designed for compound semiconductor crystal growth by the chemical reaction between materials controlled by 3C003 or 3C004;

a.3. Molecular beam epitaxial growth equipment using gas or solid sources;

b. ''Stored program controlled'' equipment designed for ion implantation, having any of the following:

b.1. A beam energy (accelerating voltage) exceeding 1MeV;

b.2. Being specially designed and optimized to operate at a beam energy (accelerating voltage of less than 2 keV;

b.3. Direct write capability; *or*

b.4. Being capable of high energy oxygen implant into a heated semiconductor material ''substrate'';

c. ''Stored program controlled'' anisotropic plasma dry etching equipment, as follows:

c.1. Equipment with cassette-to-cassette operation and load-locks, and having any of the following:

c.1.a. Magnetic confinement; *or*

c.1.b. Electron cyclotron resonance (ECR);

c.2. Equipment specially designed for equipment controlled by 3B001.e and having any of the following:

c.2.a. Magnetic confinement; *or*

c.2.b. ECR;

d. ''Stored program controlled'' plasma enhanced CVD equipment, as follows:

d.1. Equipment with cassette-to-cassette operation and load-locks, and having any of the following:

d.1.a. Magnetic confinement; *or*

d.1.b. ECR;

d.2. Equipment specially designed for equipment controlled by 3B001.e and having any of the following:

d.2.a. Magnetic confinement; *or*

d.2.b. ECR;

e. ''Stored program controlled'' automatic loading multi-chamber central wafer handling systems, having all of the following:

e.1. Interfaces for wafer input and output, to which more than two pieces of semiconductor processing equipment are to be connected; *and*

e.2. Designed to form an integrated system in a vacuum environment for sequential multiple wafer processing;

Note: 3B001.e does not control automatic robotic wafer handling systems not designed to operate in a vacuum environment.

f. ''Stored program controlled'' lithography equipment, as follows:

f.1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods, having any of the following:

f.1.a. A light source wavelength shorter than 350 nm; *or*

f.1.b. Capable of producing a pattern with a minimum resolvable feature size of 0.5 μm or less;

Note: The minimum resolvable feature size is calculated by the following formula:

$$MRF = \frac{(\text{an exposure light source wavelength in } \mu m) \times (\text{K factor})}{\text{numerical aperture}}$$

Where the K factor = 0.7.
MRF = minimum resolvable feature size.

f.2. Equipment specially designed for mask making or semiconductor device processing using deflected focussed electron beam, ion beam or ''laser'' beam, having any of the following:

f.2.a. A spot size smaller than 0.2 μm;

f.2.b. Being capable of producing a pattern with a feature size of less than 1 μm; *or*

f.2.c. An overlay accuracy of better than ± 0.20 μm (3 sigma);

g. Masks and reticles designed for integrated circuits controlled by 3A001;

h. Multi-layer masks with a phase shift layer.

3B991 Equipment not controlled by 3B001 for the manufacture of electronic components and materials, and specially designed components and accessories therefor.

* * * * *

List of Items Controlled

Unit: Equipment in number
Related Controls: N/A
Related Definitions: N/A
Items:

a. Equipment specially designed for the manufacture of electron tubes, optical elements and specially designed components therefor controlled by 3A001 or 3A991;

b. Equipment specially designed for the manufacture of semiconductor devices, integrated circuits and ''assemblies'', as follows, and systems incorporating or having the characteristics of such equipment:

Note: 3B991.b also controls equipment used or modified for use in the manufacture of other devices, such as imaging devices,

electro-optical devices, acoustic-wave devices.

b.1. Equipment for the processing of materials for the manufacture of devices and components as specified in the heading of 3B991.b, as follows:

Note: 3B991 does not control quartz furnace tubes, furnace liners, paddles, boats (except specially designed caged boats), bubblers, cassettes or crucibles specially designed for the processing equipment controlled by 3B991.b.1.

b.1.a. Equipment for producing polycrystalline silicon and materials controlled by 3C001;

b.1.b. Equipment specially designed for purifying or processing III/V and II/VI semiconductor materials controlled by 3C001, 3C002, 3C003, or 3C004, except crystal pullers, for which see 3B991.b.1.c below;

b.1.c. Crystal pullers and furnaces, as follows:

Note: 3B991.b.1.c does not control diffusion and oxidation furnaces.

b.1.c.1. Annealing or recrystallizing equipment other than constant temperature furnaces employing high rates of energy transfer capable of processing wafers at a rate exceeding 0.005 m^2 per minute;

b.1.c.2. ''Stored program controlled'' crystal pullers having any of the following characteristics:

b.1.c.2.a. Rechargeable without replacing the crucible container;

b.1.c.2.b. Capable of operation at pressures above 2.5 x 10^5 Pa; *or*

b.1.c.2.c. Capable of pulling crystals of a diameter exceeding 100 mm;

b.1.d. ''Stored program controlled'' equipment for epitaxial growth having any of the following characteristics:

b.1.d.1. Capable of producing a layer thickness uniformity across the wafer of equal to or better than ±3.5%;

b.1.d.2. Rotation of individual wafers during processing; *or*

b.1.e. Molecular beam epitaxial growth equipment;

b.1.f. Magnetically enhanced ''sputtering'' equipment with specially designed integral load locks capable of transferring wafers in an isolated vacuum environment;

b.1.g. Equipment specially designed for ion implantation, ion-enhanced or photo-enhanced diffusion, having any of the following characteristics:

b.1.g.1. Patterning capability;

b.1.g.2. Beam energy (accelerating voltage) exceeding 200 keV;

b.1.g.3 Optimized to operate at a beam energy (accelerating voltage) of less than 10 keV; *or*

b.1.g.4. Capable of high energy oxygen implant into a heated ''substrate'';

b.1.h. ''Stored program controlled'' equipment for the selective removal (etching) by means of anisotropic dry methods (e.g., plasma), as follows:

b.1.h.1. Batch types having either of the following:

b.1.h.1.a. End-point detection, other than optical emission spectroscopy types; *or*

b.1.h.1.b. Reactor operational (etching) pressure of 26.66 Pa or less;

b.1.h.2. Single wafer types having any of the following:

b.1.h.2.a. End-point detection, other than optical emission spectroscopy types;

b.1.h.2.b. Reactor operational (etching) pressure of 26.66 Pa or less; *or*

b.1.h.2.c. Cassette-to-cassette and load locks wafer handling;

Notes: 1. ''Batch types'' refers to machines not specially designed for production processing of single wafers. Such machines can process two or more wafers simultaneously with common process parameters, e.g., RF power, temperature, etch gas species, flow rates.

2. ''Single wafer types'' refers to machines specially designed for production processing of single wafers. These machines may use automatic wafer handling techniques to load a single wafer into the equipment for processing. The definition includes equipment that can load and process several wafers but where the etching parameters, e.g., RF power or end point, can be independently determined for each individual wafer.

b.1.i. ''Chemical vapor deposition'' (CVD) equipment, e.g., plasma-enhanced CVD (PECVD) or photo-enhanced CVD, for semiconductor device manufacturing, having either of the following capabilities, for deposition of oxides, nitrides, metals or polysilicon:

b.1.i.1. ''Chemical vapor deposition'' equipment operating below 10^5 Pa; *or*

b.1.i.2. PECVD equipment operating either below 60 Pa (450 millitorr) or having automatic cassette-to-cassette and load lock wafer handling;

Note: 3B991.b.1.i does not control low pressure ''chemical vapor deposition'' (LPCVD) systems or reactive ''sputtering'' equipment.

b.1.j. Electron beam systems specially designed or modified for mask making or semiconductor device processing having any of the following characteristics:

b.1.j.1. Electrostatic beam deflection;

b.1.j.2. Shaped, non-Gaussian beam profile;

b.1.j.3. Digital-to-analog conversion rate exceeding 3 MHz;

b.1.j.4. Digital-to-analog conversion accuracy exceeding 12 bit; *or*

b.1.j.5. Target-to-beam position feedback control precision of 1 micrometer or finer;

Note: 3B991.b.1.j does not control electron beam deposition systems or general purpose scanning electron microscopes.

b.1.k. Surface finishing equipment for the processing of semiconductor wafers as follows:

b.1.k.1. Specially designed equipment for backside processing of wafers thinner than 100 micrometer and the subsequent separation thereof; *or*

b.1.k.2. Specially designed equipment for achieving a surface roughness of the active surface of a processed wafer with a two-sigma value of 2 micrometer or less, total indicator reading (TIR);

Note: 3B991.b.1.k does not control single-side lapping and polishing equipment for wafer surface finishing.

b.1.l. Interconnection equipment which includes common single or multiple vacuum chambers specially designed to permit the integration of any equipment controlled by 3B991 into a complete system;

b.1.m. ''Stored program controlled'' equipment using ''lasers'' for the repair or trimming of ''monolithic integrated circuits'' with either of the following characteristics:

b.1.m.1. Positioning accuracy less than ± 1 micrometer; *or*

b.1.m.2. Spot size (kerf width) less than 3 micrometer.

