IAEA 60 Years Atoms for Peace and Development

Information Circular

INFCIRC/254/Rev.10/Part 2[a]
Date: 8 November 2016

General Distribution
Original: English

Communication received from the Permanent Mission of the Republic of Korea to the International Atomic Energy Agency regarding Certain Member States' Guidelines for Transfers of Nuclear-related Dual-use Equipment, Materials, Software and Related Technology

1. The Secretariat has received a note verbale from the Permanent Mission of the Republic of Korea, dated 24 October 2016, in which it requests that the Agency circulate to all Member States, a letter of 21 October 2016 from the Chairperson of the Nuclear Suppliers Group, Ambassador Young-wan Song, to the Director General, on behalf of the Governments of Argentina, Australia, Austria, Belarus, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Kazakhstan, Republic of Korea, Latvia, Lithuania, Luxembourg, Malta, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland and the United States of America[b], providing further information on those Governments' Guidelines for Nuclear Transfers.

2. In light of the wish expressed in the above-mentioned note verbale, the text of the note verbale, as well as the letter and attachments thereto, are hereby reproduced for the information of all Member States.

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[a] INFCIRC/254/Part 1, as amended, contains Guidelines for the export of nuclear material, equipment and technology.

[b] The European Commission and the Chair of the Zangger Committee participate as observers.

PERMANENT MISSION OF THE REPUBLIC OF KOREA
VIENNA

KPM-2016-302

The Permanent Mission of the Republic of Korea to the International Organisations in Vienna presents its compliments to the International Atomic Energy Agency (IAEA) and has the honour to forward a letter, dated 21 October 2016 from Ambassador Young-wan Song, Resident Permanent Representative of the Republic of Korea to the International Organisations in Vienna, Chairperson of the Nuclear Suppliers Group (NSG), regarding the agreed amendments to INFCIRC 254/Part 2 (the NSG Part 2 Guidelines), including its Annex, to be conveyed to the Director General of the IAEA, Mr. Yukiya Amano.

The Permanent Mission has further the honour to request that the amended INFCIRC 254/Part 2, including its Annexes and a comparison table of changes, together with Ambassador Young-wan Song's letter be circulated among the Member States of the IAEA.

The Permanent Mission of the Republic of Korea to the International Organisations in Vienna avails itself of this opportunity to renew to the IAEA the assurances of its highest consideration.

Vienna, 24 October 2016

PERMANENT MISSION OF THE REPUBLIC OF KOREA
VIENNA

Chairman of the Nuclear Suppliers Group

Ministry of Foreign Affairs
Seoul,
Republic of Korea

21 October 2016

Your Excellency,

On behalf of the Governments of Argentina, Australia, Austria, Belarus, Belgium, Brazil, Bulgaria, Canada, China, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Kazakhstan, Republic of Korea, Latvia, Lithuania, Luxemburg, Malta, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and United States[1] , I have the honour to refer to all previous relevant communications from these Governments concerning their decisions to act in accordance with the Guidelines for Nuclear Transfers currently published by the International Atomic Energy Agency (IAEA) as an Information Circular document INFCIRC/254/Rev.9/Part 2, including its Annex.

These Governments have decided to amend Paragraphs 4 and 8 of the NSG Part 2 Guidelines. The new text reads as follows:

BEGIN TEXT:

<u>ESTABLISHMENT OF EXPORT LICENSING PROCEDURES</u>

4. Suppliers should have in place legal measures to ensure the effective implementation of the Guidelines, including export licensing regulations, enforcement measures, and penalties for violations. In considering whether to authorise transfers, suppliers should exercise prudence in order to carry out the Basic Principle and should take relevant factors into account, including:

   (a) Whether the recipient state is a party to the Nuclear Non-Proliferation Treaty (NPT), or to the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (Treaty of Tlatelolco), the South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga), Treaty on the Southeast Asia Nuclear-Weapon-Free Zone (Treaty of Bangkok), African Nuclear-Weapon-Free Zone Treaty (Treaty of Pelindaba), the Treaty on a Nuclear-Weapon-Free Zone in Central Asia (Treaty of Semipalatinsk) or to a similar international legally-binding nuclear non-proliferation agreement, and has an IAEA safeguards agreement in force applicable to all its peaceful nuclear activities;

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[1] The European Commission and the Chair of the Zangger Committee participate as observers.

(b) Whether any recipient state that is not party to the NPT, Treaty of Tlatelolco, Treaty of Rarotonga, Treaty of Bangkok, Treaty of Pelindaba, Treaty of Semipalatinsk, or a similar international legally-binding nuclear non-proliferation agreement has any facilities or installations listed in paragraph 3(b) above that are operational or being designed or constructed that are not, or will not be, subject to IAEA safeguards;

8. The supplier reserves to itself discretion as to the application of the Guidelines to other items of significance in addition to those identified in the Annex, and as to the application of other conditions for transfer that it may consider necessary in addition to those provided for in paragraph 6 of the Guidelines.

END OF TEXT:

The above Governments have also decided to amend the Annex of the NSG Part 2 Guidelines (the Dual-Use List), in order to more clearly define the standard of implementation that all Participating Governments of the Nuclear Suppliers Group regard as essential for the fulfilment of the Guidelines, as follows.

- 1.B.2.c "Machine Tools for Grinding" . This change clarifies the scope of control on machine tools for grinding.
- 1.B.3. "Dimensional inspection machines". This change clarifies the criteria of Note 1 of 1.B.3. and excludes any duplications.
- 1.B.7. "Test and Production Equipment". This change clarifies the control language on vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment, and adds plasma torches and electron beam guns as controlled equipment.
- 3.A.7.c "Pressure Transducers". This change modifies parameter values for pressure transducers according to the definition of "accuracy" in the Control List.
- 3.B.3 "Centrifugal multiplane balancing machines". This change clarifies language in the centrifugal balancing machines control.
- 5.B.5 "Hydrodynamic Experiments PVDF". This change corrects the name of an alternate shock pressure gauge material.
- Editorial corrections; e.g. standardising spelling to British English; changes to units to be consistent with standard practice; changes to indicate that the singular also represents the plural; stricter use of markings for globally defined terms.

In the interest of clarity, the complete text of the modified Guidelines and its Annexes is reproduced in the attachment, as well as a "Comparison Table of Changes to the Guidelines for Nuclear Transfers."

The above Governments have decided to act in accordance with the Guidelines so revised and to implement them in accordance with their respective national legislation.

In reaching this decision, these Governments are fully aware of the need to contribute to economic development while avoiding contributing in any way to a proliferation of nuclear weapons or other nuclear explosive devices or the diversion to acts of nuclear terrorism, and of the need to separate the issue of non-proliferation or non-diversion assurances from that of commercial competition.

Insofar as trade within the European Union is concerned, the Governments that are Member States of the European Union will implement this decision in light of their commitments as Member States of the Union.

I would be grateful if you would bring this Note and its attachment to the attention of all Member States of the IAEA, as INFCIRC/254/Rev.10/Part 2.

On behalf of the above Governments I wish to avail myself of this opportunity to renew to you the assurances of the Governments' highest consideration.

Sincerely,

Ambassador Young-wan Song
Chairperson of the Nuclear Suppliers Group

H.E. Mr. Yukiya Amano
Director General
International Atomic Energy Agency
Vienna, Austria

GUIDELINES FOR TRANSFERS OF NUCLEAR-RELATED DUAL-USE EQUIPMENT, MATERIALS, SOFTWARE, AND RELATED TECHNOLOGY

OBJECTIVE

1. With the objective of averting the proliferation of nuclear weapons and preventing acts of nuclear terrorism, suppliers have had under consideration procedures in relation to the transfer of certain equipment, materials, software, and related technology that could make a major contribution to a "nuclear explosive activity," an "unsafeguarded nuclear fuel-cycle activity" or acts of nuclear terrorism. In this connection, suppliers have agreed on the following principles, common definitions, and an export control list of equipment, materials, software, and related technology. The Guidelines are not designed to impede international co-operation as long as such co-operation will not contribute to a "nuclear explosive activity", an "unsafeguarded nuclear fuel-cycle activity" or acts of nuclear terrorism. Suppliers intend to implement the Guidelines in accordance with national legislation and relevant international commitments.

BASIC PRINCIPLE

2. Suppliers should not authorise transfers of equipment, materials, software, or related technology identified in the Annex:

   - for use in a non-nuclear-weapon state in a nuclear explosive activity or an unsafeguarded nuclear fuel-cycle activity, or

   - in general, when there is an unacceptable risk of diversion to such an activity, or when the transfers are contrary to the objective of averting the proliferation of nuclear weapons, or

   - when there is an unacceptable risk of diversion to acts of nuclear terrorism.

EXPLANATION OF TERMS

3. (a) "Nuclear explosive activity" includes research on or development, design, manufacture, construction, testing or maintenance of any nuclear explosive device or components or subsystems of such a device.

   (b) "Unsafeguarded nuclear fuel-cycle activity" includes research on or development, design, manufacture, construction, operation or maintenance of any reactor, critical facility, conversion plant, fabrication plant, reprocessing plant, plant for the separation of isotopes of source or special fissionable material, or separate storage installation, where there is no obligation to accept International Atomic Energy Agency (IAEA) safeguards at the relevant facility or installation, existing or future, when it contains any source or special fissionable material; or of any heavy water production plant where there is no obligation to accept IAEA safeguards on any nuclear material produced by or used in connection with any heavy water produced therefrom; or where any such obligation is not met.

ESTABLISHMENT OF EXPORT LICENSING PROCEDURES

4. Suppliers should have in place legal measures to ensure the effective implementation of the Guidelines, including export licensing regulations, enforcement measures, and penalties for violations. In considering whether to authorise transfers, suppliers should exercise prudence in order to carry out the Basic Principle and should take relevant factors into account, including:

   (a) Whether the recipient state is a party to the Nuclear Non-Proliferation Treaty (NPT), or to the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (Treaty of Tlatelolco), the South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga), Treaty on the Southeast Asia Nuclear-Weapon-Free Zone (Treaty of Bangkok), African Nuclear-Weapon-Free Zone Treaty (Treaty of Pelindaba), the Treaty on a Nuclear-Weapon-Free Zone in Central Asia (Treaty of Semipalatinsk) or to a similar international legally-binding nuclear non-proliferation agreement, and has an IAEA safeguards agreement in force applicable to all its peaceful nuclear activities;

   (b) Whether any recipient state that is not party to the NPT, Treaty of Tlatelolco, Treaty of Rarotonga, Treaty of Bangkok, Treaty of Pelindaba, Treaty of Semipalatinsk, or a similar international legally-binding nuclear non-proliferation agreement has any facilities or installations listed in paragraph 3(b) above that are operational or being designed or constructed that are not, or will not be, subject to IAEA safeguards;

   (c) Whether the equipment, materials, software, or related technology to be transferred is appropriate for the stated end-use and whether that stated end-use is appropriate for the end-user;

   (d) Whether the equipment, materials, software, or related technology to be transferred is to be used in research on or development, design, manufacture, construction, operation, or maintenance of any reprocessing or enrichment facility;

   (e) Whether governmental actions, statements, and policies of the recipient state are supportive of nuclear non-proliferation and whether the recipient state is in compliance with its international obligations in the field of non-proliferation;

   (f) Whether the recipients have been engaged in clandestine or illegal procurement activities;

   (g) Whether a transfer has not been authorised to the end-user or whether the end-user has diverted for purposes inconsistent with the Guidelines any transfer previously authorised;

   (h) Whether there is reason to believe that there is a risk of diversion to acts of nuclear terrorism; and

   (i) Whether there is a risk of retransfers of equipment, material, software, or related technology identified in the Annex or of transfers of any replica thereof contrary to the Basic Principle, as a result of a failure by the recipient State to develop and maintain appropriate, effective national export and transshipment controls, as identified by United Nations Security Council Resolution (UNSCR) 1540.

5. Suppliers should ensure that their national legislation requires an authorisation for the transfer of items not listed in the Annex if the items in question are or may be intended, in their entirety or in part, for use in connection with a “nuclear explosive activity”.

Suppliers will implement such an authorisation requirement in accordance with their domestic licensing practices.

Suppliers are encouraged to share information on "catch-all" denials.

CONDITIONS FOR TRANSFERS

6. In the process of determining that the transfer will not pose any unacceptable risk of diversion, in accordance with the Basic Principle and to meet the objectives of the Guidelines, the supplier should obtain, before authorising the transfer and in a manner consistent with its national law and practices, the following:

   (a) a statement from the end-user specifying the uses and end-use locations of the proposed transfers; and

   (b) an assurance explicitly stating that the proposed transfer or any replica thereof will not be used in any "nuclear explosive activity" or "unsafeguarded nuclear fuel-cycle activity".

CONSENT RIGHTS OVER RETRANSFERS

7. Before authorising the transfer of equipment, materials, software, or related technology identified in the Annex to a country not adhering to the Guidelines, suppliers should obtain assurances that their consent will be secured, in a manner consistent with their national law and practices, prior to any retransfer to a third country of the equipment, materials, software, or related technology, or any replica thereof.

CONCLUDING PROVISIONS

8. The supplier reserves to itself discretion as to the application of the Guidelines to other items of significance in addition to those identified in the Annex, and as to the application of other conditions for transfer that it may consider necessary in addition to those provided for in paragraph 6 of the Guidelines.

9. In furtherance of the effective implementation of the Guidelines, suppliers should, as necessary and appropriate, exchange relevant information and consult with other states adhering to the Guidelines.

10. In the interest of international peace and security, the adherence of all states to the Guidelines would be welcome.

ANNEX

LIST OF NUCLEAR-RELATED DUAL-USE EQUIPMENT, MATERIALS, SOFTWARE, AND RELATED TECHNOLOGY

ANNEX

Note: The International System of Units (SI) is used in this Annex. In all cases, the physical quantity defined in SI units should be considered the official recommended control value. However, some machine tool parameters are given in their customary units, which are not SI.