b.2. Masks, mask ''substrates'', mask-making equipment and image transfer equipment for the manufacture of devices and components as specified in the heading of 3B991, as follows:

Note: The term ''masks'' refers to those used in electron beam lithography, X-ray lithography, and ultraviolet lithography, as well as the usual ultraviolet and visible photo-lithography.

b.2.a. Finished masks, reticles and designs therefor, except:

b.2.a.1. Finished masks or reticles for the production of unembargoed integrated circuits; *or*

b.2.a.2. Masks or reticles, having both of the following characteristics:

b.2.a.2.a. Their design is based on geometries of 2.5 micrometer or more; *and*

b.2.a.2.b. The design does not include special features to alter the intended use by means of production equipment or ''software'';

b.2.b. Mask ''substrates'' as follows:

b.2.b.1. Hard surface (e.g., chromium,silicon, molybdenum) coated ''substrates'' (e.g., glass, quartz, sapphire) for the preparation of masks having dimensions exceeding 125 mm × 125 mm; *or*

b.2.b.2. ''Substrates'' specially designed for X-ray masks;

b.2.c. Equipment, other than general purpose computers, specially designed for computer aided design (CAD) of semiconductor devices or integrated circuits;

b.2.d. Equipment or machines, as follows, for mask or reticle fabrication:

b.2.d.1. Photo-optical step and repeat cameras capable of producing arrays larger than 100 mm × 100 mm, or capable of producing a single exposure larger than 6 mm × 6 mm in the image (i.e., focal) plane, or capable of producing line widths of less than 2.5 micrometer in the photoresist on the ''substrate'';

b.2.d.2. Mask or reticle fabrication equipment using ion or ''laser'' beam lithography capable of producing line widths of less than 2.5 micrometer; *or*

b.2.d.3. Equipment or holders for altering masks or reticles or adding pellicles to remove defects;

Note: 3B991.b.2.d.1 and b.2.d.2 do not control mask fabrication equipment using photo-optical methods which was either commercially available before the 1st January, 1980, or has a performance no better than such equipment.

b.2.e. ''Stored program controlled'' equipment for the inspection of masks, reticles or pellicles with:

b.2.e.1. A resolution of 0.25 micrometer or finer; *and*

b.2.e.2. A precision of 0.75 micrometer or finer over a distance in one or two coordinates of 63.5 mm or more;

Note: 3B991.b.2.e does not control general purpose scanning electron microscopes except when specially designed and instrumented for automatic pattern inspection.

b.2.f. Align and expose equipment for wafer production using photo-optical or X-ray methods, including both projection image transfer equipment and step and repeat (direct step on wafer) or step and scan (scanner) equipment, capable of performing any of the following functions:

Note: 3B991.b.2.f does not control photo-optical contact and proximity mask align and expose equipment or contact image transfer equipment.

b.2.f.1. Production of a pattern size of less than 2.5 micrometer;

b.2.f.2. Alignment with a precision finer than ± 0.25 micrometer (3 sigma);

b.2.f.3. Machine-to-machine overlay no better than ± 0.3 micrometer;

b.2.f.4. A light source wavelength shorter than 400 nm; *or*

b.2.f.5. Capable of producing a pattern with a minimum resolvable feature size of 0.7 microns or less.

b.2.g. Electron beam, ion beam or X-ray equipment for projection image transfer capable of producing patterns less than 2.5 micrometer;

Note: For focussed, deflected-beam systems (direct write systems), see 3B991.b.1.j or b.10.

b.2.h. Equipment using ''lasers'' for direct write on wafers capable of producing patterns less than 2.5 micrometer.

b.3. Equipment for the assembly of integrated circuits, as follows:

b.3.a. ''Stored program controlled'' die bonders having all of the following characteristics:

b.3.a.1. Specially designed for ''hybrid integrated circuits'';

b.3.a.2. X–Y stage positioning travel exceeding 37.5 x 37.5 mm; *and*

b.3.a.3. Placement accuracy in the X–Y plane of finer than ± 10 micrometer;

b.3.b. ''Stored program controlled'' equipment for producing multiple bonds in a single operation (e.g., beam lead bonders, chip carrier bonders, tape bonders);

b.3.c. Semi-automatic or automatic hot cap sealers, in which the cap is heated locally to a higher temperature than the body of the package, specially designed for ceramic microcircuit packages controlled by 3A001 and that have a throughput equal to or more than one package per minute.

Note: 3B991.b.3 does not control general purpose resistance type spot welders.

b.4. Filters for clean rooms capable of providing an air environment of 10 or less particles of 0.3 micrometer or smaller per 0.02832 m^3 and filter materials therefor;

3C002 Resist material and ''substrates'' coated with controlled resists.

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List of Items Controlled

Unit: $ value
Related Controls: N/A
Related Definitions: Silylation techniques are defined as processes incorporating oxidation of the resist surface to enhance performance for both wet and dry developing.
Items:

a. Positive resists designed for semiconductor lithography specially adjusted (optimized) for use at wavelengths below 350 nm;

b. All resists designed for use with electron beams or ion beams, with a sensitivity of 0.01 µcoulomb/mm^2 or better;

c. All resists designed for use with X-rays, with a sensitivity of 2.5 mJ/mm^2 or better;

d. All resists optimized for surface imaging technologies, including silylated resists.

3C992 Positive resists designed for semiconductor lithography specially adjusted (optimized) for use at wavelengths between 370 and 350 nm.

License Requirements

Reason for Control: AT

Control(s)	*Country Chart*
AT applies to entire entry	AT Column 1

License Exceptions

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

List of Items Controlled

Unit: $ value
Related Controls: N/A
Related Definitions: N/A
Items:

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

3E001 ''Technology'' according to the General Technology Note for the ''development'' or ''production'' of equipment or materials controlled by 3A (except 3A292, 3A980, 3A981, 3A991 or 3A992), 3B (except 3B991 and 3B992) or 3C.

* * * * *

List of Items Controlled

Unit: N/A
Related Controls: (1.) See also 3E101 and 3E201.(2.) 3E001 does not control ''technology'' for the ''development'' or ''production'' of: (a) Microwave transistors operating at frequencies below 31 GHz; (b) Integrated circuits controlled by 3A001.a.3 to a.12, having all of the following: 1. Using ''technology'' of 0.7 micrometer or more, AND 2. Not incorporating multi-layer structures. (3.) The term multi-layer structures in this entry does not include devices incorporating a maximum of two metal layers and two polysilicon layers.
Related Definition: N/A
Items:

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

3E002 Other ''technology'' for the ''development'' or ''production'' of items described in the List of Items Controlled.

* * * * *

License Exceptions

CIV: N/A
TSR: Yes, except .e and .f

List of Items Controlled

Unit: N/A
Related Controls: See 3E001 for silicon-on-insulation (SOI) technology for the ''development'' or ''production'' related to radiation hardening of integrated circuits
Related Definitions: N/A
Items:

a. Vacuum microelectronic devices;

b. Hetero-structure semiconductor devices such as high electron mobility transistors (HEMT), hetero-bipolar transistors (HBT), quantum well and super lattice devices;

c. ''Superconductive'' electronic devices;

d. Substrates of films of diamond for electronic components;

e. Substrates of silicon-on-insulator (SOI) for integrated circuits in which the insulator is silicon dioxide;

f. Substrates of silicon carbide for electronic components.

10. In Supplement No. 1 to part 774 (the Commerce Control List), Category 4—computers is amended by revising Export Control Classification Number (ECCN) 4A003, to read as follows:

4A003 ''Digital computers'', ''electronic assemblies'', and related equipment therefor, and specially designed components therefor.

License Requirements

Reason for Control: NS, MT, CC, AT, NP, XP

Control(s)	*Country Chart*
NS applies to 4A003.b and .c.	NS Column 1
NS applies to 4A003.a, .d, .e, and .g.	NS Column 2
MT applies to digital computers used as ancillary equipment for test facilities and equipment that are controlled by 9B005 or 9B006.	MT Column 1
CC applies to digital computers for computerized finger-print equipment.	CC Column 1
AT applies to entire entry (refer to 4A994 for controls on digital computers with a CTP ≥ 6 but ≤ to 2,000 Mtops).	AT Column 1

NP applies to digital computers with a CTP greater than 2,000 Mtops, unless a License Exception is available. See § 742.3(b) of the EAR for information on applicable licensing review policies.

XP applies to digital computers with a CTP greater than 2,000 Mtops, unless a License Exception is available. XP controls vary according to destination and end-user and end-use. See § 742.12 of the EAR for additional information.

Note: For all destinations, except Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria, no license is required (NLR) for computers with a CTP of 2,000 Mtops, and for assemblies described in 4A003.c that are not capable of exceeding a CTP of 2,000 Mtops in aggregation. Computers controlled in this entry for MT reasons are not eligible for NLR.

License Requirement Notes: See § 743.1 of the EAR for reporting requirements for exports under License Exceptions.

License Exceptions

LVS: $5000; N/A for MT and ''digital'' computers controlled by 4A003.b and having a CTP exceeding 10,000 MTOPS; or ''electronic assemblies'' controlled by 4A003.c and capable of enhancing performance by aggregation of ''computing elements'' so that the CTP of the aggregation exceeds 10,000 MTOPS.

GBS: Yes, for 4A003.d, .e, and .g and specially designed components therefor, exported separately or as part of a system.

CTP: Yes, for computers controlled by 4A003.a, .b and .c, to the exclusion of other technical parameters, with the exception of parameters specified as controlled for Missile Technology (MT) concerns and 4A003.e (equipment performing analog-to-digital or digital-to-analog conversions exceeding the limits of 3A001.a.5.a). See § 740.7 of the EAR.

CIV: Yes, for 4A003.d (having a 3–D vector rate less than 10 M vectors/sec), .e, and .g.

List of Items Controlled

Unit: Equipment in number; parts and accessories in $ value
Related Controls: See also 4A994
Related Definitions: N/A
Items:

Note 1: 4A003 includes the following:

a. Vector processors;
b. Array processors;
c. Digital signal processors;
d. Logic processors;
e. Equipment designed for ''image enhancement'';
f. Equipment designed for ''signal processing''.

Note 2: The control status of the ''digital computers'' and related equipment described in 4A003 is determined by the control status of other equipment or systems provided:

a. The ''digital computers'' or related equipment are essential for the operation of the other equipment or systems;

b. The ''digital computers'' or related equipment are not a ''principal element'' of the other equipment or systems; *and*

N.B. 1: The control status of ''signal processing'' or ''image enhancement'' equipment specially designed for other equipment with functions limited to those required for the other equipment is determined by the control status of the other equipment even if it exceeds the ''principal element'' criterion.

N.B. 2: For the control status of ''digital computers'' or related equipment for telecommunications equipment, see Category 5, Part 1 (Telecommunications).

c. The ''technology'' for the ''digital computers'' and related equipment is determined by 4E.

a. Designed or modified for ''fault tolerance'';

Note: For the purposes of 4A003.a., ''digital computers'' and related equipment are not considered to be designed or modified for ''fault tolerance'' if they utilize any of the following:

1. Error detection or correction algorithms in ''main storage'';
2. The interconnection of two ''digital computers'' so that, if the active central processing unit fails, an idling but mirroring central processing unit can continue the system's functioning;
3. The interconnection of two central processing units by data channels or by use of shared storage to permit one central processing unit to perform other work until the second central processing unit fails, at which time the first central processing unit takes over in order to continue the system's functioning; or
4. The synchronization of two central processing units by ''software'' so that one central processing unit recognizes when the other central processing unit fails and recovers tasks from the failing unit.

b. ''Digital computers'' having a ''composite theoretical performance'' (''CTP'') exceeding 2,000 million theoretical operations per second (Mtops);

c. ''Electronic assemblies'' specially designed or modified to be capable of enhancing performance by aggregation of ''computing elements'' (''CEs'') so that the ''CTP'' of the aggregation exceeds the limit in 4A003.b;

Note 1: 4A003.c applies only to ''electronic assemblies'' and programmable interconnections not exceeding the limit in 4A003.b when shipped as unintegrated ''electronic assemblies''. It does not apply to ''electronic assemblies'' inherently limited by nature of their design for use as related equipment controlled by 4A003.d, or 4A003.e.

Note 2: 4A003.c does not control ''electronic assemblies'' specially designed for a product or family of products whose maximum configuration does not exceed the limit of 4A003.b.

d. Graphics accelerators and graphics coprocessors exceeding a ''three dimensional Vector Rate'' of 3,000,000;

e. Equipment performing analog-to-digital conversions exceeding the limits in 3A001.a.5;

f. Reserved.

g. Equipment specially designed to provide external interconnection of

''digital computers'' or associated equipment that allows communications at data rates exceeding 80 Mbyte/s.

Note: 4A003.g does not control internal interconnection equipment (e.g., backplanes, buses) passive interconnection equipment, ''network access controllers'' or ''communication channel controllers''.

11. In Supplement No. 1 to part 774, the Commerce Control List, Category 4—Computers is amended by revising the table following the EAR99 entry to read as follows:

Information on How to Calculate ''Composite Theoretical Performance (''CTP'')

Technical Note: ''COMPOSITE THEORETICAL PERFORMANCE'' (''CTP'')

Abbreviations used in this Technical Note

''CE''	''computing element'' (typically an arithmetic logical unit)
FP	floating point
XP	fixed point
t	execution time
XOR	exclusive OR
CPU	central processing unit
TP	theoretical performance (of a single ''CE'')
''CTP''	''composite theoretical performance'' (multiple ''CEs'')
R	effective calculating rate
WL	word length
L	word length adjustment
*	multiply

Execution time t is expressed in microseconds, TP and ''CTP'' are expressed in millions of theoretical operations per second (Mtops) and WL is expressed in bits.

Outline of ''CTP'' calculation method

''CTP'' is a measure of computational performance given in Mtops. In calculating the ''CTP'' of an aggregation of ''CEs'' the following three steps are required:

1. Calculate the effective calculating rate R for each ''CE'';

2. Apply the word length adjustment (L) to the effective calculating rate (R), resulting in a Theoretical Performance (TP) for each ''CE'';

3. If there is more than one ''CE'', combine the TPs, resulting in a ''CTP'' for the aggregation.

Details for these steps are given in the following sections.

Note 1: For aggregations of multiple ''CEs'' that have both shared and unshared memory subsystems, the calculation of ''CTP'' is completed hierarchically, in two steps: first, aggregate the groups of ''CEs'' sharing memory; second, calculate the ''CTP'' of the groups using the calculation method for multiple ''CEs'' not sharing memory.

Note 2: ''CEs'' that are limited to input/output and peripheral functions (e.g., disk drive, communication and video display controllers) are not aggregated into the ''CTP'' calculation.

The following table shows the method of calculating the Effective Calculating Rate R for each ''CE'':

Step 1: The effective calculating rate R

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For "CEs" Implementing: **Note:** Every "CE" must be evaluated independently.	Effective calculating Rate, R
XP only (R_{xp})	1 --- 3 * ($t_{xp\ add}$) if no add is implemented use: 1 --- ($t_{xp\ mult}$) If neither add nor multiply is implemented use the fastest available arithmetic operation as follows: 1 --- 3 * t_{xp} See Notes X & Z
FP only (R_{fp})	1 1 max ---, --- $t_{fp\ add}$ $t_{fp\ mult}$ See Notes X & Y
Both FP and XP (R)	Calculate both R_{xp}, R_{fp}

For simple logic processors not implementing any of the specified arithmetic operations.	1 --- $3 * t_{log}$ Where t_{log} is the execute time of the XOR, or for logic hardware not implementing the XOR, the fastest simple logic operation. See Notes X & Z
For special logic processors not using any of the specified arithmetic or logic operations.	R = R' * WL/64 Where R' is the number of results per second, WL is the number of bits upon which the logic operation occurs, and 64 is a factor to normalize to a 64 bit operation.

BILLING CODE 3510–33–C

Note W: For a pipelined "CE" capable of executing up to one arithmetic or logic operation every clock cycle after the pipeline is full, a pipelined rate can be established. The effective calculating rate (R) for such a "CE" is the faster of the pipelined rate or non-pipelined execution rate.

Note X: For a "CE" that performs multiple operations of a specific type in a single cycle (e.g., two additions per cycle or two identical logic operations per cycle), the execution time t is given by:

$$t = \frac{\text{cycle time}}{\text{the number of identical operations per machine cycle}}$$

"CEs" that perform different types of arithmetic or logic operations in a single machine cycle are to be treated as multiple separate "CEs" performing simultaneously (e.g., a "CE" performing an addition and a multiplication in one cycle is to be treated as two "CEs", the first performing an addition in one cycle and the second performing a multiplication in one cycle). If a single "CE" has both scalar function and vector function, use the shorter execution time value.

Note Y: For the "CE" that does not implement FP add or FP multiply, but that performs FP divide:

$$R_{fp} = \frac{1}{t_{fpdivide}}$$

If the "CE" implements FP reciprocal but not FP add, FP multiply or FP divide, then

$$R_{fp} = \frac{1}{t_{fpreciprocal}}$$

If none of the specified instructions is implemented, the effective FP rate is 0.