Commonly used abbreviations (and their prefixes denoting size) in this Annex are as follows:

A	-	ampere(s)	-	Electric current
CAS	-	Chemical Abstracts Service	-	
cm	-	centimetre(s)	-	Length
cm^2	-	square centimetre(s)	-	Area
cm^3	-	cubic centimetre(s)	-	Volume
°	-	degree(s)	-	Angle
°C	-	degree(s) Celsius	-	Temperature
g	-	gram(s)	-	Mass
g_0	-	acceleration of gravity (9.80665 m/s^2)	-	Acceleration
GBq	-	gigabecquerel(s)	-	Activity (radioactive)
GPa	-	gigapascal(s)	-	Pressure
Gy	-	gray(s)	-	Absorbed ionising radiation
h	-	hour(s)	-	Time
Hz	-	hertz	-	Frequency
J	-	joule(s)	-	Energy, work, heat
keV	-	kiloelectron volt(s)	-	Energy, electrical
kg	-	kilogram(s)	-	Mass
kHz	-	kilohertz	-	Frequency
kN	-	kilonewton(s)	-	Force
kPa	-	kilopascal(s)	-	Pressure
kV	-	kilovolt(s)	-	Electrical potential
kW	-	kilowatt(s)	-	Power
K	-	kelvin	-	Thermodynamic temperature
l	-	litre(s)	-	Volume (liquids)
MeV	-	megaelectron volt(s)	-	Energy, electrical
MPa	-	megapascal(s)	-	Pressure
MPE	-	Maximum Permissible Error	-	Length measurement
MW	-	megawatt(s)	-	Power
m	-	metre(s)	-	Length
m^2	-	square metre(s)	-	Area
m^3	-	cubic metre(s)	-	Volume
mA	-	milliampere(s)	-	Electric current
ml	-	millilitre(s)	-	Volume (liquids)
mm	-	millimetre(s)	-	Length
mPa	-	millipascal(s)	-	Pressure
µF	-	microfarad(s)	-	Electric capacitance
µm	-	micrometre(s)	-	Length
µs	-	microsecond(s)	-	Time
N	-	newton(s)	-	Force
nF	-	nanofarad(s)	-	Electrical capacitance
nH	-	nanohenry(s)	-	Electrical inductance
nm	-	nanometre(s)	-	Length
ns	-	nanosecond(s)	-	Time
Ω	-	ohm(s)	-	Electric resistance
Pa	-	pascal(s)	-	Pressure
ps	-	picosecond(s)	-	Time
rpm	-	revolution(s) per minute	-	Angular velocity
s	-	second(s)	-	Time
"	-	second(s) of arc	-	Angle

T	-	tesla(s)	-	Magnetic flux density
V	-	volt(s)	-	Electrical potential
W	-	watt(s)	-	Power

GENERAL NOTE

The following paragraphs are applied to the List of Nuclear-Related Dual-Use Equipment, Material, Software, and Related Technology.

1. The description of any item on the List includes that item in either new or second-hand condition.

2. When the description of any item on the List contains no qualifications or specifications, it is regarded as including all varieties of that item. Category captions are only for convenience in reference and do not affect the interpretation of item definitions.

3. The object of these controls should not be defeated by the transfer of any non-controlled item (including plants) containing one or more controlled components when the controlled component or components are the principal element of the item and can feasibly be removed or used for other purposes.

   Note: In judging whether the controlled component or components are to be considered the principal element, governments should weigh the factors of quantity, value, and technological know-how involved and other special circumstances which might establish the controlled component or components as the principal element of the item being procured.

4. The object of these controls should not be defeated by the transfer of component parts. Each government will take such action as it can to achieve this aim and will continue to seek a workable definition for component parts, which could be used by all the suppliers.

TECHNOLOGY CONTROLS

The transfer of “technology” is controlled according to the Guidelines and as described in each section of the Annex. “Technology” directly associated with any item in the Annex will be subject to as great a degree of scrutiny and control as will the item itself, to the extent permitted by national legislation.

The approval of any Annex item for export also authorises the export to the same end user of the minimum “technology” required for the installation, operation, maintenance, and repair of the item.

Note: Controls on “technology” transfer do not apply to information “in the public domain” or to “basic scientific research”.

GENERAL SOFTWARE NOTE

The transfer of “software” is controlled according to the Guidelines and as described in the Annex.

Note: Controls on “software” transfers do not apply to “software” as follows:

1. Generally available to the public by being:
   a. Sold from stock at retail selling points without restriction; and
   b. Designed for installation by the user without further substantial support by the supplier;

   or
2. “In the public domain”.

DEFINITIONS

"Accuracy" --

Usually measured in terms of inaccuracy, defined as the maximum deviation, positive or negative, of an indicated value from an accepted standard or true value.

"Angular position deviation" --

The maximum difference between angular position and the actual, very accurately measured angular position after the workpiece mount of the table has been turned out of its initial position.

"Basic scientific research" --

Experimental or theoretical work undertaken principally to acquire new knowledge of the fundamental principles of phenomena and observable facts, not primarily directed toward a specific practical aim or objective.

"Contouring control" --

Two or more "numerically controlled" motions operating in accordance with instructions that specify the next required position and the required feed rates to that position. These feed rates are varied in relation to each other so that a desired contour is generated. (Ref. International Organization for Standardization (ISO) 2806(1994) as amended)

"Development" --

is related to all phases before "production" such as:

- design
- design research
- design analysis
- design concepts
- assembly and testing of prototypes
- pilot production schemes
- design data
- process of transforming design data into a product
- configuration design
- integration design
- layouts

"Fibrous or filamentary materials" --

means continuous 'monofilaments', 'yarns', 'rovings', 'tows' or 'tapes'.

N.B.:

1. 'Filament' or 'monofilament' --

   is the smallest increment of fibre, usually several µm in diameter.

2. 'Roving' --

   is a bundle (typically 12-120) of approximately parallel 'strands'.

3. 'Strand' --

   is a bundle of 'filaments' (typically over 200) arranged approximately parallel.

4. 'Tape' --

   is a material constructed of interlaced or unidirectional 'filaments', 'strands', 'rovings', 'tows' or 'yarns', etc., usually preimpregnated with resin.

5. 'Tow' --

   is a bundle of 'filaments', usually approximately parallel.

6. 'Yarn' --

   is a bundle of twisted 'strands'.

'Filament' --

See "Fibrous or filamentary materials".

"In the public domain" --

"In the public domain", as it applies herein, means "technology" or "software" that has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove "technology" or "software" from being "in the public domain".)

"Linearity" --

(Usually measured in terms of non-linearity) is the maximum deviation of the actual characteristic (average of upscale and downscale readings), positive or negative, from a straight line so positioned as to equalise and minimise the maximum deviations.

"Measurement uncertainty" --

The characteristic parameter which specifies in what range around the output value the correct value of the measurable variable lies with a confidence level of 95%. It includes the uncorrected systematic deviations, the uncorrected backlash, and the random deviations.

"Microprogram" --

A sequence of elementary instructions, maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction into an instruction register.

'Monofilament'--

See "Fibrous or filamentary materials".

"Numerical control" --

The automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress. (Ref. ISO 2382 (2015))

"Positioning accuracy" --

of "numerically controlled" machine tools is to be determined and presented in accordance with Item 1.B.2., in conjunction with the requirements below:

(a) Test conditions (ISO 230/2 (1988), paragraph 3):

(1) For 12 h before and during measurements, the machine tool and accuracy measuring equipment will be kept at the same ambient temperature. During the premeasurement time, the slides of the machine will be continuously cycled identically to the way they will be cycled during the accuracy measurements;

(2) The machine shall be equipped with any mechanical, electronic, or software compensation to be exported with the machine;

(3) Accuracy of measuring equipment for the measurements shall be at least four times more accurate than the expected machine tool accuracy;

(4) Power supply for slide drives shall be as follows:

(i) Line voltage variation shall not be greater than ± 10% of nominal rated voltage;

(ii) Frequency variation shall not be greater than ± 2 Hz of normal frequency;

(iii) Lineouts or interrupted service are not permitted.

(b) Test program (paragraph 4):

(1) Feed rate (velocity of slides) during measurement shall be the rapid traverse rate;

N.B.: In the case of machine tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute.

(2) Measurements shall be made in an incremental manner from one limit of the axis travel to the other without returning to the starting position for each move to the target position;

(3) Axes not being measured shall be retained at mid-travel during test of an axis.

(c) Presentation of the test results (paragraph 2):

The results of the measurements must include:

(1) "Positioning accuracy" (A); and

(2) The mean reversal error (B).

"Production" --

means all production phases such as:

- construction
- production engineering
- manufacture
- integration
- assembly (mounting)
- inspection
- testing
- quality assurance

"Program" --

A sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer.

"Resolution" --

The least increment of a measuring device; on digital instruments, the least significant bit.
(Ref. American National Standards Institute (ANSI) B-89.1.12)

'Roving' --

See "Fibrous or filamentary materials".

"Software" --

A collection of one or more "programs" or "microprograms" fixed in any tangible medium of expression.

'Strand' --

See "Fibrous or filamentary materials".

'Tape' --

See "Fibrous or filamentary materials".

"Technical assistance" --

"Technical assistance" may take forms such as: instruction, skills, training, working knowledge, consulting services.

Note: "Technical assistance" may involve transfer of "technical data".

"Technical data" --

"Technical data" may take forms such as blueprints, plans, diagrams, models, formulae, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.

"Technology" --

means specific information required for the "development", "production", or "use" of any item contained in the List. This information may take the form of "technical data" or "technical assistance".

'Tow' --

See "Fibrous or filamentary materials".

"Use" --

Operation, installation (including on-site installation), maintenance (checking), repair, overhaul, and refurbishing.

'Yarn' --

See "Fibrous or filamentary materials".

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1. INDUSTRIAL EQUIPMENT

1.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

1.A.1. High-density (lead glass or other) radiation shielding windows, having all of the following characteristics, and specially designed frames therefor:

a. A ‘cold area’ greater than 0.09 m^2;

b. A density greater than 3 g/cm^3; <u>and</u>

c. A thickness of 100 mm or greater.

<u>Technical Note</u>: *In Item 1.A.1.a. the term ‘cold area’ means the viewing area of the window exposed to the lowest level of radiation in the design application.*

1.A.2. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5×10^4 Gy (silicon) without operational degradation.

<u>*Technical Note:*</u> *The term Gy (silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.*

1.A.3. ‘Robots’, ‘end-effectors’ and control units as follows:

a. ‘Robots’ or ‘end-effectors’ having either of the following characteristics:

1. Specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives); <u>or</u>

2. Specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5×10^4 Gy (silicon) without operational degradation;

<u>*Technical Note:*</u> *The term Gy (silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.*

b. Control units specially designed for any of the ‘robots’ or ‘end-effectors’ specified in Item 1.A.3.a.

<u>Note:</u> Item 1.A.3. does not control ‘robots’ specially designed for non-nuclear industrial applications such as automobile paint-spraying booths.

<u>*Technical Notes:*</u> *1. ‘Robots’*

In Item 1.A.3. ‘robot’ means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use ‘sensors’, and has all of the following characteristics:

(a) is multifunctional;

(b) is capable of positioning or orienting material, parts, tools, or special devices through variable movements in three-dimensional space;

(c) incorporates three or more closed or open loop servo-devices which may include stepping motors; and

(d) has 'user-accessible programmability' by means of teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.

N.B.1:

In the above definition 'sensors' means detectors of a physical phenomenon, the output of which (after conversion into a signal that can be interpreted by a control unit) is able to generate "programs" or modify programmed instructions or numerical "program" data. This includes 'sensors' with machine vision, infrared imaging, acoustical imaging, tactile feel, inertial position measuring, optical or acoustic ranging or force or torque measuring capabilities.

N.B.2:

In the above definition 'user-accessible programmability' means the facility allowing a user to insert, modify or replace "programs" by means other than:

(a) a physical change in wiring or interconnections; or

(b) the setting of function controls including entry of parameters.

N.B.3:

The above definition does not include the following devices:

(a) Manipulation mechanisms which are only manually/teleoperator controllable;

(b) Fixed sequence manipulation mechanisms which are automated moving devices operating according to mechanically fixed programmed motions. The "program" is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic, or electrical means;

(c) Mechanically controlled variable sequence manipulation mechanisms which are automated moving devices operating according to mechanically fixed programmed motions. The "program" is mechanically limited by fixed, but adjustable, stops such as pins or cams. The sequence of motions and the selection of paths or angles are variable within the fixed "program" pattern. Variations or modifications of the "program" pattern (e.g.,

changes of pins or exchanges of cams) in one or more motion axes are accomplished only through mechanical operations;

(d) Non-servo-controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The "program" is variable but the sequence proceeds only by the binary signal from mechanically fixed electrical binary devices or adjustable stops;

(e) Stacker cranes defined as Cartesian coordinate manipulator systems manufactured as an integral part of a vertical array of storage bins and designed to access the contents of those bins for storage or retrieval.

2. 'End-effectors'

In Item 1.A.3. 'end-effectors' are grippers, 'active tooling units', and any other tooling that is attached to the baseplate on the end of a 'robot' manipulator arm.

<u>N.B.:</u>

In the above definition 'active tooling units' is a device for applying motive power, process energy or sensing to the workpiece.

1.A.4. Remote manipulators that can be used to provide remote actions in radiochemical separation operations or hot cells, having either of the following characteristics:

a. A capability of penetrating 0.6 m or more of hot cell wall (through-the-wall operation); <u>or</u>

b. A capability of bridging over the top of a hot cell wall with a thickness of 0.6 m or more (over-the-wall operation).

<u>Technical Note</u>: *Remote manipulators provide translation of human operator actions to a remote operating arm and terminal fixture. They may be of a master/slave type or operated by joystick or keypad.*

1.B. TEST AND PRODUCTION EQUIPMENT

1.B.1. Flow-forming machines, spin-forming machines capable of flow-forming functions, and mandrels, as follows:

a. Machines having both of the following characteristics:

1. Three or more rollers (active or guiding); <u>and</u>

2. Which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control;

b. Rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 and 400 mm.

<u>Note:</u> Item 1.B.1.a. includes machines which have only a single roller designed to deform metal plus two auxiliary rollers which support the mandrel, but do not participate directly in the deformation process.

1.B.2. Machine tools, as follows, and any combination thereof, for removing or cutting metals, ceramics, or composites, which, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes:

N.B.: For "numerical control" units controlled by their associated "software", see Item 1.D.3.

a. Machine tools for turning, that have "positioning accuracies" with all compensations available better (less) than 6 µm according to ISO 230/2 (1988) along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm;

Note: Item 1.B.2.a. does not control bar machines (Swissturn), limited to machining only bar feed thru, 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.

b. Machine tools for milling, having any of the following characteristics:

1. "Positioning accuracies" with all compensations available better (less) than 6 µm according to ISO 230/2 (1988) along any linear axis (overall positioning);

2. Two or more contouring rotary axes; or

3. Five or more axes which can be coordinated simultaneously for "contouring control".

Note: Item 1.B.2.b. does not control milling machines having both of the following characteristics:

1. X-axis travel greater than 2 m; and

2. Overall "positioning accuracy" on the x-axis worse (more) than 30 µm according to ISO 230/2 (1988).

c. Machine tools for grinding, having any of the following characteristics:

1. "Positioning accuracies" with all compensations available better (less) than 4 µm according to ISO 230/2 (1988) along any linear axis (overall positioning);

2. Two or more contouring rotary axes; or

3 Five or more axes which can be coordinated simultaneously for "contouring control".

Note: Item 1.B.2.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 a maximum workpiece capacity of 150 mm outside diameter or length; and

b. Axes limited to x, z and c.

2. Jig grinders that do not have a z-axis or a w-axis with an overall "positioning accuracy" less (better) than 4 µm according to ISO 230/2 (1988).

d. Non-wire type Electrical Discharge Machines (EDM) that have two or more contouring rotary axes and that can be coordinated simultaneously for “contouring control”.

Notes: 1. Stated “positioning accuracy” levels derived under the following procedures from measurements made according to ISO 230/2 (1988) or national equivalents may be used for each machine tool model if provided to, and accepted by, national authorities instead of individual machine tests.

Stated “positioning accuracy” levels are to be derived as follows:

a. Select five machines of a model to be evaluated;

b. Measure the linear axis accuracies according to ISO 230/2 (1988);

c. Determine the accuracy values (A) for each axis of each machine. The method of calculating the accuracy value is described in the ISO 230/2 (1988) standard;

d. Determine the average accuracy value of each axis. This average value becomes the stated “positioning accuracy” of each axis for the model ($\hat{A}_x$, $\hat{A}_y$...);

e. Since Item 1.B.2. refers to each linear axis, there will be as many stated “positioning accuracy” values as there are linear axes;

f. If any axis of a machine tool not controlled by Items 1.B.2.a., 1.B.2.b., or 1.B.2.c. has a stated “positioning accuracy” of 6 µm or better (less) for grinding machines, and 8 µm or better (less) for milling and turning machines, both according to ISO 230/2 (1988), then the builder should be required to reaffirm the accuracy level once every eighteen months.

2. Item 1.B.2. does not control special purpose machine tools limited to the manufacture of any of the following parts:

a. Gears;

b. Crankshafts or cam shafts;

c. Tools or cutters;

d. Extruder worms.

Technical Notes: 1. *Axis nomenclature shall be in accordance with ISO 841(2001), “Numerical Control Machines - Axis and Motion Nomenclature”.*

2. *Not counted in the total number of contouring axes are secondary parallel contouring axes (e.g., the w-axis on horizontal boring mills or a secondary rotary axis the centreline of which is parallel to the primary rotary axis).*

3. *Rotary axes do not necessarily have to rotate over 360 º. A rotary axis can be driven by a linear device, e.g., a screw or a rack-and-pinion.*

4. *For the purposes of 1.B.2. the number of axes which can be coordinated simultaneously for “contouring control” is the number of axes along or around which, during processing of the workpiece, simultaneous and interrelated motions are performed between the workpiece and a tool. This does not include any additional axes along or around which other relative motions within the machine are performed, such as:*

a. Wheel-dressing systems in grinding machines;

b Parallel rotary axes designed for mounting of separate workpieces;

c. Co-linear rotary axes designed for manipulating the same workpiece by holding it in a chuck from different ends.

5. A machine tool having at least 2 of the 3 turning, milling or grinding capabilities (e.g., a turning machine with milling capability) must be evaluated against each applicable entry, 1.B.2.a., 1.B.2.b. and 1.B.2.c.

6. Items 1.B.2.b.3. and 1.B.2.c.3. include machines based on a parallel linear kinematic design (e.g., hexapods) that have 5 or more axes none of which is a rotary axis.

1.B.3. Dimensional inspection machines, instruments, or systems, as follows:

a. Computer controlled or numerically controlled coordinate measuring machines (CMM) having either of the following characteristics:

1. Having only two axes and having a maximum permissible error of length measurement along any axis (one dimensional), identified as any combination of $E_{0x\ MPE}$, $E_{0y\ MPE}$ or $E_{0z\ MPE}$, equal to or less (better) than (1.25 + L/1000) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2(2009); or

2. Three or more axes and having a three dimensional (volumetric) maximum permissible error of length measurement ($E_{0,\ MPE}$ equal to or less (better) than (1.7 + L/800) µm (where L is the measured length in mm) at any point within the operating range of the machine (i.e., within the length of the axis), according to ISO 10360-2(2009).

<u>Technical Note:</u> *The $E_{0,\ MPE}$ of the most accurate configuration of the CMM specified according to ISO 10360-2(2009) by the manufacturer (e.g., best of the following: probe, stylus length, motion parameters, environment) and with all compensations available shall be compared to the 1.7 + L/800 µm threshold.*

b. Linear displacement measuring instruments, as follows:

1. Non-contact type measuring systems with a "resolution" equal to or better (less) than 0.2 µm within a measuring range up to 0.2 mm;

2. Linear variable differential transformer (LVDT) systems having both of the following characteristics:

a. 1. "Linearity" equal to or less (better) than 0.1% measured from 0 to the full operating range, for LVDTs with an operating range up to 5 mm; <u>or</u>

2. "Linearity" equal to or less (better) than 0.1% measured from 0 to 5 mm for LVDTs with an operating range greater than 5 mm; <u>and</u>

b. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature ± 1 K (± 1 ºC);

3. Measuring systems having both of the following characteristics:

a. Containing a laser; <u>and</u>

b. Capable of maintaining for at least 12 h, over a temperature range of ± 1 K (-± 1 ºC) around a standard temperature and a standard pressure:

1. A "resolution" over their full scale of 0.1 µm or better; and

2. With a "measurement uncertainty" equal to or better (less) than (0.2 + L/2000) µm (L is the measured length in mm);

Note: Item 1.B.3.b.3. does not control measuring interferometer systems, without closed or open loop feedback, containing a laser to measure slide movement errors of machine tools, dimensional inspection machines, or similar equipment.

Technical Note: *In Item 1.B.3.b. 'linear displacement' means the change of distance between the measuring probe and the measured object.*

c. Angular displacement measuring instruments having an "angular position deviation" equal to or better (less) than 0.00025°;

Note: Item 1.B.3.c. does not control optical instruments, such as autocollimators, using collimated light (e.g., laser light) to detect angular displacement of a mirror.

d. Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics:

1. "Measurement uncertainty" along any linear axis equal to or better (less) than 3.5 µm per 5 mm; and

2. "Angular position deviation" equal to or less than 0.02°.

Notes: 1. Item 1.B.3. includes machine tools, other than those specified by 1.B.2, that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.

2. Machines described in Item 1.B.3. are controlled if they exceed the threshold specified anywhere within their operating range.

Technical Note: *All parameters of measurement values in this item represent plus/minus, i.e., not total band.*

1.B.4. Controlled atmosphere (vacuum or inert gas) induction furnaces, and power supplies therefor, as follows:

a. Furnaces having all of the following characteristics:

1. Capable of operation at temperatures above 1123 K (850 °C);

2. Induction coils 600 mm or less in diameter; and

3. Designed for power inputs of 5 kW or more;

Note: Item 1.B.4.a. does not control furnaces designed for the processing of semiconductor wafers.

b. Power supplies, with a specified output power of 5 kW or more, specially designed for furnaces specified in Item 1.B.4.a.

1.B.5. 'Isostatic presses', and related equipment, as follows:

a. 'Isostatic presses' having both of the following characteristics:

1. Capable of achieving a maximum working pressure of 69 MPa or greater; <u>and</u>

2. A chamber cavity with an inside diameter in excess of 152 mm;

b. Dies, moulds, and controls specially designed for the "isostatic presses" specified in Item 1.B.5.a.

<u>Technical Notes:</u> 1. *In Item 1.B.5. 'Isostatic presses' means equipment capable of pressurising a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.*

2. *In Item 1.B.5. 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.*

1.B.6. Vibration test systems, equipment, and components as follows:

a. Electrodynamic vibration test systems, having all of the following characteristics:

1. Employing feedback or closed loop control techniques and incorporating a digital control unit;

2. Capable of vibrating at 10 g_0 root mean square (RMS) or more between 20 and 2000 Hz; <u>and</u>

3. Capable of imparting forces of 50 kN or greater measured 'bare table';

b. Digital control units, combined with "software" specially designed for vibration testing, with a real-time bandwidth greater than 5 kHz and being designed for a system specified in Item 1.B.6.a.;

c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force of 50 kN or greater measured 'bare table', which are usable for the systems specified in Item 1.B.6.a.;

d. Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN or greater, measured 'bare table', which are usable for the systems specified in Item 1.B.6.a.

<u>Technical Note:</u> *In Item 1.B.6. 'bare table' means a flat table, or surface, with no fixtures or fittings.*

1.B.7. Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment, as follows:

a. Arc remelt furnaces, arc melt furnaces and arc melt and casting furnaces having both of the following characteristics:

1. Consumable electrode capacities between 1000 and 20000 cm^3; <u>and</u>

2. Capable of operating with melting temperatures above 1973 K (1700 °C);

b. Electron beam melting furnaces, plasma atomisation furnaces and plasma melting furnaces having both of the following characteristics:

1. A power of 50 kW or greater; and

2. Capable of operating with melting temperatures above 1473 K (1200 °C);

c. Computer control and monitoring systems specially configured for any of the furnaces specified in Item 1.B.7.a. or 1.B.7.b.

d. Plasma torches specially designed for the furnaces specified in 1.B.7.b having both of the following characteristics:

1. Operating at a power greater than 50kW; and
2. Capable of operating above 1473 K (1200°C);

e. Electron beam guns specially designed for the furnaces specified in 1.B.7.b operating at a power greater than 50kW.

1.C. MATERIALS

None.

1.D. SOFTWARE

1.D.1. "Software" specially designed or modified for the "use" of equipment specified in Item 1.A.3., 1.B.1., 1.B.3., 1.B.5., 1.B.6.a., 1.B.6.b., 1.B.6.d. or 1.B.7.

Note: "Software" specially designed or modified for systems specified in Item 1.B.3.d. includes "software" for simultaneous measurements of wall thickness and contour.

1.D.2. "Software" specially designed or modified for the "development", "production", or "use" of equipment specified in Item 1.B.2.

Note: Item 1.D.2. does not control part programming "software" that generates "numerical control" command codes but does not allow direct use of equipment for machining various parts.

1.D.3. "Software" for any combination of electronic devices or system enabling such a device or such devices to function as a "numerical control" unit for machine tools, that is capable of controlling five or more interpolating axes that can be coordinated simultaneously for "contouring control".

Notes:
1. "Software" is controlled whether exported separately or residing in a "numerical control" unit or any electronic device or system.

2. Item 1.D.3. does not control "software" specially designed or modified by the manufacturers of the control unit or machine tool to operate a machine tool that is not specified in Item 1.B.2.

1.E. TECHNOLOGY

1.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 1.A. through 1.D.

2. MATERIALS

2.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

2.A.1. Crucibles made of materials resistant to liquid actinide metals, as follows:

a. Crucibles having both of the following characteristics:

1. A volume of between 150 cm^3 (150 ml) and 8000 cm^3 (8 l); and

2. Made of or coated with any of the following materials, or combination of the following materials, having an overall impurity level of 2% or less by weight:

a. Calcium fluoride (CaF_2);

b. Calcium zirconate (metazirconate) ($CaZrO_3$);

c. Cerium sulphide (Ce_2S_3);

d. Erbium oxide (erbia) (Er_2O_3);

e. Hafnium oxide (hafnia) (HfO_2);

f. Magnesium oxide (MgO);

g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);

h. Yttrium oxide (yttria) (Y_2O_3); or

i. Zirconium oxide (zirconia) (ZrO_2);

b. Crucibles having both of the following characteristics:

1. A volume of between 50 cm^3 (50 ml) and 2000 cm^3 (2 l); and

2. Made of or lined with tantalum, having a purity of 99.9% or greater by weight;

c. Crucibles having all of the following characteristics:

1. A volume of between 50 cm^3 (50 ml) and 2000 cm^3 (2 l);

2. Made of or lined with tantalum, having a purity of 98% or greater by weight; and

3. Coated with tantalum carbide, nitride, boride, or any combination thereof.

2.A.2. Platinised catalysts specially designed or prepared for promoting the hydrogen isotope exchange reaction between hydrogen and water for the recovery of tritium from heavy water or for the production of heavy water.

2.A.3. Composite structures in the form of tubes having both of the following characteristics:

a. An inside diameter of between 75 and 400 mm; <u>and</u>

b. Made with any of the “fibrous or filamentary materials” specified in Item 2.C.7.a. or carbon prepreg materials specified in Item 2.C.7.c.

2.B. TEST AND PRODUCTION EQUIPMENT

2.B.1. Tritium facilities or plants, and equipment therefor, as follows:

a. Facilities or plants for the production, recovery, extraction, concentration or handling of tritium;

b. Equipment for tritium facilities or plants, as follows:

1. Hydrogen or helium refrigeration units capable of cooling to 23 K (-250 ºC) or less, with heat removal capacity greater than 150 W;

2. Hydrogen isotope storage or purification systems using metal hydrides as the storage or purification medium.

2.B.2. Lithium isotope separation facilities or plants, and systems and equipment therefor, as follows:

N.B.: *Certain lithium isotope separation equipment and components for the plasma separation process (PSP) are also directly applicable to uranium isotope separation and are controlled under INFCIRC/254 Part 1 (as amended).*

a. Facilities or plants for the separation of lithium isotopes;

b. Equipment for the separation of lithium isotopes based on the lithium-mercury amalgam process, as follows:

1. Packed liquid-liquid exchange columns specially designed for lithium amalgams;

2. Mercury or lithium amalgam pumps;

3. Lithium amalgam electrolysis cells;

4. Evaporators for concentrated lithium hydroxide solution;

c. Ion exchange systems specially designed for lithium isotope separation, and specially designed component parts therefor;

d. Chemical exchange systems (employing crown ethers, cryptands, or lariat ethers) specially designed for lithium isotope separation, and specially designed component parts therefor.

2.C. MATERIALS

2.C.1. Aluminium alloys having both of the following characteristics:

a. ‘Capable of’ an ultimate tensile strength of 460 MPa or more at 293 K (20 °C); <u>and</u>

b. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

<u>Technical Note:</u> *In Item 2.C.1. the phrase ‘capable of’ encompasses aluminium alloys before or after heat treatment.*

2.C.2. Beryllium metal, alloys containing more than 50% beryllium by weight, beryllium compounds, manufactures thereof, and waste or scrap of any of the foregoing.

Note: Item 2.C.2. does not control the following:

a. Metal windows for X-ray machines or for bore-hole logging devices;

b. Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits;

c. Beryl (silicate of beryllium and aluminium) in the form of emeralds or aquamarines.

2.C.3. Bismuth having both of the following characteristics:

a. A purity of 99.99% or greater by weight; and

b. Containing less than 10 ppm (parts per million) by weight of silver.

2.C.4. Boron enriched in the boron-10 (^{10}B) isotope to greater than its natural isotopic abundance, as follows: elemental boron, compounds, mixtures containing boron, manufactures thereof, waste or scrap of any of the foregoing.

Note: In Item 2.C.4. mixtures containing boron include boron loaded materials.

Technical Note: *The natural isotopic abundance of boron-10 is approximately 18.5 weight percent (20 atom percent).*

2.C.5. Calcium having both of the following characteristics:

a. Containing less than 1000 ppm by weight of metallic impurities other than magnesium; and

b. Containing less than 10 ppm by weight of boron.

2.C.6. Chlorine trifluoride (ClF_3).

2.C.7. "Fibrous or filamentary materials", and prepregs, as follows:

a. Carbon or aramid "fibrous or filamentary materials" having either of the following characteristics:

1. A 'specific modulus' of 12.7 x 10^6 m or greater; or

2. A 'specific tensile strength' of 23.5 x 10^4 m or greater;

Note: Item 2.C.7.a. does not control aramid "fibrous or filamentary materials" having 0.25% or more by weight of an ester based fibre surface modifier.

b. Glass "fibrous or filamentary materials" having both of the following characteristics:

1. A 'specific modulus' of 3.18 x 10^6 m or greater; and

2. A 'specific tensile strength' of 7.62 x 10^4 m or greater;

c. Thermoset resin impregnated continuous “yarns”, “rovings”, “tows” or “tapes” with a width of 15 mm or less (prepregs), made from carbon or glass “fibrous or filamentary materials” specified in Item 2.C.7.a. or Item 2.C.7.b.