Note Z: In simple logic operations, a single instruction performs a single logic manipulation of no more than two operands of given lengths. In complex logic operations, a single instruction performs multiple logic manipulations to produce one or more results from two or more operands.

Rates should be calculated for all supported operand lengths considering both pipelined operations (if supported), and non-pipelined operations using the fastest executing instruction for each operand length based on:

1. Pipelined or register-to-register operations. Exclude extraordinarily short execution times generated for operations on a predetermined operand or operands (for example, multiplication by 0 or 1). If no register-to-register operations are implemented, continue with (2).

2. The faster of register-to-memory or memory-to-register operations; if these also do not exist, then continue with (3).

3. Memory-to-memory.

In each case above, use the shortest execution time certified by the manufacturer.

Step 2: *TP for each supported operand length WL*

Adjust the effective rate R (or R′) by the word length adjustment L as follows:
TP = R * L, where L = (1/3 + WL/96)

Note: The word length WL used in these calculations is the operand length in bits. (If an operation uses operands of different lengths, select the largest word length.) The combination of a mantissa ALU and an exponent ALU of a floating point processor or unit is considered to be one ''CE'' with a Word Length (WL) equal to the number of bits in the data representation (typically 32 or 64) for purposes of the ''CTP'' calculation.

This adjustment is not applied to specialized logic processors that do not use XOR instructions. In this case TP = R.

Select the maximum resulting value of TP for:

Each XP-only ''CE'' (R_{xp});

Each FP-only ''CE'' (R_{fp});

Each combined FP and XP ''CE'' (R);

Each simple logic processor not implementing any of the specified arithmetic operations; *and*

Each special logic processor not using any of the specified arithmetic or logic operations.

Step 3: *''CTP'' for aggregations of ''CEs'', including CPUs.*

For a CPU with a single ''CE'', ''CTP'' = TP (for ''CEs'' performing both fixed and floating point operations TP = max (TP_{fp}, TP_{xp}))

''CTP'' for aggregations of multiple ''CEs'' operating simultaneously is calculated as follows:

Note 1: For aggregations that do not allow all of the ''CEs'' to run simultaneously, the possible combination of ''CEs'' that provides the largest ''CTP'' should be used. The TP of each contributing ''CE'' is to be calculated at its maximum value theoretically possible before the ''CTP'' of the combination is derived.

N.B.: To determine the possible combinations of simultaneously operating ''CEs'', generate an instruction sequence that initiates operations in multiple ''CEs'', beginning with the slowest ''CE'' (the one needing the largest number of cycles to complete its operation) and ending with the fastest ''CE''. At each cycle of the sequence, the combination of ''CEs'' that are in operation during that cycle is a possible combination. The instruction sequence must take into account all hardware and/or architectural constraints on overlapping operations.

Note 2: A single integrated circuit chip or board assembly may contain multiple ''CEs''.

Note 3: Simultaneous operations are assumed to exist when the computer manufacturer claims concurrent, parallel or simultaneous operation or execution in a manual or brochure for the computer.

Note 4: ''CTP'' values are not to be aggregated for ''CE'' combinations (inter)connected by ''Local Area Networks'', Wide Area Networks, I/O shared connections/devices, I/O controllers and any communication interconnection implemented by ''software''.

Note 5: ''CTP'' values must be aggregated for multiple ''CEs'' specially designed to enhance performance by aggregation, operating simultaneously and sharing memory,-or multiple memory/''CE''-combinations operating simultaneously utilizing specially designed hardware.

This aggregation does not apply to ''electronic assemblies'' described by 4A003.c.

$$\text{''CTP''} = TP_1 + C_2 * TP_2 + \ldots + C_n * TP_n,$$

Where the TPs are ordered by value, with TP_1 being the highest, TP_2 being the second highest, ..., and TP_n being the lowest. C_i is a coefficient determined by the strength of the interconnection between ''CEs'', as follows:

For multiple ''CEs'' operating simultaneously and sharing memory:

$C_2 = C_3 = C_4 = \ldots = C_n = 0.75$

Note 1: When the ''CTP'' calculated by the above method does not exceed 194 Mtops, the following formula may be used to calculate C_i:

$$C_i = \frac{0.75}{\sqrt{m}} \qquad (i = 2, \ldots, n)$$

Where m=the number of ''CEs'' or groups of ''CEs'' sharing access.

provided:

1. The TP_1 of each ''CE'' or group of ''CEs'' does not exceed 30 Mtops;

2. The ''CEs'' or groups of ''CEs'' share access to main memory (excluding cache memory) over a single channel; *and*

3. Only one ''CE'' or group of ''CEs'' can have use of the channel at any given time.

N.B.: This does not apply to items controlled under Category 3.

Note 2: ''CEs'' share memory if they access a common segment of solid state memory. This memory may include cache memory, main memory or other internal memory. Peripheral memory devices such as disk drives, tape drives or RAM disks are not included.

For Multiple ''CEs'' or groups of ''CEs'' not sharing memory, interconnected by one or more data channels:

$C_i = 0.75 * k_i$ (i=2,..., 32) (see Note below)

$= 0.60 * k_i$ (i=33,..., 64)

$= 0.45 * k_i$ (i=65,..., 256)

$= 0.30 * k_i$ (i >256)

The value of C_i is based on the number of ''CE''s, not the number of nodes.

Where $k_i = \min (S_i/K_r, 1)$, and
K_r=normalizing factor of 20 MByte/s.
S_i = sum of the maximum data rates (in units of MByte/s) for all data channels connected to the i^{th} ''CE'' or group of ''CEs'' sharing memory.

When calculating a C_i for a group of ''CEs'', the number of the first ''CE'' in a group determines the proper limit for C_i. For example, in an aggregation of groups consisting of 3 ''CEs'' each, the 22nd group will contain ''CE''_{64}, ''CE''_{65} and ''CE''_{66}. The proper limit for C_i for this group is 0.60.

Aggregation (of ''CEs'' or groups of ''CEs'') should be from the fastest-to-slowest; i.e.: $TP_1 \geq TP_2 \geq \ldots \geq TP_n$, and

in the case of $TP_i = TP_{i+1}$, from the largest to smallest; i.e.: $C_i \geq C_{i+1}$

Note: The k_i factor is not to be applied to ''CEs'' 2 to 12 if the TP_i of the ''CE'' or group of ''CEs'' is more than 50 Mtops; i.e., C_i for ''CEs'' 2 to 12 is 0.75.

12. In Supplement No. 1 to part 774 (the Commerce Control List), Category 5—Telecommunications and ''Information Security'', Part I—Telecommunications is amended by revising the telecommunications notes that immediately follow the Category 5—I ''telecommunications'' heading, to read as follows:

Category 5—Telecommunications and ''Information Security''

I. Telecommunications

Notes: 1. The control status of components, ''lasers'', test and ''production'' equipmentand ''software'' therefor which are specially designed for telecommunications

equipment or systems is determined in Category 5, Part I.

2. ''Digital computers'', related equipment or ''software'', when essential for the operation and support of telecommunications equipment described in this Category, are regarded as specially designed components, provided they are the standard models customarily supplied by the manufacturer. This includes operation, administration, maintenance, engineering or billing computer systems.

13. In Supplement No. 1 to part 774 (the Commerce Control List), Category 5—Telecommunications and ''Information Security'', is amended as follows:

a. By revising ECCN 5A001;

b. By revising ECCN 5A991;

c. By revising ECCN 5B001;

d. By removing ECCN 5C001;

e. By adding a new ECCN 5C991; and

f. By revising the License Exceptions section and the List of Items Controlled for ECCNs 5D001 and 5E001, to read as follows:

5A001 Telecommunications systems, equipment, and components.

License Requirements

Reason for Control: NS, AT

Control(s)	*Country Chart*
NS applies to 5A001.a	NS Column 1
NS applies to 5A001.b, .c, or .d.	NS Column 2
AT applies to entire entry	AT Column 1

License Requirement Notes: See § 743.1 of the EAR for reporting requirements for exports under License Exceptions.

License Exceptions

LVS: N/A for 5A001.a and b.4
$5000 for 5A001b.2, b.3, b.5, and .d
$3000 for 5A001.c
GBS: Yes, except 5A001.a and b.4
CIV: Yes, except 5A001.a, b.3 and b.4

List of Items Controlled

Unit: Equipment in number; parts and accessories in $ value
Related Controls: See also 5A101 and 5A991
Related Definitions: N/A
Items:

a. Any type of telecommunications equipment having any of the following characteristics, functions or features:

a.1. Specially designed to withstand transitory electronic effects or electromagnetic pulse effects, both arising from a nuclear explosion;

a.2. Specially hardened to withstand gamma, neutron or ion radiation; *or*

a.3. Specially designed to operate outside the temperature range from 218 K (−55°C) to 397 K (124°C).

Note: 5A001.a.3 applies only to electronic equipment.

Note: 5A001.a.2 and 5A001.a.3 do not apply to equipment on board satellites.

b. Telecommunication transmission equipment and systems, and specially designed components and accessories therefor, having any of the following characteristics, functions or features:

b.1 Being underwater communications systems having any of the following characteristics:

b.1.a. An acoustic carrier frequency outside the range from 20 kHz to 60 kHz;

b.1.b. Using an electromagnetic carrier frequency below 30 kHz; *or*

b.1.c. Using electronic beam steering techniques;

b.2. Being radio equipment operating in the 1.5 MHz to 87.5 MHz band and having any of the following characteristics:

b.2.a. Incorporating adaptive techniques providing more than 15 dB suppression of an interfering signal; or

b.2.b. Having all of the following:

b.2.b.1. Automatically predicting and selecting frequencies and ''total digital transfer rates'' per channel to optimize the transmission; *and*

b.2.b.2. Incorporating a linear power amplifier configuration having a capability to support multiple signals simultaneously at an output power of 1 kW or more in the 1.5 MHz to 30 MHz frequency range or 250 W or more in the 30 MHz to 87.5 MHz frequency range, over an ''instantaneous bandwidth'' of one octave or more and with an output harmonic and distortion content of better than −80 dB;

b.3. Being radio equipment employing ''spread spectrum'' or ''frequency agility'' (frequency hopping) techniques having any of the following characteristics:

b.3.a. User programmable spreading codes; or b.3.b. A total transmitted bandwidth which is 100 or more times the bandwidth of any one information channel and in excess of 50 kHz;

Note: 5A001. b.3.b does not control cellular radio equipment operating in civil bands.

Note: 5A001.b.3 does not control equipment operating at an output power of 1.0 Watt or less.

b.4. Being digitally controlled radio receivers having all of the following:

b.4.a. More than 1,000 channels;

b.4.b. A ''frequency switching time'' of less than 1 ms;

b.4.c. Automatic searching or scanning of a part of the electromagnetic spectrum;

and

b.4.d. Identification of the received signals or the type of transmitter; *or*

Note: 5A001.b.4 does not control cellular radio equipment operating in civil bands.

b.5. Employing functions of digital ''signal processing'' to provide voice coding at rates of less than 2,400 bit/s.

c. Optical fiber communication cables, optical fibers and accessories, as follows:

c.1. Optical fibers of more than 500 m in length specified by the manufacturer as being capable of withstanding a proof test tensile stress of 2 x 10^9 N/m^2 or more;

Technical Note: Proof Test: on-line or off-line production screen testing that dynamically applies a prescribed tensile stress over a 0.5 to 3 m length of fiber at a running rate of 2 to 5 m/s while passing between capstans approximately 150 mm in diameter. The ambient temperature is a nominal 293 K (20° C) and relative humidity 40%.

N.B.: Equivalent national standards may be used for executing the proof test.

c.2. Optical fiber cables and accessories designed for underwater use.

Note: 5A001.c.2 does not control standard civil telecommunication cables and accessories.

N.B. 1: For underwater umbilical cables, and connectors thereof, see 8A002.a.3.

N.B. 2: For fiber-optic hull penetrators or connectors, see 8A002.c.

d. ''Electronically steerable phased array antennae'' operating above 31 GHz.

Note: 5A001.d does not control ''electronically steerable phased array antennae'' for landing systems with instruments meeting ICAO standards covering microwave landing systems (MLS).

5A991 Telecommunication Equipment, Not Controlled by 5A001.

License Requirements

Reason for Control: AT

Control(s)	*Country Chart*
AT applies to entire entry	AT Column 1

License Exceptions

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

List of Items Controlled

Unit: $ value
Related Controls: N/A
Related Definitions: N/A
Items:

a. Any type of telecommunications equipment, not controlled by 5A001.a, specially designed to operate outside the temperature range from 219 K (−54° C) to 397 K (124° C).

b. Telecommunication transmission equipment and systems, and specially

designed components and accessories therefor, having any of the following characteristics, functions or features:

Note: Telecommunication transmission equipment:

a. Categorized as follows, or combinations thereof:
1. Radio equipment (e.g., transmitters, receivers and transceivers);
2. Line terminating equipment;
3. Intermediate amplifier equipment;
4. Repeater equipment;
5. Regenerator equipment;
6. Translation encoders (transcoders);
7. Multiplex equipment (statistical mutiplex included);
8. Modulators/demodulators (modems);
9. Transmultiplex equipment (see CCITT Rec. G701);
10. ''Stored program controlled'' digital crossconnection equipment;
11. ''Gateways'' and bridges;
12. ''Media access units''; *and*

b. Designed for use in single or multi-channel communication via any of the following:
1. Wire (line);
2. Coaxial cable;
3. Optical fiber cable;
4. Electromagnetic radiation; *or*
5. Underwater acoustic wave propagation.

b.1. Employing digital techniques, including digital processing of analog signals, and designed to operate at a ''digital transfer rate'' at the highest multiplex level exceeding 45 Mbit/s or a ''total digital transfer rate'' exceeding 90 Mbit/s;

Note: 5A991.b.1 does not control equipment specially designed to be integrated and operated in any satellite system for civil use.

b.2. Modems using the ''bandwidth of one voice channel'' with a ''data signalling rate'' exceeding 9,600 bits per second;

b.3. Being ''stored program controlled'' digital cross connect equipment with ''digital transfer rate'' exceeding 8.5 Mbit/s per port.

b.4. Being equipment containing any of the following:

b.4.a. ''Network access controllers'' and their related common medium having a ''digital transfer rate'' exceeding 33 Mbit/s; *or*

b.4.b. ''Communication channel controllers'' with a digital output having a ''data signalling rate'' exceeding 64,000 bit/s per channel;

Note: If any uncontrolled equipment contains a ''network access controller'', it cannot have any type of telecommunications interface, *except* those described in, but not controlled by 5A991.b.4.

b.5. Employing a ''laser'' and having any of the following characteristics:

b.5.a. A transmission wavelength exceeding 1,000 nm; *or*

b.5.b. Employing analog techniques and having a bandwidth exceeding 45 MHz;

Note: 5A991.b.5.b does not control commercial TV systems.

b.5.c. Employing coherent optical transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques);

b.5.d. Employing wavelength division multiplexing techniques; *or*

b.5.e. Performing ''optical amplification'';

b.6. Radio equipment operating at input or output frequencies exceeding:

b.6.1. 31 GHz for satellite-earth station applications; *or*

b.6.2. 26.5 GHz for other applications;

Note: 5A991.b.6 does not control equipment for civil use when conforming with an International Telecommunications Union (ITU) allocated band between 26.5 GHz and 31 GHz.

b.7. Being radio equipment employing any of the following:

b.7.a. Quadrature-amplitude-modulation (QAM) techniques above level 4 if the ''total digital transfer rate'' exceeds 8.5 Mbit/s;

b.7.b. QAM techniques above level 16 if the ''total digital transfer rate'' is equal to or less than 8.5 Mbit/s; *or*

b.7.c. Other digital modulation techniques and having a ''spectral efficiency'' exceeding 3 bit/sec/Hz;

Notes: 1. 5A001.b.7 does not control equipment specially designed to be integrated and operated in any satellite system for civil use.

2. 5A001.b.7 does not control radio relay equipment for operation in an ITU allocated band:

a. Having any of the following:

a.1. Not exceeding 960 MHz; *or*

a.2. With a ''total digital transfer rate'' not exceeding 8.5 Mbit/s;

and

b. Having a ''spectral efficiency'' not exceeding 4 bit/sec/Hz.

b.8. Providing functions of digital ''signal processing'' as follows:

b.8.a. Voice coding at rates less than 2,400 bit/s;

b.8.b. Employing circuitry that incorporates ''user-accessible programmability'' of digital ''signal processing'' circuits exceeding the limits of 4A003.b.

c. ''Stored program controlled'' switching equipment and related signalling systems, having any of the following characteristics, functions or features, and specially designed components and accessories therefor:

Note: Statistical multiplexers with digital input and digital output which provide switching are treated as ''stored program controlled'' switches.

c.1. ''Data (message) switching'' equipment or systems designed for ''packet-mode operation'' and assemblies and components therefor, n.e.s.

c.2. Containing ''Integrated Services Digital Network'' (ISDN) functions and having any of the following:

c.2.a. Switch-terminal (e.g., subscriber line) interfaces with a ''digital transfer rate'' at the highest multiplex level exceeding 192,000 bit/s, including the associated signalling channel (e.g., 2B+D); *or*

c.2.b. The capability that a signalling message received by a switch on a given channel that is related to a communication on another channel may be passed through to another switch.