<u>Technical Note:</u> *The resin forms the matrix of the composite.*

<u>Technical Notes:</u>

1. *In Item 2.C.7. ‘Specific modulus’ is the Young’s modulus in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 296 ± 2 K (23 ± 2 °C) and a relative humidity of 50 ± 5%.*

2. *In Item 2.C.7. ‘Specific tensile strength’ is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 296 ± 2 K (23 ± 2 °C) and a relative humidity of 50 ± 5%.*

2.C.8. Hafnium metal, alloys containing more than 60% hafnium by weight, hafnium compounds containing more than 60% hafnium by weight, manufactures thereof, and waste or scrap of any of the foregoing.

2.C.9. Lithium enriched in the lithium-6 (^6Li) isotope to greater than its natural isotopic abundance and products or devices containing enriched lithium, as follows: elemental lithium, alloys, compounds, mixtures containing lithium, manufactures thereof, waste or scrap of any of the foregoing.

<u>Note:</u> Item 2.C.9. does not control thermoluminescent dosimeters.

<u>Technical Note:</u> *The natural isotopic abundance of lithium-6 is approximately 6.5 weight percent (7.5 atom percent).*

2.C.10. Magnesium having both of the following characteristics:

a. Containing less than 200 ppm by weight of metallic impurities other than calcium; <u>and</u>

b. Containing less than 10 ppm by weight of boron.

2.C.11. Maraging steel ‘capable of’ an ultimate tensile strength of 1950 MPa or more at 293 K (20 °C).

<u>Note:</u> Item 2.C.11. does not control forms in which all linear dimensions are 75 mm or less.

<u>Technical Note:</u> *In Item 2.C.11., the phrase ‘capable of’ encompasses maraging steel before or after heat treatment.*

2.C.12. Radium-226 (^{226}Ra), radium-226 alloys, radium-226 compounds, mixtures containing radium-226, manufactures thereof, and products or devices containing any of the foregoing.

<u>Note:</u> Item 2.C.12. does not control the following:

a. Medical applicators;

b. A product or device containing less than 0.37 GBq of radium-226.

2.C.13. Titanium alloys having both of the following characteristics:

a. ‘Capable of’ an ultimate tensile strength of 900 MPa or more at 293 K (20 °C); <u>and</u>

b. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

<u>Technical Note:</u> *In Item 2.C.13. the phrase ‘capable of’ encompasses titanium alloys before or after heat treatment.*

2.C.14. Tungsten, tungsten carbide, and alloys containing more than 90% tungsten by weight, having both of the following characteristics:

a. In forms with a hollow cylindrical symmetry (including cylinder segments) with an inside diameter between 100 and 300 mm; <u>and</u>

b. A mass greater than 20 kg.

<u>Note:</u> Item 2.C.14. does not control manufactures specially designed as weights or gamma-ray collimators.

2.C.15. Zirconium with a hafnium content of less than 1 part hafnium to 500 parts zirconium by weight, as follows: metal, alloys containing more than 50% zirconium by weight, compounds, manufactures thereof, waste or scrap of any of the foregoing.

<u>Note:</u> Item 2.C.15. does not control zirconium in the form of foil having a thickness of 0.10 mm or less.

2.C.16. Nickel powder and porous nickel metal, as follows:

<u>*N.B.:*</u> *For nickel powders which are especially prepared for the manufacture of gaseous diffusion barriers see INFCIRC/254/Part 1 (as amended).*

a. Nickel powder having both of the following characteristics:

1. A nickel purity content of 99.0% or greater by weight; <u>and</u>

2. A mean particle size of less than 10 µm measured by the American Society for Testing and Materials (ASTM) B 330 standard;

b. Porous nickel metal produced from materials specified in Item 2.C.16.a.

<u>Note:</u> Item 2.C.16. does not control the following:

a. Filamentary nickel powders;

b. Single porous nickel metal sheets with an area of 1000 cm^2 per sheet or less.

<u>Technical Note:</u> *Item 2.C.16.b. refers to porous metal formed by compacting and sintering the material in Item 2.C.16.a. to form a metal material with fine pores interconnected throughout the structure.*

2.C.17. Tritium, tritium compounds, mixtures containing tritium in which the ratio of tritium to hydrogen atoms exceeds 1 part in 1000, and products or devices containing any of the foregoing.

Note: Item 2.C.17. does not control a product or device containing less than 1.48×10^3 GBq of tritium.

2.C.18. Helium-3 (^3He), mixtures containing helium-3, and products or devices containing any of the foregoing.

Note: Item 2.C.18. does not control a product or device containing less than 1 g of helium-3.

2.C.19. Radionuclides appropriate for making neutron sources based on alpha-n reaction:

Actinium-225(^{225}Ac)	Curium-244(^{244}Cm)	Polonium-209(^{209}Po)
Actinium-227(^{227}Ac)	Einsteinium-253(^{253}Es)	Polonium-210(^{210}Po)
Californium-253(^{253}Cf)	Einsteinium-254(^{254}Es)	Radium-223(^{223}Ra)
Curium-240(^{240}Cm)	Gadolinium-148(^{148}Gd)	Thorium-227(^{227}Th)
Curium-241(^{241}Cm)	Plutonium-236(^{236}Pu)	Thorium-228(^{228}Th)
Curium-242(^{242}Cm)	Plutonium-238(^{238}Pu)	Uranium-230(^{230}U)
Curium-243(^{243}Cm)	Polonium-208(^{208}Po)	Uranium-232(^{232}U)

In the following forms:

a. Elemental;

b. Compounds having a total activity of 37 GBq per kg or greater;

c. Mixtures having a total activity of 37 GBq per kg or greater;

d. Products or devices containing any of the foregoing.

Note: Item 2.C.19. does not control a product or device containing less than 3.7 GBq of activity.

2.C.20. Rhenium, and alloys containing 90% by weight or more rhenium; and alloys of rhenium and tungsten containing 90% by weight or more of any combination of rhenium and tungsten, having both of the following characteristics:

a. In forms with a hollow cylindrical symmetry (including cylinder segments) with an inside diameter between 100 and 300 mm; and

b. A mass greater than 20 kg.

2.D. SOFTWARE

None

2.E. TECHNOLOGY

2.E.1. “Technology” according to the Technology Controls for the “development”, “production” or “use” of equipment, material or “software” specified in 2.A. through 2.D.

3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS
(Other than Trigger List items)

3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

3.A.1. Frequency changers or generators, usable as a variable frequency or fixed frequency motor drive, having all of the following characteristics:

N.B.1: *Frequency changers and generators especially designed or prepared for the gas centrifuge process are controlled under INFCIRC/254/Part 1 (as amended).*

N.B.2: "Software" specially designed to enhance or release the performance of frequency changers or generators to meet the characteristics below is controlled in 3.D.2 and 3.D.3.

a. Multiphase output providing a power of 40 VA or greater;

b. Operating at a frequency of 600 Hz or more; and

c. Frequency control better (less) than 0.2%.

Notes:
1. Item 3.A.1. only controls frequency changers intended for specific industrial machinery and/or consumer goods (machine tools, vehicles, etc.) if the frequency changers can meet the characteristics above when removed, and subject to General Note 3.
2. For the purpose of export control, the Government will determine whether or not a particular frequency changer meets the characteristics above, taking into account hardware and software constraints.

Technical Notes:
1. *Frequency changers in Item 3.A.1. are also known as converters or inverters.*
2. *The characteristics specified in item 3.A.1. may be met by certain equipment marketed such as: Generators, Electronic Test Equipment, AC Power Supplies, Variable Speed Motor Drives, Variable Speed Drives (VSDs), Variable Frequency Drives (VFDs), Adjustable Frequency Drives (AFDs), or Adjustable Speed Drives (ASDs).*

3.A.2. Lasers, laser amplifiers and oscillators as follows:

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

1. Operating at wavelengths between 500 and 600 nm; and
2. An average output power equal to or greater than 30 W;

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

1. Operating at wavelengths between 400 and 515 nm; and
2. An average output power greater than 40 W;

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

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

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

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

   or

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

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

   1. Operating at wavelengths between 300 and 800 nm;

   2. An average output power greater than 1 W;

   3. A repetition rate greater than 1 kHz; and

   4. Pulse width less than 100 ns;

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

   1. Operating at wavelengths between 300 and 800 nm;

   2. An average output power greater than 30 W;

   3. A repetition rate greater than 1 kHz; and

   4. Pulse width less than 100 ns;

   Note: Item 3.A.2.e. does not control single mode oscillators.

f. Alexandrite lasers having all of the following characteristics:

   1. Operating at wavelengths between 720 and 800 nm;

   2. A bandwidth of 0.005 nm or less;

   3. A repetition rate greater than 125 Hz; and

   4. An average output power greater than 30 W;

g. Pulsed carbon dioxide (CO_2) lasers having all of the following characteristics:

   1. Operating at wavelengths between 9000 and 11000 nm;

   2. A repetition rate greater than 250 Hz;

3. An average output power greater than 500 W; and

4. Pulse width of less than 200 ns;

Note: Item 3.A.2.g. does not control the higher power (typically 1 to 5 kW) industrial CO_2 lasers used in applications such as cutting and welding, as these latter lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.

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

1. Operating at wavelengths between 240 and 360 nm;

2. A repetition rate greater than 250 Hz; and

3. An average output power greater than 500 W;

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

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

1. Operating at wavelengths between 5000 and 6000 nm;

2. A repetition rate greater than 250 Hz;

3. An average output power greater than 200 W; and

4. Pulse width of less than 200 ns.

Note: Item 3.A.2.j. does not control the higher power (typically 1 to 5 kW) industrial CO lasers used in applications such as cutting and welding, as these latter lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.

3.A.3. Valves having all of the following characteristics:

a. A nominal size of 5 mm or greater;

b. Having a bellows seal; and

c. Wholly made of or lined with aluminium, aluminium alloy, nickel, or nickel alloy containing more than 60% nickel by weight.

Technical Note: *For valves with different inlet and outlet diameter, the nominal size parameter in Item 3.A.3.a. refers to the smallest diameter.*

3.A.4. Superconducting solenoidal electromagnets having all of the following characteristics:

a. Capable of creating magnetic fields greater than 2 T;

b. A ratio of length to inner diameter greater than 2;

c. Inner diameter greater than 300 mm; and

d. Magnetic field uniform to better than 1% over the central 50% of the inner volume.

Note: Item 3.A.4. does not control magnets specially designed for and exported ‘as part of’ medical nuclear magnetic resonance (NMR) imaging systems.

N.B.: ‘As part of’, does not necessarily mean physical part in the same shipment. Separate shipments from different sources are allowed, provided the related export documents clearly specify the ‘as part of’ relationship.

3.A.5. High-power direct current power supplies having both of the following characteristics:

a. Capable of continuously producing, over a time period of 8 h, 100 V or greater with current output of 500 A or greater; and

b. Current or voltage stability better than 0.1% over a time period of 8 h.

3.A.6. High-voltage direct current power supplies having both of the following characteristics:

a. Capable of continuously producing, over a time period of 8 h, 20 kV or greater with current output of 1 A or greater; and

b. Current or voltage stability better than 0.1% over a time period of 8 h.

3.A.7. All types of pressure transducers capable of measuring absolute pressures and having all of the following characteristics:

a. Pressure sensing elements made of or protected by aluminium, aluminium alloy, aluminium oxide (alumina or sapphire), nickel, nickel alloy with more than 60% nickel by weight, or fully fluorinated hydrocarbon polymers;

b. Seals, if any, essential for sealing the pressure sensing element, and in direct contact with the process medium, made of or protected by aluminium, aluminium alloy, aluminium oxide (alumina or sapphire), nickel, nickel alloy with more than 60% nickel by weight, or fully fluorinated hydrocarbon polymers; and

c. Having either of the following characteristics:

1. A full scale of less than 13 kPa and an “accuracy” of better than ~~±~~ **1%** of full scale; or

2. A full scale of 13 kPa or greater and an “accuracy” of better than ~~±~~ **130 Pa** when measuring at 13 kPa.

Technical Notes:

1. In Item 3.A.7. pressure transducers are devices that convert pressure measurements into a signal.

2. In Item 3.A.7. “accuracy” *includes non-linearity, hysteresis and repeatability at ambient temperature.*

3.A.8. Vacuum pumps having all of the following characteristics:

a. Input throat size equal to or greater than 380 mm;

b. Pumping speed equal to or greater than 15 m^3/s; and

c. Capable of producing an ultimate vacuum better than 13.3 mPa.

Technical Notes: *1. The pumping speed is determined at the measurement point with nitrogen gas or air.*

2. The ultimate vacuum is determined at the input of the pump with the input of the pump blocked off.

3.A.9. Bellows-sealed scroll-type compressors and bellows-sealed scroll-type vacuum pumps having all of the following characteristics:

a. Capable of an inlet volume flow rate of 50 m^3/h or greater;

b. Capable of a pressure ratio of 2:1 or greater; and

c. Having all surfaces that come in contact with the process gas made from any of the following materials:
1. Aluminium or aluminium alloy;
2. Aluminium oxide;
3. Stainless steel;
4. Nickel or nickel alloy;
5. Phosphor bronze; or
6. Fluoropolymers.

Technical Notes: *1. In a scroll compressor or vacuum pump, crescent-shaped pockets of gas are trapped between one or more pairs of intermeshed spiral vanes, or scrolls, one of which moves while the other remains stationary. The moving scroll orbits the stationary scroll; it does not rotate. As the moving scroll orbits the stationary scroll, the gas pockets diminish in size (i.e., they are compressed) as they move toward the outlet port of the machine.*

2. In a bellows-sealed scroll compressor or vacuum pump, the process gas is totally isolated from the lubricated parts of the pump and from the external atmosphere by a metal bellows. One end of the bellows is attached to the moving scroll and the other end is attached to the stationary housing of the pump.

3. Fluoropolymers include, but are not limited to, the following materials:
a. Polytetrafluoroethylene (PTFE),
b. Fluorinated Ethylene Propylene (FEP),
c. Perfluoroalkoxy (PFA),
d. Polychlorotrifluoroethylene (PCTFE); and
e. Vinylidene fluoride-hexafluoropropylene copolymer.

3.B. TEST AND PRODUCTION EQUIPMENT

3.B.1. Electrolytic cells for fluorine production with an output capacity greater than 250 g of fluorine per hour.

3.B.2. Rotor fabrication or assembly equipment, rotor straightening equipment, bellows-forming mandrels and dies, as follows:

a. Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles, and end caps;

Note: Item 3.B.2.a. includes precision mandrels, clamps, and shrink fit machines.

b. Rotor straightening equipment for alignment of gas centrifuge rotor tube sections to a common axis;

Technical Note: *In Item 3.B.2.b. such equipment normally consists of precision measuring probes linked to a computer that subsequently controls the action of, for example, pneumatic rams used for aligning the rotor tube sections.*

c. Bellows-forming mandrels and dies for producing single-convolution bellows.