Note: 5A991.c. does not preclude the evaluation and appropriate actions taken by the receiving switch or unrelated user message traffic on a D channel of ISDN.

c.3. Routing or switching of ''datagram'' packets;

c.4. Routing or switching of ''fast select'' packets;

Note: The restrictions in 5A991.c.3 and c.4 do not apply to networks restricted to using only ''network access controllers'' or to ''network access controllers'' themselves.

c.5. Multi-level priority and pre-emption for circuit switching;

Note: 5A991.c.5 does not control single-level call preemption.

c.6. Designed for automatic hand-off of cellular radio calls to other cellular switches or automatic connection to a centralized subscriber data base common to more than one switch;

c.7. Containing ''stored program controlled'' digital crossconnect equipment with ''digital transfer rate'' exceeding 8.5 Mbit/s per port.

c.8. ''Common channel signalling'' operating in either non-associated or quasi-associated mode of operation;

c.9. ''Dynamic adaptive routing'';

Note: 5A991.c.10 does not control packet switches or routers with ports or lines not exceeding the limits in 5A001.c.10.

c.10. Being packet switches, circuit switches and routers with ports or lines exceeding any of the following:

c.10.a. A ''data signalling rate'' of 64,000 bit/s per channel for a ''communications channel controller''; *or*

Note: 5A991.c.10.a does not control multiplex composite links composed only of communication channels not individually controlled by 5A991.b.1.

c.10.b. A ''digital transfer rate'' of 33 Mbit/s for a ''network access controller'' and related common media;

c.10.c. ''Optical switching'';

c.10.d. Employing ''Asynchronous Transfer Mode'' (''ATM'') techniques.

d. Optical fibers and optical fiber cables of more than 50 m in length designed for single mode operation;

e. Centralized network control having all of the following characteristics:

e.1. Receives data from the nodes; *and*

e.2. Process these data in order to provide control of traffic not requiring operator decisions, and thereby performing ''dynamic adaptive routing'';

Note: 5A991.e does not preclude control of traffic as a function of predictable statistical traffic conditions.

f. Phased array antennae, operating above 10.5 GHz, containing active elements and distributed components, and designed to permit electronic control of beam shaping and pointing, except for landing systems with instruments meeting International Civil Aviation Organization (ICAO) standards (microwave landing systems (MLS)).

g. Mobile communications equipment, n.e.s., and assemblies and components therefor; *or*

h. Radio relay communications equipment designed for use at frequencies equal to or exceeding 19.7 GHz and assemblies and components therefor, n.e.s.

B. Test, Inspection and Production Equipment

5B001 Telecommunication test, inspection and production equipment, as follows (See List of Items Controlled).

License Requirements

Reason for Control: NS, AT

Control(s)	*Country Chart*
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

License Requirement Notes: See § 743.1 of the EAR for reporting requirements for exports under License Exceptions.

License Exceptions

LVS: $5000
GBS: Yes
CIV: Yes

List of Items Controlled

Unit: Equipment in number; parts and accessories in $ value
Related Controls: See also 5B991.
Related Definition: N/A
Items:

a. Equipment and specially designed components or accessories therefor, specially designed for the ''development'', ''production'' or ''use'' of equipment, functions or features controlled by 5A001, 5D001 or 5E001.

Note: 5B001.a does not control optical fiber characterization equipment not using semiconductor ''lasers''.

b. Equipment and specially designed components or accessories therefor, specially designed for the ''development'' of any of the following telecommunication transmission or ''stored program controlled'' switching equipment:

b.1. Equipment employing digital techniques, including ''Asynchronous Transfer Mode'' (''ATM''), designed to operate at a ''total digital transfer rate'' exceeding 1.5 Gbit/s;

b.2. Equipment employing a ''laser'' and having any of the following:

b.2.a. A transmission wavelength exceeding 1750 nm;

b.2.b. Performing ''optical amplification'';

b.2.c. Employing coherent transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques); *or*

b.2.d. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;

Note: 5B001.b.2.d does not include equipment specially designed for the ''development'' of commercial TV systems.

b.3. Equipment employing ''optical switching'';

b.4. Radio equipment having any of the following:

b.4.a. Quadrature-amplitude-modulation (QAM) techniques above level 128; *or*

b.4.b. Operating at input or output frequencies exceeding 31 GHz; *or*

Note: 5B001.b.4.b does not include equipment specially designed for the ''development'' of equipment designed or modified for operation in any ITU allocated band.

b.5. Equipment employing ''common channel signalling'' operating in either the non-associated mode of operation.

5C991 Preforms of glass or of any other material optimized for the manufacture of optical fibers controlled by 5A991.

License Requirements

Reason for Control: AT

Control(s)	*Country Chart*
AT applies to entire entry	AT Column 1

License Exceptions

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

List of Items Controlled

Unit: $ value
Related Controls: N/A
Related Definitions: N/A
Items:

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

D. Software

5D001 ''Software'', as described in the List of Items Controlled.

* * * * *

License Exceptions

CIV: Yes, except for ''software'' controlled by 5D001.a and specially designed for the ''development'' or ''production'' of items controlled by 5A001.b.4 TSR: Yes, except for exports and reexports to destinations outside of Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Portugal, Spain, Sweden, or the United Kingdom of ''software'' controlled by 5D001.a and specially designed for items controlled by 5A001.b.4.

List of Items Controlled

Unit: $ value
Related Controls: See also 5D991
Related Definitions: N/A
Items:

a. ''Software'' specially designed or modified for the ''development'', ''production'' or ''use'' of equipment, functions or features controlled by 5A001 or 5B001.

b. ''Software'' specially designed or modified to support ''technology'' controlled by 5E001.

c. Specific ''software'' as follows:

c.1. ''Software'' specially designed or modified to provide characteristics, functions or features of equipment controlled by 5A001 or 5B001;

c.2. ''Software'' which provides the capability of recovering ''source code'' of telecommunications ''software'' controlled by 5D001;

c.3. ''Software'', other than in machine-executable form, specially designed for ''dynamic adaptive routing''.

d. ''Software'' specially designed or modified for the ''development'' of any of the following telecommunication transmission or ''stored program controlled'' switching equipment:

d.1. Equipment employing digital techniques, including ''Asynchronous Transfer Mode'' (''ATM''), designed to operate at a ''total digital transfer rate'' exceeding 1.5 Gbit/s;

d.2. Equipment employing a ''laser'' and having any of the following:

d.2.a. A transmission wavelength exceeding 1750 nm;

d.2.b. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;

Note: 5D001.d.2.b does not include ''software'' specially designed or modified for the ''development'' of commercial TV systems.

d.3. Equipment employing ''optical switching''; *or*

d.4. Radio equipment having any of the following:

d.4.a. Quadrature-amplitude-modulation (QAM) techniques above level 128; *or*

d.4.b. Operating at input or output frequencies exceeding 31 GHz; *or*

Note: 5D001.d.4.b does not include ''software'' specially designed or modified for the ''development'' of equipment designed or modified for operation in any ITU allocated band.

5E001 ''Technology'', (see List of Items Controlled).

* * * * *

License Exceptions

CIV: N/A

TSR: Yes, except for exports or reexports to destinations outside of Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Portugal, Spain, Sweden, or the United Kingdom of ''technology'' controlled by 5E001.a for the ''development'' or ''production'' of the following:

(1) Items controlled by 5A001.b.4; or

(2) ''Software'' controlled by 5D001.a that is specially designed for the ''development'' or ''production'' of items controlled by 5A001.b.4.

List of Items Controlled

Unit: $ value

Related Controls: See also 5E101 and 5E991

Related Definitions: N/A

Items:

a. ''Technology'' according to the General Technology Note for the ''development'', ''production'' or ''use'' (excluding operation) of equipment, functions or features or ''software'' controlled by 5A001, 5B001or 5D001.

b. Specific ''technologies'', as follows:

b.1. ''Required'' ''technology'' for the ''development'' or ''production'' of telecommunications equipment specially designed to be used on board satellites;

b.2. ''Technology'' for the ''development'' or ''use'' of ''laser'' communication techniques with the capability of automatically acquiring and tracking signals and maintaining communications through exoatmosphere or sub-surface (water) media;

b.3. ''Technology'' for the ''development'' of digital cellular radio systems;

b.4. ''Technology'' for the ''development'' of ''spread spectrum'' or ''frequency agility'' (frequency hopping) techniques.

c. ''Technology'' according the General Technology Note for the ''development'' of any of the following telecommunication transmission or ''stored program controlled'' switching equipment, functions or features:

c.1. Equipment employing digital techniques, including ''Asynchronous Transfer Mode'' (''ATM''), designed to operate at a ''total digital transfer rate'' exceeding 1.5 Gbit/s;

c.2. Equipment employing a ''laser'' and having any of the following:

c.2.a. A transmission wavelength exceeding 1750 nm;

c.2.b. Performing ''optical amplification'' using praseodymium-doped fluoride fiber amplifiers (PDFFA);

c.2.c. Employing coherent optical transmission or coherent optical detection techniques (also called optical heterodyne or homodyne techniques);

c.2.d. Employing wavelength division multiplexing techniques exceeding 8 optical carriers in a single optical window; *or*

c.2.e. Employing analogue techniques and having a bandwidth exceeding 2.5 GHz;

Note: 5E001.c.2.e does not include ''technology'' for the ''development'' or ''production'' of commercial TV systems.

c.3. Equipment employing ''optical switching''; *or*

c.4. Radio equipment having any of the following:

c.4.a. Quadrature-amplitude-modulation (QAM) techniques above level 128; *or*

c.4.b. Operating at input or output frequencies exceeding 31 GHz; *or*

Note: 5E001.c.4.b does not include ''technology'' for the ''development'' or ''production'' of equipment designed or modified for operation in any ITU allocated band.

c. 5. Equipment employing ''common channel signalling'' operating in either non-associated or quasi-associated mode of operation.

14. In Supplement No. 1 to part 774 (the Commerce Control List), Category 6—Sensors and Lasers, the following Export Control Classification Numbers (ECCNs) are amended:

a. By revising the List of Items Controlled section for ECCNs 6A003, 6A005 and 6C002; and

b. By revising the entry heading for ECCN 6C992, to read as follows:

6A003 Cameras

* * * * *

List of Items Controlled

Unit: Number

Related Controls: See also 6A203. See 8A002.d and .e for cameras specially designed or modified for underwater use.

Related Definitions: N/A.

Items:

a. Instrumentation cameras, as follows:

a.1. High-speed cinema recording cameras using any film format from 8 mm to 16 mm inclusive, in which the film is continuously advanced throughout the recording period, and that are capable of recording at framing rates exceeding 13,150 frames/s;

Note: 6A003.a.1 does not control cinema recording cameras designed for civil purposes.

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

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

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 1 μs per full frame; and

a.5.b. A read out time allowing a framing rate of more than 125 full frames per second.

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 any of the following:

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

b.1.b. More than 4 x 10^6 ''active pixels'' per solid state array for color cameras incorporating three solid state arrays; *or*

b.1.c. More than 12 x 10^6 ''active pixels'' for solid state array color cameras incorporating one solid state array;

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

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

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

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

b.4. Imaging cameras incorporating ''focal plane arrays'' having the characteristics listed in 6A002.a.3.

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

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

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

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

d. Equipment specially designed for laboratory use; *or*

e. Medical equipment.

6A005 ''Lasers'', components and optical equipment, as follows (see List of Items Controlled).

* * * * *

List of Items Controlled

Unit: Equipment in number; parts and accessories in $ value

Related Controls: (1.) See also 6A205, 6A995, 0B001.g.5 and 0B001.b.6. (2.) For excimer ''lasers'' specially designed for lithography equipment, see 3B001. (3.) Shared aperture optical elements, capable of operating in ''super-high power laser'' applications are subject to the export licensing authority of the U.S. Department of State, Office of Defense Trade Controls. (See 22 CFR part 121.)

Related Definitions: (1.) Pulsed ''lasers'' include those that run in a continuous wave (CW) mode with pulses superimposed. (2.) Pulse-excited ''lasers'' include those that run in a continuously excited mode with pulse excitation superimposed. (3.) The control status of Raman ''lasers'' is determined by the parameters of the pumping source ''lasers''. The pumping source ''lasers'' can be any of the ''lasers'' described as follows:

Items:

a. Gas ''lasers'', as follows:

a.1. Excimer ''lasers'', having any of the following:

a.1.a. An output wavelength not exceeding 150 nm and having any of the following:

a.1.a.1. An output energy exceeding 50 mJ per pulse; *or*

a.1.a.2. An average or CW output power exceeding 1 W;

a.1.b. An output wavelength exceeding 150 nm but not exceeding 190 nm and having any of the following:

a.1.b.1. An output energy exceeding 1.5 J per pulse; *or*

a.1.b.2. An average or CW output power exceeding 120 W;

a.1.c. An output wavelength exceeding 190 nm but not exceeding 360 nm and having any of the following:

a.1.c.1. An output energy exceeding 10 J per pulse; *or*

a.1.c.2. An average or CW output power exceeding 500 W; *or*

a.1.d. An output wavelength exceeding 360 nm and having any of the following:

a.1.d.1. An output energy exceeding 1.5 J per pulse; *or*

a.1.d.2. An average or CW output power exceeding 30 W;

a.2. Metal vapor ''lasers'', as follows:

a.2.a. Copper (Cu) ''lasers'' having an average or CW output power exceeding 20 W;

a.2.b. Gold (Au) ''lasers'' having an average or CW output power exceeding 5 W;

a.2.c. Sodium (Na) ''lasers'' having an output power exceeding 5 W;

a.2.d. Barium (Ba) ''lasers'' having an average or CW output power exceeding 2 W;

a.3. Carbon monoxide (CO) ''lasers'' having any of the following:

a.3.a. An output energy exceeding 2 J per pulse and a pulsed ''peak power'' exceeding 5 Kw; *or*

a.3.b. An average or CW output power exceeding 5 Kw;

a.4. Carbon dioxide (CO_2) ''lasers'' having any of the following:

a.4.a. A CW output power exceeding 15 Kw;

a.4.b. A pulsed output having a ''pulse duration'' exceeding 10 μs and having any of the following:

a.4.b.1. An average output power exceeding 10 Kw; *or*

a.4.b.2. A pulsed ''peak power'' exceeding 100 Kw; *or*

a.4.c. A pulsed output having a ''pulse duration'' equal to or less than 10 μs; and having any of the following:

a.4.c.1. A pulse energy exceeding 5 J per pulse; *or*

a.4.c.2. An average output power exceeding 2.5 Kw;

a.5. ''Chemical lasers'', as follows:

a.5.a. Hydrogen Fluoride (HF) ''lasers'';

a.5.b. Deuterium Fluoride (DF) ''lasers'';

a.5.c. ''Transfer lasers'', as follows:

a.5.c.1. Oxygen Iodine (O_2–I) ''lasers'';

a.5.c.2. Deuterium Fluoride-Carbon dioxide (DF-CO_2) ''lasers'';

a.6. Krypton ion or argon ion ''lasers'' having any of the following:

a.6.a. An output energy exceeding 1.5 J per pulse and a pulsed ''peak power'' exceeding 50 W; *or*

a.6.b. An average or CW output power exceeding 50 W;

a.7. Other gas ''lasers'', having any of the following:

Note: 6A005.a.7 does not control nitrogen ''lasers''.

a.7.a. An output wavelength not exceeding 150 nm and having any of the following:

a.7.a.1. An output energy exceeding 50 mJ per pulse and a pulsed ''peak power'' exceeding 1 W; *or*

a.7.a.2. An average or CW output power exceeding 1 W;

a.7.b. An output wavelength exceeding 150 nm but not exceeding 800 nm and having any of the following:

a.7.b.1. An output energy exceeding 1.5 J per pulse and a pulsed ''peak power'' exceeding 30 W; *or*

a.7.b.2. An average or CW output power exceeding 30 W;

a.7.c. An output wavelength exceeding 800 nm but not exceeding 1,400 nm and having any of the following:

a.7.c.1. An output energy exceeding 0.25 J per pulse and a pulsed ''peak power'' exceeding 10 W; *or*

a.7.c.2. An average or CW output power exceeding 10 W; *or*

a.7.d. An output wavelength exceeding 1,400 nm and an average or CW output power exceeding 1 W.

b. Semiconductor ''lasers'', having a wavelength of less than 950 nm or more than 2000 nm, as follows:

b.1. Individual single-transverse mode semiconductor ''lasers'' having an average or CW output power exceeding 100 mW;

b.2. Individual, multiple-transverse mode semiconductor ''lasers'' and arrays of individual semiconductor ''lasers'', having any of the following:

b.2.a. An output energy exceeding 500 μJ per pulse and a pulsed ''peak power'' exceeding 10 W; *or*

b.2.b. An average or CW output power exceeding 10 W.

Technical Note: Semiconductor ''lasers'' are commonly called ''laser'' diodes.

Note 1: 6A005.b includes semiconductor ''lasers'' having optical output connectors (e.g. fiber optic pigtails).