Technical Note: *The bellows referred to in Item 3.B.2.c. have all of the following characteristics:*

1. Inside diameter between 75 and 400 mm;

2. Length equal to or greater than 12.7 mm;

3. Single convolution depth greater than 2 mm; and

4. Made of high-strength aluminium alloys, maraging steel, or high strength "fibrous or filamentary materials".

3.B.3. Centrifugal multiplane balancing machines, fixed or portable, horizontal or vertical, as follows:

a. Centrifugal balancing machines designed for balancing flexible rotors having a length of 600 mm or more and having all of the following characteristics:

1. Swing or journal diameter greater than 75 mm;

2. Mass capability of from 0.9 to 23 kg; and

3. Capable of balancing speed of revolution greater than 5000 rpm;

b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics:

1. Journal diameter greater than 75 mm;

2. Mass capability of from 0.9 to 23 kg;

3. A minimum achievable residual specific unbalance equal to or less than 10 g mm/kg per plane; and

4. Belt drive type.

3.B.4. Filament winding machines and related equipment, as follows:

a. Filament winding machines having all of the following characteristics:

1. Having motions for positioning, wrapping, and winding fibres coordinated and programmed in two or more axes;

2. Specially designed to fabricate composite structures or laminates from "fibrous or filamentary materials"; and

3. Capable of winding cylindrical tubes with an internal diameter between 75 and 650 mm and lengths of 300 mm or greater;

b. Coordinating and programming controls for the filament winding machines specified in Item 3.B.4.a.;

c. Precision mandrels for the filament winding machines specified in Item 3.B.4.a.

3.B.5. Electromagnetic isotope separators designed for, or equipped with, single or multiple ion sources capable of providing a total ion beam current of 50 mA or greater.

Notes: 1. Item 3.B.5. includes separators capable of enriching stable isotopes as well as those for uranium.

N.B.: A separator capable of separating the isotopes of lead with a one-mass unit difference is inherently capable of enriching the isotopes of uranium with a three-unit mass difference.

2. Item 3.B.5. includes separators with the ion sources and collectors both in the magnetic field and those configurations in which they are external to the field.

Technical Note: A single 50 mA ion source cannot produce more than 3 g of separated highly enriched uranium (HEU) per year from natural abundance feed.

3.B.6. Mass spectrometers capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, as follows, and ion sources therefor:

N.B.: Mass spectrometers especially designed or prepared for analysing on-line samples of uranium hexafluoride (UF_6) are controlled under INFCIRC/254/Part 1 (as amended).

a. Inductively coupled plasma mass spectrometers (ICP/MS);

b. Glow discharge mass spectrometers (GDMS);

c. Thermal ionisation mass spectrometers (TIMS);

d. Electron bombardment mass spectrometers having both of the following features:

1. A molecular beam inlet system that injects a collimated beam of analyte molecules into a region of the ion source where the molecules are ionised by an electron beam; and

2. One or more cold traps that can be cooled to a temperature of 193 K (-80 °C) or less in order to trap analyte molecules that are not ionised by the electron beam;

e. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

<u>Technical Notes</u>:

1. *Item 3.B.6.d. describes mass spectrometers that are typically used for isotopic analysis of UF_6 gas samples.*

2. *Electron bombardment mass spectrometers in Item 3.B.6.d. are also known as electron impact mass spectrometers or electron ionisation mass spectrometers.*

3. *In Item 3.B.6.d.2., a 'cold trap' is a device that traps gas molecules by condensing or freezing them on cold surfaces. For the purposes of this entry, a closed-loop gaseous helium cryogenic vacuum pump is not a cold trap.*

3.C. MATERIALS

None.

3.D. SOFTWARE

3.D.1. "Software" specially designed for the "use" of equipment specified in Items 3.A.1., 3.B.3. or 3.B.4.

3.D.2. "Software" or encryption keys/codes specially designed to enhance or release the performance characteristics of equipment not controlled in Item 3.A.1. so that it meets or exceeds the characteristics specified in Item 3.A.1.

3.D.3 "Software" specially designed to enhance or release the performance characteristics of equipment controlled in Item 3.A.1.

3.E. TECHNOLOGY

3.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 3.A. through 3.D.

4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT
(Other than Trigger List items)

4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

4.A.1. Specialised packings which may be used in separating heavy water from ordinary water, having both of the following characteristics:

a. Made of phosphor bronze mesh chemically treated to improve wettability; <u>and</u>

b. Designed to be used in vacuum distillation towers.

4.A.2. Pumps capable of circulating solutions of concentrated or dilute potassium amide catalyst in liquid ammonia (KNH_2/NH_3), having all of the following characteristics:

a. Airtight (i.e., hermetically sealed);

b. A capacity greater than 8.5 m^3/h; <u>and</u>

c. Either of the following characteristics:

1. For concentrated potassium amide solutions (1% or greater), an operating pressure of 1.5 to 60 MPa; <u>or</u>

2. For dilute potassium amide solutions (less than 1%), an operating pressure of 20 to 60 MPa.

4.A.3. Turboexpanders or turboexpander-compressor sets having both of the following characteristics:

a. Designed for operation with an outlet temperature of 35 K (-238 ºC) or less; <u>and</u>

b. Designed for a throughput of hydrogen gas of 1000 kg/h or greater.

4.B. TEST AND PRODUCTION EQUIPMENT

4.B.1. Water-hydrogen sulphide exchange tray columns and internal contactors, as follows:

<u>N.B.:</u> *For columns which are especially designed or prepared for the production of heavy water, see INFCIRC/254/Part 1 (as amended).*

a. Water-hydrogen sulphide exchange tray columns, having all of the following characteristics:

1. Can operate at pressures of 2 MPa or greater;

2. Constructed of carbon steel having an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; <u>and</u>

3. With a diameter of 1.8 m or greater;

b. Internal contactors for the water-hydrogen sulphide exchange tray columns specified in Item 4.B.1.a.

<u>Technical Note:</u> *Internal contactors of the columns are segmented trays which have an effective assembled diameter of 1.8 m or greater; are designed to facilitate countercurrent contacting and are constructed of stainless steels with a carbon content of 0.03% or less. These may be sieve trays, valve trays, bubble cap trays or turbogrid trays.*

4.B.2. Hydrogen-cryogenic distillation columns having all of the following characteristics:

a. Designed for operation at internal temperatures of 35 K (-238 ºC) or less;

b. Designed for operation at internal pressures of 0.5 to 5 MPa;

c. Constructed of either:

1. Stainless steel of the Society of Automotive Engineers International (SAE) 300 series with low sulphur content and with an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; <u>or</u>

2. Equivalent materials which are both cryogenic and hydrogen (H_2)-compatible; <u>and</u>

d. With internal diameters of 30 cm or greater and 'effective lengths' of 4 m or greater.

<u>Technical Note:</u> *The term 'effective length' means the active height of packing material in a packed-type column, or the active height of internal contactor plates in a plate-type column.*

4.B.3. *[No longer used – since 14 June 2013]*

4.C. MATERIALS

None.

4.D. SOFTWARE

None.

4.E. TECHNOLOGY

4.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 4.A. through 4.D.

5. TEST AND MEASUREMENT EQUIPMENT FOR THE DEVELOPMENT OF NUCLEAR EXPLOSIVE DEVICES

5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

5.A.1. Photomultiplier tubes having both of the following characteristics:

a. Photocathode area of greater than 20 cm^2; and

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

5.B. TEST AND PRODUCTION EQUIPMENT

5.B.1. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics:

a. 1. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and

2. With a figure of merit (K) of 0.25 or greater; or

b. 1. An accelerator peak electron energy of 25 MeV or greater; and

2. A peak power greater than 50 MW.

Note: Item 5.B.1. does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes.

Technical Notes:

1. *The figure of merit K is defined as:* $K=1.7 \times 10^3 V^{2.65}Q$. *V is the peak electron energy in million electron volts. If the accelerator beam pulse duration is less than or equal to 1µs, then Q is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1 µs, then Q is the maximum accelerated charge in 1 µs. Q equals the integral of i with respect to t, over the lesser of 1 µs or the time duration of the beam pulse (* $Q=\int idt$ *) where i is beam current in amperes and t is the time in seconds.*

2. *Peak power = (peak potential in volts)* x *(peak beam current in amperes).*

3. *In machines based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 µs or the duration of the bunched beam packet resulting from one microwave modulator pulse.*

4. *In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.*

5.B.2. High-velocity gun systems (propellant, gas, coil, electromagnetic, and electrothermal types, and other advanced systems) capable of accelerating projectiles to 1.5 km/s or greater.

Note: This item does not control guns specially designed for high velocity weapon systems.

5.B.3. High-speed cameras and imaging devices and components therefor, as follows:

N.B.: "Software" specially designed to enhance or release the performance of cameras or imaging devices to meet the characteristics below is controlled in 5.D.1. and 5.D.2.

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

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

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

3. Streak tubes for cameras specified in 5.B.3.a.2.;

4. Plug-ins specially designed for use with streak cameras which have modular structures and that enable the performance specifications in 5.B.3.a.1. or 5.B.3.a.2.;

5. Synchronizing electronics units, rotor assemblies consisting of turbines, mirrors and bearings specially designed for cameras specified in 5.B.3.a.1.

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

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

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

3. Framing tubes and solid-state imaging devices having a fast image gating (shutter) time of 50ns or less specially designed for cameras specified in 5.B.3.b.1. or 5.B.3.b.2.;

4. Plug-ins specially designed for use with framing cameras which have modular structures and that enable the performance specifications in 5.B.3.b.1. or 5.B.3.b.2.;

5. Synchronizing electronics units, rotor assemblies consisting of turbines, mirrors and bearings specially designed for cameras specified in 5.B.3.b.1. or 5.B.3.b.2.

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

1. Solid-state cameras or electron tube cameras with a fast image gating (shutter) time of 50 ns or less;

2. Solid-state imaging devices and image intensifiers tubes having a fast image gating (shutter) time of 50 ns or less specially designed for cameras specified in 5.B.3.c.1.;

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

4. Plug-ins specially designed for use with cameras which have modular structures and that enable the performance specifications in 5.B.3.c.1.

Technical Note: *High speed single frame cameras can be used alone to produce a single image of a dynamic event, or several such cameras can be combined in a sequentially-triggered system to produce multiple images of an event.*

5.B.4. *[No longer used – since 14 June 2013]*

5.B.5. Specialised instrumentation for hydrodynamic experiments, as follows:

a. Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 μs;

b. Shock pressure gauges capable of measuring pressures greater than 10 GPa, including gauges made with manganin, ytterbium, and polyvinylidene fluoride (PVDF) / polyvinyl difluoride

(PVF_2);

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

Note: Item 5.B.5.a. includes velocity interferometers such as VISARs (Velocity Interferometer Systems for Any Reflector), DLIs (Doppler Laser Interferometers) and PDV (Photonic Doppler Velocimeters) also known as Het-V (Heterodyne Velocimeters).

5.B.6. High-speed pulse generators, and pulse heads therefor, having both of the following characteristics:

a. Output voltage greater than 6 V into a resistive load of less than 55 Ω; and

b. ‘Pulse transition time’ less than 500 ps.

Technical Notes:

1. *In Item 5.B.6.b. ‘pulse transition time’ is defined as the time interval between 10% and 90% voltage amplitude.*

2. *Pulse heads are impulse forming networks designed to accept a voltage step function and shape it into a variety of pulse forms that can include rectangular, triangular, step, impulse, exponential, or monocycle types. Pulse heads can be an integral part of the pulse generator, they can be a plug-in module to the device or they can be an externally connected device.*

5.B.7. High explosive containment vessels, chambers, containers and other similar containment devices designed for the testing of high explosives or explosive devices and having both of the following characteristics:

a. Designed to fully contain an explosion equivalent to 2 kg of trinitrotoluene (TNT) or greater; and

b. Having design elements or features enabling real time or delayed transfer of diagnostic or measurement information.

5.C. MATERIALS

None.

5.D. SOFTWARE

5.D.1. “Software” or encryption keys/codes specially designed to enhance or release the performance characteristics of equipment not controlled in Item 5.B.3. so that it meets or exceeds the characteristics specified in Item 5.B.3.

5.D.2. “Software” or encryption keys/codes specially designed to enhance or release the performance characteristics of equipment controlled in Item 5.B.3.

5.E. TECHNOLOGY

5.E.1. “Technology” according to the Technology Controls for the “development”, “production” or “use” of equipment, material or “software” specified in 5.A. through 5.D.

6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES

6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

6.A.1. Detonators and multipoint initiation systems, as follows:

a. Electrically driven explosive detonators, as follows:

1. Exploding bridge (EB);

2. Exploding bridge wire (EBW);

3. Slapper;

4. Exploding foil initiators (EFI);

b. Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface over an area greater than 5000 mm^2 from a single firing signal with an initiation timing spread over the surface of less than 2.5 µs.

Note: Item 6.A.1. does not control detonators using only primary explosives, such as lead azide.

Technical Note: *In Item 6.A.1. the detonators of concern all utilise a small electrical conductor (bridge, bridge wire, or foil) that explosively vapourises when a fast, high-current electrical pulse is passed through it. In nonslapper types, the exploding conductor starts a chemical detonation in a contacting high-explosive material such as PETN (pentaerythritoltetranitrate). In slapper detonators, the explosive vapourisation of the electrical conductor drives a flyer or slapper across a gap, and the impact of the slapper on an explosive starts a chemical detonation. The slapper in some designs is driven by magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator. Also, the word initiator is sometimes used in place of the word detonator.*

6.A.2. Firing sets and equivalent high-current pulse generators, as follows:

a. Detonator firing sets (initiation systems, firesets), including electronically-charged, explosively-driven and optically-driven firing sets designed to drive multiple controlled detonators specified by Item 6.A.1. above;

b. Modular electrical pulse generators (pulsers) having all of the following characteristics:

1. Designed for portable, mobile, or ruggedised-use;

2. Capable of delivering their energy in less than 15 µs into loads of less than 40 Ω;

3. Having an output greater than 100 A;

4. No dimension greater than 30 cm;

5. Weight less than 30 kg ; and

6. Specified to operate over an extended temperature range of 223 to 373 K (-50 to 100 ºC) or specified as suitable for aerospace applications.

c. Micro-firing units having all of the following characteristics:

1. No dimension greater than 35 mm;

2. Voltage rating of equal to or greater than 1 kV; and

3. Capacitance of equal to or greater than 100 nF.

Note: Optically driven firing sets include both those employing laser initiation and laser charging. Explosively-driven firing sets include both explosive ferroelectric and explosive ferromagnetic firing set types. Item 6.A.2.b. includes xenon flashlamp drivers.