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

c. Solid state ''lasers'', as follows:

c.1. ''Tunable'' ''lasers'' having any of the following:

Note: 6A005.c.1 includes titanium—sapphire (Ti: Al_2O_3), thulium—YAG (Tm: YAG), thulium—YSGG (Tm: YSGG),

alexandrite (Cr: $BeAl_2O_4$) and color center ''lasers''.

c.1.a. An output wavelength less than 600 nm and having any of the following:

c.1.a.1. An output energy exceeding 50 mJ per pulse and a pulsed ''peak power'' exceeding 1 W; *or*

c.1.a.2. An average or CW output power exceeding 1 W;

c.1.b. An output wavelength of 600 nm or more but not exceeding 1,400 nm and having any of the following:

c.1.b.1. An output energy exceeding 1 J per pulse and a pulsed ''peak power'' exceeding 20 W; *or*

c.1.b.2. An average or CW output power exceeding 20 W; or

c.1.c. An output wavelength exceeding 1,400 nm and having any of the following:

c.1.c.1. An output energy exceeding 50 mJ per pulse and a pulsed ''peak power'' exceeding 1 W; *or*

c.1.c.2. An average or CW output power exceeding 1 W;

c.2. Non-''tunable'' ''lasers'', as follows:

Note: 6A005.c.2 includes atomic transition solid state ''lasers''.

c.2.a. Neodymium glass ''lasers'', as follows:

c.2.a.1. ''Q-switched lasers'' having any of the following:

c.2.a.1.a. An output energy exceeding 20 J but not exceeding 50 J per pulse and an average output power exceeding 10 W; *or*

c.2.a.1.b. An output energy exceeding 50 J per pulse;

c.2.a.2. Non-''Q-switched lasers'' having any of the following:

c.2.a.2.a. An output energy exceeding 50 J but not exceeding 100 J per pulse and an average output power exceeding 20 W; *or*

c.2.a.2.b. An output energy exceeding 100 J per pulse;

c.2.b. Neodymium-doped (other than glass) ''lasers'', having an output wavelength exceeding 1,000 nm but not exceeding 1,100 nm, as follows:

N.B.: For neodymium-doped (other than glass) ''lasers'' having an output wavelength not exceeding 1,000 nm or exceeding 1,100 nm, see 6A005.c.2.c.

c.2.b.1. Pulse-excited, mode-locked, ''Q-switched lasers'' having a ''pulse duration'' of less than 1 ns and having any of the following:

c.2.b.1.a. A ''peak power'' exceeding 5 GW;

c.2.b.1.b. An average output power exceeding 10 W; *or*

c.2.b.1.

c. A pulsed energy exceeding 0.1 J;

c.2.b.2. Pulse-excited, ''Q-switched lasers'' having a pulse duration equal to or more than 1 ns, and having any of the following:

c.2.b.2.a. A single-transverse mode output having:

c.2.b.2.a.1. A ''peak power'' exceeding 100 MW;

c.2.b.2.a.2. An average output power exceeding 20 W; *or*

c.2.b.2.a.3. A pulsed energy exceeding 2 J; *or*

c.2.b.2.b. A multiple-transverse mode output having:

c.2.b.2.b.1. A ''peak power'' exceeding 400 MW;

c.2.b.2.b.2. An average output power exceeding 2 kW; *or*

c.2.b.2.b.3. A pulsed energy exceeding 2 J;

c.2.b.3. Pulse-excited, non-''Q-switched lasers'', having:

c.2.b.3.a. A single-transverse mode output having:

c.2.b.3.a.1. A ''peak power'' exceeding 500 kW; *or*

c.2.b.3.a.2. An average output power exceeding 150 W; *or*

c.2.b.3.b. A multiple-transverse mode output having:

c.2.b.3.b.1. A ''peak power'' exceeding 1 MW; *or*

c.2.b.3.b.2. An average power exceeding 2 kW;

c.2.b.4. Continuously excited ''lasers'' having:

c.2.b.4.a. A single-transverse mode output having:

c.2.b.4.a.1. A ''peak power'' exceeding 500 kW; *or*

c.2.b.4.a.2. An average or CW output power exceeding 150 W; *or*

c.2.b.4.b. A multiple-transverse mode output having:

c.2.b.4.b.1. A ''peak power'' exceeding 1 MW; *or*

c.2.b.4.b.2. An average or CW output power exceeding 2 kW;

c.2.c. Other non-''tunable'' ''lasers'', having any of the following:

c.2.c.1. A wavelength less than 150 nm and having any of the following:

c.2.c.1.a. An output energy exceeding 50 mJ per pulse and a pulsed ''peak power'' exceeding 1 W; *or*

c.2.c.1.b. An average or CW output power exceeding 1 W;

c.2.c.2. A wavelength of 150 nm or more but not exceeding 800 nm and having any of the following:

c.2.c.2.a. An output energy exceeding 1.5 J per pulse and a pulsed ''peak power'' exceeding 30 W; *or*

c.2.c.2.b. An average or CW output power exceeding 30 W;

c.2.c.3. A wavelength exceeding 800 nm but not exceeding 1,400 nm, as follows:

c.2.c.3.a. ''Q-switched lasers'' having:

c.2.c.3.a.1. An output energy exceeding 0.5 J per pulse and a pulsed ''peak power'' exceeding 50 W; *or*

c.2.c.3.a.2. An average output power exceeding:

c.2.c.3.a.2.a. 10 W for single-mode ''lasers'';

c.2.c.3.a.2.b. 30 W for multimode ''lasers'';

c.2.c.3.b. Non-''Q-switched lasers'' having:

c.2.c.3.b.1. An output energy exceeding 2 J per pulse and a pulsed ''peak power'' exceeding 50 W; *or*

c.2.c.3.b.2. An average or CW output power exceeding 50 W; *or*

c.2.c.4. A wavelength exceeding 1,400 nm *and* having any of the following:

c.2.c.4.a. An output energy exceeding 100 mJ per pulse and a pulsed ''peak power'' exceeding 1 W; *or*

c.2.c.4.b. An average or CW output power exceeding 1 W;

d. Dye and other liquid ''lasers'', having any of the following:

d.1. A wavelength less than 150 nm and:

d.1.a. An output energy exceeding 50 mJ per pulse and a pulsed ''peak power'' exceeding 1 W; *or*

d.1.b. An average or CW output power exceeding 1 W;

d.2. A wavelength of 150 nm or more but not exceeding 800 nm and having any of the following:

d.2.a. An output energy exceeding 1.5 J per pulse and a pulsed ''peak power'' exceeding 20 W;

d.2.b. An average or CW output power exceeding 20 W; *or*

d.2.c. 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;

d.3. A wavelength exceeding 800 nm but not exceeding 1,400 nm and having any of the following:

d.3.a. An output energy exceeding 0.5 J per pulse and a pulsed ''peak power'' exceeding 10 W; *or*

d.3.b. An average or CW output power exceeding 10 W; *or*

d.4. A wavelength exceeding 1,400 nm and having any of the following:

d.4.a. An output energy exceeding 100 mJ per pulse and a pulsed ''peak power'' exceeding 1 W; *or*

d.4.b. An average or CW output power exceeding 1 W;

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 specially designed for use with controlled ''lasers'';

f. Optical equipment, as follows:

(For shared aperture optical elements, capable of operating in ''Super-High Power Laser'' (''SHPL'') applications, see the U.S. Munitions List.)

f.1. Dynamic wavefront (phase) measuring equipment capable of mapping at least 50 positions on a beam wavefront having any of the following:

f.1.a. Frame rates equal to or more than 100 Hz and phase discrimination of at least 5% of the beam's wavelength; *or*

f.1.b. Frame rates equal to or more than 1,000 Hz and phase discrimination of at least 20% of the beam's wavelength;

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

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

f.4. Projection telescopes specially designed for use with ''SHPL'' systems.

6C002 Optical sensor materials, as follows (see List of Items Controlled).

* * * * *

List of Items Controlled

Unit: Number

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 of cadmium zinc telluride (CdZnTe), with zinc content less than 6% by weight, or cadmium telluride (CdTe), or mercury cadmium telluride (HgCdTe) of any purity level, including epitaxial wafers thereof.

6C992 Optical sensing fibers not controlled by 6A002.d.3 which 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 weight.

* * * * *

15. In Supplement No. 1 to part 774 (the Commerce Control List), Category 7—Navigation and Avionics is amended by revising the notes that immediately follow the Category 7A (Systems, Equipment and Components) heading, to read as follows:

Category 7—Navigation and Avionics

A. SYSTEMS, EQUIPMENT AND COMPONENTS

N.B. 1: For automatic pilots for underwater vehicles, see Category 8. For radar, see Category 6.

N.B. 2: For inertial navigation equipment for ships or submersibles see item 9.e on the Wassenaar Munitions List.

16. In Supplement No. 1 to part 774 (the Commerce Control List), Category 9—Propulsion Systems, Space Vehicles and Related Equipment is amended by revising the parenthetical phrase that immediately follows the Category 9A (Systems, Equipment and Components) heading, to read as follows:

Category 9—Propulsion Systems, Space Vehicles and Related Equipment

A. SYSTEMS, EQUIPMENT AND COMPONENTS

N.B.: For propulsion systems designed or rated against neutron or transient ionizing, see the U.S. Munitions List, 22 CFR part 121.

Dated: July 13, 1999.

R. Roger Majak,

Assistant Secretary for Export Administration.

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