6.A.3. Switching devices as follows:

a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:

1. Containing three or more electrodes;

2. Anode peak voltage rating of 2.5 kV or more;

3. Anode peak current rating of 100 A or more; and

4. Anode delay time of 10 µs or less;

Note: Item 6.A.3.a. includes gas krytron tubes and vacuum sprytron tubes.

b. Triggered spark-gaps having both of the following characteristics:

1. Anode delay time of 15 µs or less; and

2. Rated for a peak current of 500 A or more;

c. Modules or assemblies with a fast switching function having all of the following characteristics:

1. Anode peak voltage rating greater than 2 kV;

2. Anode peak current rating of 500 A or more; and

3. Turn-on time of 1 µs or less.

6.A.4. Pulse discharge capacitors having either of the following sets of characteristics:

a. 1. Voltage rating greater than 1.4 kV;

2. Energy storage greater than 10 J;

3. Capacitance greater than 0.5 µF; and

4. Series inductance less than 50 nH; or

b. 1. Voltage rating greater than 750 V;

2. Capacitance greater than 0.25 μF; and

3. Series inductance less than 10 nH.

6.A.5. Neutron generator systems, including tubes, having both of the following characteristics:

a. Designed for operation without an external vacuum system; and

b. 1. Utilising electrostatic acceleration to induce a tritium-deuterium nuclear reaction; or
2. Utilising electrostatic acceleration to induce a deuterium-deuterium nuclear reaction and capable of an output of 3×10^9 neutrons/s or greater.

6.A.6. Striplines to provide low inductance path to detonators with the following characteristics:

a. Voltage rating greater than 2 kV; and

b. Inductance of less than 20 nH.

6.B. TEST AND PRODUCTION EQUIPMENT

None.

6.C. MATERIALS

6.C.1. High explosive substances or mixtures, containing more than 2% by weight of any of the following:

a. Cyclotetramethylenetetranitramine (HMX) (CAS 2691-41-0);

b. Cyclotrimethylenetrinitramine (RDX) (CAS 121-82-4);

c. Triaminotrinitrobenzene (TATB) (CAS 3058-38-6);

d. Aminodinitrobenzo-furoxan or 7-amino-4,6 nitrobenzofurazane-1-oxide (ADNBF) (CAS 97096-78-1);

e. 1,1-diamino-2,2-dinitroethylene (DADE or FOX7) (CAS 145250-81-3);

f. 2,4-dinitroimidazole (DNI) (CAS 5213-49-0);

g. Diaminoazoxyfurazan (DAAOF or DAAF) (CAS 78644-89-0);

h. Diaminotrinitrobenzene (DATB) (CAS 1630-08-6);

i. Dinitroglycoluril (DNGU or DINGU) (CAS 55510-04-8);

j. 2,6-Bis (picrylamino)-3,5-dinitropyridine (PYX) (CAS 38082-89-2);

k. 3,3′-diamino-2,2′,4,4′,6,6′-hexanitrobiphenyl or dipicramide (DIPAM) (CAS 17215-44-0);

l. Diaminoazofurazan (DAAzF) (CAS 78644-90-3);

m. 1,4,5,8-tetranitro-pyridazino[4,5-d] pyridazine (TNP) (CAS 229176-04-9);

n. Hexanitrostilbene (HNS) (CAS 20062-22-0); or

o. Any explosive with a crystal density greater than 1.8 g/cm^3 and having a detonation velocity greater than 8000 m/s.

6.D. SOFTWARE

None.

6.E. TECHNOLOGY

6.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 6.A. through 6.D.

Comparison Table of Changes to the Guidelines for Nuclear Transfers and the Annex of the Guidelines for Nuclear Transfers (INFCIRC/254/Part 2)

Old (Revision 9)	New
ESTABLISHMENT OF EXPORT LICENSING PROCEDURES 4. Suppliers should have in place legal measures to ensure the effective implementation of the Guidelines, including export licensing regulations, enforcement measures, and penalties for violations. In considering whether to authorize transfers, suppliers should exercise prudence in order to carry out the Basic Principle and should take relevant factors into account, including: (a) Whether the recipient state is a party to the Nuclear Non-Proliferation Treaty (NPT) or to the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco), or to a similar international legally-binding nuclear non-proliferation agreement, and has an IAEA safeguards agreement in force applicable to all its peaceful nuclear activities; (b) Whether any recipient state that is not party to the NPT, Treaty of Tlatelolco, or a similar international legally-binding nuclear non-proliferation agreement has any facilities or installations listed in paragraph 3(b) above that are operational or being designed or constructed that are not, or will not be, subject to IAEA safeguards;	ESTABLISHMENT OF EXPORT LICENSING PROCEDURES 4. Suppliers should have in place legal measures to ensure the effective implementation of the Guidelines, including export licensing regulations, enforcement measures, and penalties for violations. In considering whether to authorise transfers, suppliers should exercise prudence in order to carry out the Basic Principle and should take relevant factors into account, including: (a) Whether the recipient state is a party to the Nuclear Non-Proliferation Treaty (NPT), or to the Treaty for the Prohibition of Nuclear Weapons in Latin America **and the Caribbean** (Treaty of Tlatelolco)**, the South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga), Treaty on the Southeast Asia Nuclear-Weapon-Free Zone (Treaty of Bangkok), African Nuclear-Weapon-Free Zone Treaty (Treaty of Pelindaba), the Treaty on a Nuclear-Weapon-Free Zone in Central Asia (Treaty of Semipalatinsk)** or to a similar international legally-binding nuclear non-proliferation agreement, and has an IAEA safeguards agreement in force applicable to all its peaceful nuclear activities; (b) Whether any recipient state that is not party to the NPT, Treaty of Tlatelolco, **Treaty of Rarotonga, Treaty of Bangkok, Treaty of Pelindaba, Treaty of Semipalatinsk,** or a similar international legally-binding nuclear non-proliferation agreement has any facilities or installations listed in paragraph 3(b) above that are operational or being designed or constructed that are not, or will not be, subject to IAEA safeguards;

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(f) Whether the recipients have been engaged in clandestine or illegal procurement activities; and (g) Whether a transfer has not been authorized to the end-user or whether the end-user has diverted for purposes inconsistent with the Guidelines any transfer previously authorized. (h) Whether there is reason to believe that there is a risk of diversion to acts of nuclear terrorism. (i) Whether there is a risk of retransfers of equipment, material, software, or related technology identified in the Annex or of transfers of any replica thereof contrary to the Basic Principle, as a result of a failure by the recipient State to develop and maintain appropriate, effective national export and transshipment controls, as identified by UNSC Resolution 1540.	(f) Whether the recipients have been engaged in clandestine or illegal procurement activities; ~~and~~ (g) Whether a transfer has not been authorised to the end-user or whether the end-user has diverted for purposes inconsistent with the Guidelines any transfer previously authorised~~.~~; (h) Whether there is reason to believe that there is a risk of diversion to acts of nuclear terrorism~~.~~; and (i) Whether there is a risk of retransfers of equipment, material, software, or related technology identified in the Annex or of transfers of any replica thereof contrary to the Basic Principle, as a result of a failure by the recipient State to develop and maintain appropriate, effective national export and transsshipment controls, as identified by United Nations Security Council Resolution (UNSCR ~~Resolution~~) 1540.
CONCLUDING PROVISIONS 8. The supplier reserves to itself discretion as to the application of the Guidelines to other items of significance in addition to those identified in the Annex, and as to the application of other conditions for transfer that it may consider necessary in addition to those provided for in paragraph 5 of the Guidelines.	CONCLUDING PROVISIONS 8. The supplier reserves to itself discretion as to the application of the Guidelines to other items of significance in addition to those identified in the Annex, and as to the application of other conditions for transfer that it may consider necessary in addition to those provided for in paragraph ~~5~~ 6 of the Guidelines.
ANNEX Note: The International System of Units (SI) is used in this Annex. In all cases the physical quantity defined in SI	**ANNEX** Note: The International System of Units (SI) is used in this Annex. In all cases, the physical quantity defined in SI

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units should be considered the official recommended control value. However, some machine tool parameters are given in their customary units, which are not SI.	units should be considered the official recommended control value. However, some machine tool parameters are given in their customary units, which are not SI.
Commonly used abbreviations (and their prefixes denoting size) in this Annex are as follows:	Commonly used abbreviations (and their prefixes denoting size) in this Annex are as follows:
A --- ampere(s)	A - ampere(s) - **Electric current**
Bq --- becquerel(s)	~~Bq --- becquerel(s)~~
ºC --- degree(s) Celsius	~~ºC --- degree(s) Celsius~~
CAS --- chemical abstracts service	
Ci --- curie(s)	CAS - Chemical Abstracts Service -
cm --- centimeter(s)	~~Ci --- curie(s)~~
dB --- decibel(s)	cm - centimetre(s) - **Length**
dBm --- decibel referred to 1 milliwatt	~~dB --- decibel(s)~~
g --- gram(s); also, acceleration of gravity (9.81 m/s2)	~~dBm --- decibel referred to 1 milliwatt~~
GBq --- gigabecquerel(s)	**cm^2 - square centimetre(s) - Area**
GHz --- gigahertz	**cm^3 - cubic centimetre(s) - Volume**
GPa --- gigapascal(s)	**° - degree(s) - Angle**
Gy --- gray	**°C - degree(s) Celsius - Temperature**
h --- hour(s)	g - gram(s) - **Mass**
Hz --- hertz	GBq - gigabecquerel(s) - **Activity (radioactive)**
J --- joule(s)	~~GHz --- gigahertz~~
K --- kelvin	**g_0 - acceleration of gravity (9.80665 m/s^2) -Acceleration**
keV --- thousand electron volt(s)	GPa - gigapascal(s) - **Pressure**
kg --- kilogram(s)	Gy - gray(s) - **Absorbed ionising radiation**
kHz --- kilohertz	h - hour(s) - **Time**
kN --- kilonewton(s)	Hz - hertz - **Frequency**
kPa --- kilopascal(s)	J - joule(s) - **Energy, work, heat**
kV --- kilovolt(s)	~~K --- kelvin~~
kW --- kilowatt(s)	keV - kiloelectron volt(s) - **Energy, electrical**
m --- meter(s)	kg - kilogram(s) - **Mass**
mA --- milliampere(s)	kHz - kilohertz - **Frequency**
MeV --- million electron volt(s)	kN - kilonewton(s) - **Force**
MHz --- megahertz	kPa - kilopascal(s) - **Pressure**
ml --- milliliter(s)	kV - kilovolt(s) - **Electrical potential**

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mm --- millimeter(s)	kW - kilowatt(s) - Power
MPa --- megapascal(s)	K - kelvin - Thermodynamic temperature
mPa --- millipascal(s)	l - litre(s) - Volume (liquids)
MW --- megawatt(s)	~~m --- meter(s)~~
µF --- microfarad(s)	~~mA --- milliampere(s)~~
µm --- micrometer(s)	MeV - megaelectron volt(s) - Energy, electrical
µs --- microsecond(s)	~~MHz --- megahertz~~
N --- newton(s)	~~ml --- milliliter(s)~~
nm --- nanometer(s)	~~mm --- millimeter(s)~~
ns --- nanosecond(s)	MPa - megapascal(s) - Pressure
nH --- nanohenry(ies)	~~mPa --- millipascal(s)~~
ps --- picosecond(s)	MPE - Maximum Permissible Error- Length measurement
RMS --- root mean square	m - metre(s) - Length
rpm --- revolutions per minute	m^2 - square metre(s) - Area
s --- second(s)	m^3 - cubic metre(s) - Volume
T --- tesla(s)	mA- milliampere(s) - Electric current
TIR --- total indicator reading	ml - millilitre(s) - Volume (liquids)
V --- volt(s)	mm - millimetre(s) - Length
W --- watt(s)	mPa - millipascal(s) - Pressure
	MW - megawatt(s) - Power
	µF - microfarad(s) - Electric capacitance
	µm - micrometre(s) - Length
	µs - microsecond(s) - Time
	N - newton(s) - Force
	nF - nanofarad(s) - Electrical capacitance
	nH - nanohenry(s) - Electrical inductance
	nm - nanometre(s) - Length
	ns - nanosecond(s) - Time
	Ω - ohm(s) - Electric resistance
	Pa - pascal(s) - Pressure
	ps - picosecond(s) - Time
	~~RMS --- root mean square~~
	rpm - revolution(s) per minute - Angular velocity
	s - second(s) - Time
	" - second(s) of arc - Angle
	T - tesla(s) - Magnetic flux density

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	~~TIR --- total indicator reading~~ V - volt(s) - **Electrical potential** W - watt(s) - **Power**
TECHNOLOGY CONTROLS The transfer of “technology” is controlled according to the Guidelines and as described in each section of the Annex. “Technology” directly associated with any item in the Annex will be subject to as great a degree of scrutiny and control as will the item itself, to the extent permitted by national legislation. The approval of any Annex item for export also authorizes the export to the same end user of the minimum “technology” required for the installation, operation, maintenance, and repair of the item.	TECHNOLOGY CONTROLS The transfer of “technology” is controlled according to the Guidelines and as described in each section of the Annex. “Technology” directly associated with any item in the Annex will be subject to as great a degree of scrutiny and control as will the item itself, to the extent permitted by national legislation. The approval of any Annex item for export also authori~~z~~ses the export to the same end user of the minimum “technology” required for the installation, operation, maintenance, and repair of the item.
“Contouring control” -- Two or more “numerically controlled” motions operating in accordance with instructions that specify the next required position and the required feed rates to that position. These feed rates are varied in relation to each other so that a desired contour is generated. (Ref. ISO 2806-1980 as amended)	“Contouring control” -- Two or more “numerically controlled” motions operating in accordance with instructions that specify the next required position and the required feed rates to that position. These feed rates are varied in relation to each other so that a desired contour is generated. (Ref. International Organization for Standardization (ISO) 2806-(1~~1980~~994) as amended)
“Fibrous or filamentary materials” -- means continuous “monofilaments”, “yarns”, “rovings”, “tows” or “tapes”. N.B.: 1. “Filament” or “monofilament” -- is the smallest increment of fiber, usually several µm	“Fibrous or filamentary materials” -- means continuous “monofilaments”, “yarns”, “rovings”, “tows” or “tapes”. N.B.: 1. “Filament” or “monofilament” -- is the smallest increment of ~~fiber~~fibre, usually several

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in diameter.	µm in diameter.
2. “Roving” --	2. ‘“Roving”’ --
is a bundle (typically 12-120) of approximately parallel “strands”.	is a bundle (typically 12-120) of approximately parallel ‘“strands’”.
3. “Strand” --	3. ‘“Strand”’ --
is a bundle of “filaments” (typically over 200) arranged approximately parallel.	is a bundle of ‘“filaments’” (typically over 200) arranged approximately parallel.
4. “Tape” --	4. ‘“Tape”’ --
is a material constructed of interlaced or unidirectional “filaments”, “strands”, “rovings”, “tows” or “yarns”, etc., usually preimpregnated with resin.	is a material constructed of interlaced or unidirectional ‘“filaments’”, ‘“strands’”, ‘“rovings’”, ‘“tows’” or ‘“yarns’”, etc., usually preimpregnated with resin.
5. “Tow” --	5. ‘“Tow’” --
is a bundle of “filaments”, usually approximately parallel.	is a bundle of ‘“filaments’”, usually approximately parallel.
6. “Yarn” --	6. ‘“Yarn’” --
is a bundle of twisted “strands”.	is a bundle of twisted ‘“strands”.’.
“Filament” --	‘“Filament’” --
See “Fibrous or filamentary materials”.	See “Fibrous or filamentary materials”.
“In the public domain” --	“In the public domain” --
“In the public domain”, as it applies herein, means “technology” or “software” that has been made available without restrictions upon its further	“In the public domain”, as it applies herein, means “technology” or “software” that has been made available without restrictions upon its further

dissemination. (Copyright restrictions do not remove "technology" or "software" from being "in the public domain".) "Linearity" -- (Usually measured in terms of non-linearity) is the maximum deviation of the actual characteristic (average of upscale and downscale readings), positive or negative, from a straight line so positioned as to equalize and minimize the maximum deviations.	dissemination. (Copyright restrictions do not remove "technology" or "software" from being "in the public domain".) "Linearity" -- (Usually measured in terms of non-linearity) is the maximum deviation of the actual characteristic (average of upscale and downscale readings), positive or negative, from a straight line so positioned as to ~~equalize~~ equalise and ~~minimize~~ minimise the maximum deviations.
"Monofilament" -- See "Fibrous or filamentary materials". "Numerical control" -- The automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress. (Ref. ISO 2382) "Positioning accuracy" -- of "numerically controlled" machine tools is to be determined and presented in accordance with Item 1.B.2., in conjunction with the requirements below: (a) Test conditions (ISO 230/2 (1988), paragraph 3): (1) For 12 hours before and during measurements, the machine tool and accuracy measuring equipment will be kept at the same ambient temperature. During the premeasurement time, the slides of the	"'Monofilament'~~"~~ -- See "Fibrous or filamentary materials". "Numerical control" -- The automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress. (Ref. ISO 2382 (2015)) "Positioning accuracy" -- of "numerically controlled" machine tools is to be determined and presented in accordance with Item 1.B.2., in conjunction with the requirements below: (a) Test conditions (ISO 230/2 (1988), paragraph 3): (1) For 12 h~~ours~~ before and during measurements, the machine tool and accuracy measuring equipment will be kept at the same ambient temperature. During the premeasurement time, the slides of the machine will

machine will be continuously cycled identically to the way they will be cycled during the accuracy measurements;	be continuously cycled identically to the way they will be cycled during the accuracy measurements;
(b) Test Program (paragraph 4): (1) Feed rate (velocity of slides) during measurement shall be the rapid traverse rate; N.B.: In the case of machine tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute; (2) Measurements shall be made in an incremental manner from one limit of the axis travel to the other without returning to the starting position for each move to the target position; (3) Axes not being measured shall be retained at mid-travel during test of an axis. (c) Presentation of the test results (paragraph 2): The results of the measurements must include: (1) "positioning accuracy" (A) and (2) The mean reversal error (B).	(b) Test ~~Program~~ program (paragraph 4): (1) Feed rate (velocity of slides) during measurement shall be the rapid traverse rate; N.B.: In the case of machine tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute~~;~~ . (2) Measurements shall be made in an incremental manner from one limit of the axis travel to the other without returning to the starting position for each move to the target position; (3) Axes not being measured shall be retained at mid-travel during test of an axis. (c) Presentation of the test results (paragraph 2): The results of the measurements must include: (1) "~~positioning~~ Positioning accuracy" (A); and (2) The mean reversal error (B).
"Resolution" -- The least increment of a measuring device; on digital instruments, the least significant bit. (Ref. ANSI B-89.1.12)	"Resolution" -- The least increment of a measuring device; on digital instruments, the least significant bit. (Ref. American National Standards Institute (ANSI) B-

	89.1.12)
"Roving" --	"Roving" --
See "Fibrous or filamentary materials".	See "Fibrous or filamentary materials".
"Software" --	"Software" --
A collection of one or more "programs" or "microprograms" fixed in any tangible medium of expression.	A collection of one or more "programs" or "microprograms" fixed in any tangible medium of expression.
"Strand" --	"Strand" --
See "Fibrous or filamentary materials".	See "Fibrous or filamentary materials".
"Tape" --	"Tape" --
See "Fibrous or filamentary materials".	See "Fibrous or filamentary materials".
"Technical assistance" --	"Technical assistance" --
"Technical assistance" may take forms such as: instruction, skills, training, working knowledge, consulting services.	"Technical assistance" may take forms such as: instruction, skills, training, working knowledge, consulting services.
Note: "Technical assistance" may involve transfer of "technical data".	Note: "Technical assistance" may involve transfer of "technical data".
"Technical data" --	"Technical data" --
"Technical data" may take forms such as blueprints, plans, diagrams, models, formulae, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.	"Technical data" may take forms such as blueprints, plans, diagrams, models, formulae, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.
"Technology" --	"Technology" --

means specific information required for the "development", "production", or "use" of any item contained in the List. This information may take the form of "technical data" or "technical assistance". "Tow" -- See "Fibrous or filamentary materials". "Use" -- Operation, installation (including on-site installation), maintenance (checking), repair, overhaul, and refurbishing. "Yarn" -- See "Fibrous or filamentary materials".	means specific information required for the "development", "production", or "use" of any item contained in the List. This information may take the form of "technical data" or "technical assistance". '"Tow"' -- See "Fibrous or filamentary materials". "Use" -- Operation, installation (including on-site installation), maintenance (checking), repair, overhaul, and refurbishing. '"Yarn"' -- See "Fibrous or filamentary materials".
1.A.2. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5 x 10^4 Gy (silicon) without operational degradation. <u>*Technical Note:*</u> *The term Gy (silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionizing radiation.*	1.A.2. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5 x 10^4 Gy (silicon) without operational degradation. <u>*Technical Note:*</u> *The term Gy (silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionising radiation.*
1.A.3. 'Robots', 'end-effectors' and control units as follows: a. 'Robots' or 'end-effectors' having either of the following characteristics: 1. Specially designed to comply with national safety standards applicable to handling high	1.A.3. 'Robots', 'end-effectors' and control units as follows: a. 'Robots' or 'end-effectors' having either of the following characteristics: 1. Specially designed to comply with national safety standards applicable to handling high

explosives (for example, meeting electrical code ratings for high explosives); or 2. Specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5 x 10^4 Gy (silicon) without operational degradation; *Technical Note:* *The term Gy (silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionizing radiation.* b. Control units specially designed for any of the ‘robots’ or ‘end-effectors’ specified in Item 1.A.3.a. Note: Item 1.A.3. does not control ‘robots’ specially designed for non-nuclear industrial applications such as automobile paint-spraying booths.	explosives (for example, meeting electrical code ratings for high explosives); or 2. Specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5 x 10^4 Gy (silicon) without operational degradation; *Technical Note:* *The term Gy (silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ~~ionizing~~ ionising radiation.* b. Control units specially designed for any of the ‘robots’ or ‘end-effectors’ specified in Item 1.A.3.a. Note: Item 1.A.3. does not control ‘robots’ specially designed for non-nuclear industrial applications such as automobile paint-spraying booths.
Technical Notes: *1. ‘Robots’* *In Item 1.A.3. ‘robot’ means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use “sensors”, and has all of the following characteristics:* *(a) is multifunctional;*	*Technical Notes:1. ‘Robots’* *In Item 1.A.3. ‘robot’ means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use ‘~~“~~sensors~~”,~~ ’, and has all of the following characteristics:* *(a) is multifunctional;*

(b) is capable of positioning or orienting material, parts, tools, or special devices through variable movements in three-dimensional space; *(c) incorporates three or more closed or open loop servo-devices* *which may include stepping motors; and* *(d) has "user-accessible programmability" by means of teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.* *<u>N.B.1:</u>* *In the above definition "sensors" means detectors of a physical phenomenon, the output of which (after conversion into a signal that can be interpreted by a control unit) is able to generate "programs" or modify programmed instructions or numerical "program" data. This includes "sensors" with machine vision, infrared imaging,*	*(b) is capable of positioning or orienting material, parts, tools, or special devices through variable movements in three-dimensional space;* *(c) incorporates three or more closed or open loop servo-devices* *which may include stepping motors; and* *(d) has ‘"user-accessible programmability"’ by means of teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.* *<u>N.B.1:</u>* *In the above definition ‘"sensors’" means detectors of a physical phenomenon, the output of which (after conversion into a signal that can be interpreted by a control unit) is able to generate "programs" or modify programmed instructions or numerical "program" data. This includes ‘"sensors’" with machine vision, infrared imaging, acoustical imaging, tactile feel, inertial position measuring, optical or acoustic ranging or force or torque*

acoustical imaging, tactile feel, inertial position measuring, optical or acoustic ranging or force or torque measuring capabilities. *N.B.2:* *In the above definition "user-accessible programmability" means the facility allowing a user to insert, modify or replace "programs" by means other than:*	*measuring capabilities.* *N.B.2:* *In the above definition ~~"~~'user-accessible programmability'~~"~~ means the facility allowing a user to insert, modify or replace "programs" by means other than:*
Note: Item 1.B.2.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 a maximum workpiece capacity of 150 mm outside diameter or length; and b. Axes limited to x, z and c. 2. Jig grinders that do not have a z-axis or a w-axis with an overall positioning accuracy less (better) than 4 microns. Positioning accuracy is according to ISO 230/2 (1988).	Note: Item 1.B.2.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 a maximum workpiece capacity of 150 mm outside diameter or length; and b. Axes limited to x, z and c. 2. Jig grinders that do not have a z-axis or a w-axis with an overall **"positioning accuracy"** less (better) than **4 µm** ~~microns. Positioning accuracy is~~ according to ISO 230/2 (1988).

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6. Items 1.B.2.b.3 and 1.B.2.c.3 include machines based on a parallel linear kinematic design (e.g., hexapods) that have 5 or more axes none of which are rotary axes.	*6. Items 1.B.2.b.3. and 1.B.2.c.3. include machines based on a parallel linear kinematic design (e.g., hexapods) that have 5 or more axes none of which ~~are~~ is a rotary ax~~e~~is.*
b. Linear displacement measuring instruments, as follows: 1. Non-contact type measuring systems with a "resolution" equal to or better (less) than 0.2 µm within a measuring range up to 0.2 mm; 2. Linear variable differential transformer (LVDT) systems having both of the following characteristics: a. 1. "Linearity" equal to or less (better) than 0.1% measured from 0 to the full operating range, for LVDTs with an operating range up to 5 mm; or 2. "Linearity" equal to or less (better) than 0.1% measured from 0 to 5 mm for LVDTs with an operating range greater than 5 mm; and b. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature ± 1 K;	b. Linear displacement measuring instruments, as follows: 1. Non-contact type measuring systems with a "resolution" equal to or better (less) than 0.2 µm within a measuring range up to 0.2 mm; 2. Linear variable differential transformer (LVDT) systems having both of the following characteristics: a. 1. "Linearity" equal to or less (better) than 0.1% measured from 0 to the full operating range, for LVDTs with an operating range up to 5 mm; or 2. "Linearity" equal to or less (better) than 0.1% measured from 0 to 5 mm for LVDTs with an operating range greater than 5 mm; and b. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature ± 1 K (± ~~27~~21 ºC);
3. Measuring systems having both of the following characteristics: a. Contain a laser; and	3. Measuring systems having both of the following characteristics: a. Containing a laser; and

b. Maintain for at least 12 hours, over a temperature range of ± 1 K around a standard temperature and a standard pressure: 1. A "resolution" over their full scale of 0.1 µm or better; and 2. With a "measurement uncertainty" equal to or better (less) than (0.2 + L/2000) µm (L is the measured length in millimeters);	b. Capable of ~~M~~maintaining for at least 12 h~~ours~~, over a temperature range of ± 1 K (-± 1~~272~~ ºC) around a standard temperature and a standard pressure: 1. A "resolution" over their full scale of 0.1 µm or better; and 2. With a "measurement uncertainty" equal to or better (less) than (0.2 + L/2000) µm (L is the measured length in ~~millimeters~~mm);
d. Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics: 1. "Measurement uncertainty" along any linear axis equal to or better (less) than 3.5 µm per 5 mm; and 2. "Angular position deviation" equal to or less than 0.02°. Notes: 1. Item 1.B.3. includes machine tools that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.	d. Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics: 1. "Measurement uncertainty" along any linear axis equal to or better (less) than 3.5 µm per 5 mm; and 2. "Angular position deviation" equal to or less than 0.02°. Notes: 1. Item 1.B.3. includes machine tools, **other than those specified by 1.B.2,** that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.
1.B.5. "Isostatic presses", and related equipment, as follows: a. "Isostatic presses" having both of the following characteristics:	1.B.5. "~~"~~Isostatic presses"~~"~~, and related equipment, as follows: a. "~~"~~Isostatic presses"~~"~~ having both of the following

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1. Capable of achieving a maximum working pressure of 69 MPa or greater; <u>and</u> 2. A chamber cavity with an inside diameter in excess of 152 mm; b. Dies, molds, and controls specially designed for the “isostatic presses” specified in Item 1.B.5.a. <u>*Technical Notes:*</u> *1. In Item 1.B.5. “Isostatic presses” means equipment capable of pressurizing a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.* 1.B.6. Vibration test systems, equipment, and components as follows: a. Electrodynamic vibration test systems, having all of the following characteristics: 1. Employing feedback or closed loop control techniques and incorporating a digital control unit; 2. Capable of vibrating at 10 g RMS or more between 20 and 2000 Hz; <u>and</u> 3. Capable of imparting forces of 50 kN or greater measured “bare table”;	characteristics: 1. Capable of achieving a maximum working pressure of 69 MPa or greater; <u>and</u> 2. A chamber cavity with an inside diameter in excess of 152 mm; b. Dies, moulds, and controls specially designed for the “isostatic presses” specified in Item 1.B.5.a. <u>*Technical Notes:*</u> *1. In Item 1.B.5. “Isostatic presses” means equipment capable of ~~pressurizing~~ <u>pressurising</u> a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.* 1.B.6. Vibration test systems, equipment, and components as follows: a. Electrodynamic vibration test systems, having all of the following characteristics: 1. Employing feedback or closed loop control techniques and incorporating a digital control unit; 2. Capable of vibrating at 10 g_0 <u>root means square</u> ~~g~~ (RMS) or more between 20 and 2000 Hz; <u>and</u> 3. Capable of imparting forces of 50 kN or greater

	b. Digital control units, combined with "software" specially designed for vibration testing, with a real-time bandwidth greater than 5 kHz and being designed for a system specified in Item 1.B.6.a.; c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force of 50 kN or greater measured "bare table", which are usable for the systems specified in Item 1.B.6.a.; d. Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN or greater, measured "bare table", which are usable for the systems specified in Item 1.B.6.a. <u>Technical Note:</u> *In Item 1.B.6. "bare table" means a flat table, or surface, with no fixtures or fittings.*		measured ~~"~~'bare table'~~"~~; b. Digital control units, combined with "software" specially designed for vibration testing, with a real-time bandwidth greater than 5 kHz and being designed for a system specified in Item 1.B.6.a.; c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force of 50 kN or greater measured ~~"~~'bare table~~",~~', which are usable for the systems specified in Item 1.B.6.a.; d. Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN or greater, measured ~~"~~'bare table~~",~~', which are usable for the systems specified in Item 1.B.6.a. <u>Technical Note:</u> *In Item 1.B.6. ~~"~~'bare table~~"~~' means a flat table, or surface, with no fixtures or fittings.*
1.B.7.	Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment, as follows: a. Arc remelt and casting furnaces having both of the following characteristics: 1. Consumable electrode capacities between 1000 and 20000 cm^3; <u>and</u> 2. Capable of operating with melting temperatures above 1973 K (1700 °C);	1.B.7.	Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment, as follows: a. Arc remelt ~~and casting~~ furnaces**<u>, arc melt furnaces and arc melt and casting furnaces</u>** having both of the following characteristics: 1. Consumable electrode capacities between 1000 and 20000 cm^3; <u>and</u> 2. Capable of operating with melting temperatures

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b. Electron beam melting furnaces and plasma atomization and melting furnaces, having both of the following characteristics: 1. A power of 50 kW or greater; and 2. Capable of operating with melting temperatures above 1473 K (1200 °C); c. Computer control and monitoring systems specially configured for any of the furnaces specified in Item 1.B.7.a. or 1.B.7.b.	above 1973 K (1700 °C); b. Electron beam melting furnaces, **plasma atomisation furnaces and plasma melting furnaces** ~~and plasma atomization and melting furnaces~~ having both of the following characteristics: 1. A power of 50 kW or greater; and 2. Capable of operating with melting temperatures above 1473 K (1200 °C); c. Computer control and monitoring systems specially configured for any of the furnaces specified in Item 1.B.7.a. or 1.B.7.b. **d. Plasma torches specially designed for the furnaces specified in 1.B.7.b having both of the following characteristics:** **1. Operating at a power greater than 50kW; and** **2. Capable of operating above 1473 K (1200°C);** **e. Electron beam guns specially designed for the furnaces specified in 1.B.7.b operating at a power greater than 50kW.**
1.D.3. "Software" for any combination of electronic devices or system enabling such device(s) to function as a "numerical control" unit for machine tools, that is capable of controlling five or more interpolating axes that can be coordinated simultaneously for "contouring control".	1.D.3. "Software" for any combination of electronic devices or system enabling such a device~~(s)~~ or such devices to function as a "numerical control" unit for machine tools, that is capable of controlling five or more interpolating axes that can be coordinated simultaneously for "contouring control".

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Notes: 1. "Software" is controlled whether exported separately or residing in a "numerical control" unit or any electronic device or system.	Notes: 1. "Software" is controlled whether exported separately or residing in a "numerical control" unit or any electronic device or system.
2.A.1. Crucibles made of materials resistant to liquid actinide metals, as follows: a. Crucibles having both of the following characteristics: 1. A volume of between 150 cm^3 (150 ml) and 8000 cm^3 (8 l (litres)); <u>and</u> 2. Made of or coated with any of the following materials, or combination of the following materials, having an overall impurity level of 2% or less by weight: a. Calcium fluoride (CaF_2); b. Calcium zirconate (metazirconate) (CaZrO3); c. Cerium sulfide (Ce2S3); d. Erbium oxide (erbia) (Er2O3); e. Hafnium oxide (hafnia) (HfO2); f. Magnesium oxide (MgO); g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);	2.A.1. Crucibles made of materials resistant to liquid actinide metals, as follows: a. Crucibles having both of the following characteristics: 1. A volume of between 150 cm^3 (150 ml) and 8000 cm^3 (8 l ~~(litres)~~); <u>and</u> 2. Made of or coated with any of the following materials, or combination of the following materials, having an overall impurity level of 2% or less by weight: a. Calcium fluoride (CaF_2); b. Calcium zirconate (metazirconate) ($CaZrO_3$); c. Cerium ~~sulfide~~<u>sulphide</u> (Ce_2S_3); d. Erbium oxide (erbia) (Er_2O_3); e. Hafnium oxide (hafnia) (HfO_2); f. Magnesium oxide (MgO); g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);

	h. Yttrium oxide (yttria) (Y2O3); <u>or</u> i. Zirconium oxide (zirconia) (ZrO2); b. Crucibles having both of the following characteristics: 1. A volume of between 50 cm^3 (50 ml) and 2000 cm^3 (2 liters); <u>and</u> 2. Made of or lined with tantalum, having a purity of 99.9% or greater by weight; c. Crucibles having all of the following characteristics: 1. A volume of between 50 cm^3 (50 ml) and 2000 cm^3 (2 liters); 2. Made of or lined with tantalum, having a purity of 98% or greater by weight; <u>and</u> 3. Coated with tantalum carbide, nitride, boride, or any combination thereof.		h. Yttrium oxide (yttria) (Y_2O_3); <u>or</u> i. Zirconium oxide (zirconia) (ZrO_2); b. Crucibles having both of the following characteristics: 1. A volume of between 50 cm^3 (50 ml) and 2000 cm^3 (2 ~~liter~~<u>l</u>s); <u>and</u> 2. Made of or lined with tantalum, having a purity of 99.9% or greater by weight; c. Crucibles having all of the following characteristics: 1. A volume of between 50 cm^3 (50 ml) and 2000 cm^3 (2 ~~liter~~<u>l</u>s); 2. Made of or lined with tantalum, having a purity of 98% or greater by weight; <u>and</u> 3. Coated with tantalum carbide, nitride, boride, or any combination thereof.
2.A.2.	Platinized catalysts specially designed or prepared for promoting the hydrogen isotope exchange reaction between hydrogen and water for the recovery of tritium from heavy water or for the production of heavy water.	2.A.2.	~~Platinized~~<u>Platinised</u> catalysts specially designed or prepared for promoting the hydrogen isotope exchange reaction between hydrogen and water for the recovery of tritium from heavy water or for the production of heavy water.
2.C.5.	Calcium having both of the following characteristics: a. Containing less than 1000 parts per million by weight of metallic impurities other than magnesium; <u>and</u>	2.C.5.	Calcium having both of the following characteristics: a. Containing less than 1000 ~~parts per million~~<u>ppm</u> by weight of metallic impurities other than magnesium; <u>and</u>

b. Containing less than 10 parts per million by weight of boron.	b. Containing less than 10 ~~parts per million~~ppm by weight of boron.
2.C.7. “Fibrous or filamentary materials”, and prepregs, as follows: a. Carbon or aramid “fibrous or filamentary materials” having either of the following characteristics: 1. A “specific modulus” of 12.7 x 10^6 m or greater; or 2. A “specific tensile strength” of 23.5 x 10^4 m or greater; Note: Item 2.C.7.a. does not control aramid “fibrous or filamentary materials” having 0.25% or more by weight of an ester based fiber surface modifier. b. Glass “fibrous or filamentary materials” having both of the following characteristics: 1. A “specific modulus” of 3.18 x 10^6 m or greater; and 2. A “specific tensile strength” of 7.62 x 10^4 m or greater; c. Thermoset resin impregnated continuous “yarns”, “rovings”, “tows” or “tapes” with a width of 15 mm or less (prepregs), made from carbon or glass “fibrous or filamentary materials” specified in	2.C.7. “Fibrous or filamentary materials”, and prepregs, as follows: a. Carbon or aramid “fibrous or filamentary materials” having either of the following characteristics: 1. A ‘~~“~~specific modulus’~~”~~ of 12.7 x 10^6 m or greater; or 2. A ‘~~“~~specific tensile strength’~~”~~ of 23.5 x 10^4 m or greater; Note: Item 2.C.7.a. does not control aramid “fibrous or filamentary materials” having 0.25% or more by weight of an ester based ~~fiber~~fibre surface modifier. b. Glass “fibrous or filamentary materials” having both of the following characteristics: 1. A ‘~~“~~specific modulus’~~”~~ of 3.18 x 10^6 m or greater; and 2. A ‘~~“~~specific tensile strength’~~”~~ of 7.62 x 10^4 m or greater; c. Thermoset resin impregnated continuous “yarns”, “rovings”, “tows” or “tapes” with a width of 15 mm or less (prepregs), made from carbon or glass “fibrous or filamentary materials” specified in Item 2.C.7.a. or Item 2.C.7.b.

Item 2.C.7.a. or Item 2.C.7.b. *Technical Note: The resin forms the matrix of the composite.* *Technical Notes: 1. In Item 2.C.7. "Specific modulus" is the Young's modulus in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 296 ± 2 K (23 ± 2 °C) and a relative humidity of 50 ± 5%.* *2. In Item 2.C.7. "Specific tensile strength" is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 296 ± 2 K (23 ± 2 °C) and a relative humidity of 50 ± 5%.*	*Technical Note: The resin forms the matrix of the composite.* *Technical Notes: 1. In Item 2.C.7. "Specific modulus" is the Young's modulus in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 296 ± 2 K (23 ± 2 °C) and a relative humidity of 50 ± 5%.* *2. In Item 2.C.7. "Specific tensile strength" is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 296 ± 2 K (23 ± 2 °C) and a relative humidity of 50 ± 5%.*
2.C.10. Magnesium having both of the following characteristics: a. Containing less than 200 parts per million by weight of metallic impurities other than calcium; <u>and</u> b. Containing less than 10 parts per million by weight of boron.	2.C.10. Magnesium having both of the following characteristics: a. Containing less than 200 ~~parts per million~~ppm by weight of metallic impurities other than calcium; <u>and</u> b. Containing less than 10 ~~parts per million~~ppm by weight of boron.
2.C.11. Maraging steel 'capable of' an ultimate tensile strength of 1950 MPa or more at 293 K (20 °C).	2.C.11. Maraging steel "capable of" an ultimate tensile strength of 1950 MPa or more at 293 K (20 °C).

<u>Note:</u> Item 2.C.11. does not control forms in which all linear dimensions are 75 mm or less. *<u>Technical Note:</u> In Item 2.C.11. the phrase 'capable of' encompasses maraging steel before or after heat treatment.*	<u>Note:</u> Item 2.C.11. does not control forms in which all linear dimensions are 75 mm or less. *<u>Technical Note:</u> In Item 2.C.11., the phrase 'capable of' encompasses maraging steel before or after heat treatment.*
2.C.16. Nickel powder and porous nickel metal, as follows: <u>N.B.:</u> For nickel powders which are especially prepared for the manufacture of gaseous diffusion barriers see INFCIRC/254/Part 1 (as amended). a. Nickel powder having both of the following characteristics: 1. A nickel purity content of 99.0% or greater by weight; <u>and</u> 2. A mean particle size of less than 10 µm measured by the ASTM B 330 standard;	2.C.16. Nickel powder and porous nickel metal, as follows: *<u>N.B.:</u> For nickel powders which are especially prepared for the manufacture of gaseous diffusion barriers see INFCIRC/254/Part 1 (as amended).* a. Nickel powder having both of the following characteristics: 1. A nickel purity content of 99.0% or greater by weight; <u>and</u> 2. A mean particle size of less than 10 µm measured by the American Society for Testing and Materials (ASTM) B 330 standard;
2.C.19. Radionuclides appropriate for making neutron sources based on alpha-n reaction: Actinium 225 Curium 244 Polonium 209 Actinium 227 Einsteinium 253 Polonium 210 Californium 253 Einsteinium 254 Radium 223 Curium 240 Gadolinium 148 Thorium 227 Curium 241 Plutonium 236 Thorium 228	2.C.19. Radionuclides appropriate for making neutron sources based on alpha-n reaction: Actinium-225(^{225}Ac) Curium-244(^{244}Cm) Polonium-209(^{209}Po) Actinium-227(^{227}Ac) Einsteinium-253(^{253}Es) Polonium-210(^{210}Po) Californium-253(^{253}Cf) Einsteinium-254(^{254}Es) Radium-223(^{223}Ra) Curium-240(^{240}Cm) Gadolinium-148(^{148}Gd)

Curium 242 Plutonium 238 Uranium 230 Curium 243 Polonium 208 Uranium 232	Thorium-227(^{227}Th) Curium-241 (^{241}Cm) Plutonium-236(^{236}Pu) Thorium-228(^{228}Th) Curium-242 (^{242}Cm) Plutonium-238(^{238}Pu) Uranium-230(^{230}U) Curium-243 (^{243}Cm) Polonium-208(^{208}Po) Uranium-232(^{232}U)
3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS (Other Than Trigger List Items)	3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS (Other ~~Than~~ than Trigger List ~~Items~~items)
3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS	3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS
3.A.2. Lasers, laser amplifiers and oscillators as follows: a. Copper vapor lasers having both of the following characteristics: 1. Operating at wavelengths between 500 and 600 nm; and 2. An average output power equal to or greater than 30 W;	3.A.2. Lasers, laser amplifiers and oscillators as follows: a. Copper ~~vapor~~vapour lasers having both of the following characteristics: 1. Operating at wavelengths between 500 and 600 nm; and 2. An average output power equal to or greater than 30 W;
g. Pulsed carbon dioxide lasers having all of the following characteristics: 1. Operating at wavelengths between 9000 and 11000 nm; 2. A repetition rate greater than 250 Hz;	g. Pulsed carbon dioxide (CO_2) lasers having all of the following characteristics: 1. Operating at wavelengths between 9000 and 11000 nm; 2. A repetition rate greater than 250 Hz;
j. Pulsed carbon monoxide lasers having all of the following characteristics:	j. Pulsed carbon monoxide (CO) lasers having all of the following characteristics:

1. Operating at wavelengths between 5000 and 6000 nm; 2. A repetition rate greater than 250 Hz; 3. An average output power greater than 200 W; and 4. Pulse width of less than 200 ns. Note: Item 3.A.2.j. does not control the higher power (typically 1 to 5 kW) industrial CO lasers used in applications such as cutting and welding, as these latter lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.	1. Operating at wavelengths between 5000 and 6000 nm; 2. A repetition rate greater than 250 Hz; 3. An average output power greater than 200 W; and 4. Pulse width of less than 200 ns. Note: Item 3.A.2.j. does not control the higher power (typically 1 to 5 kW) industrial ~~Carbon dioxide (~~CO_2~~)~~ lasers used in applications such as cutting and welding, as these latter lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.
3.A.4. Superconducting solenoidal electromagnets having all of the following characteristics: a. Capable of creating magnetic fields greater than 2 T; b. A ratio of length to inner diameter greater than 2; c. Inner diameter greater than 300 mm; and d. Magnetic field uniform to better than 1% over the central 50% of the inner volume. Note: Item 3.A.4. does not control magnets specially designed for and exported *as part of* medical nuclear magnetic resonance (NMR) imaging	3.A.4. Superconducting solenoidal electromagnets having all of the following characteristics: a. Capable of creating magnetic fields greater than 2 T; b. A ratio of length to inner diameter greater than 2; c. Inner diameter greater than 300 mm; and d. Magnetic field uniform to better than 1% over the central 50% of the inner volume. Note: Item 3.A.4. does not control magnets specially designed for and exported ‘as part of’ medical nuclear magnetic resonance (NMR) imaging

systems. N.B.: *As part of,* does not necessarily mean physical part in the same shipment. Separate shipments from different sources are allowed, provided the related export documents clearly specify the *as part of* relationship.	systems. *N.B.: 'As part of', does not necessarily mean physical part in the same shipment. Separate shipments from different sources are allowed, provided the related export documents clearly specify the 'as part of' relationship.*
3.A.5. High-power direct current power supplies having both of the following characteristics: a. Capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater; and b. Current or voltage stability better than 0.1% over a time period of 8 hours.	3.A.5. High-power direct current power supplies having both of the following characteristics: a. Capable of continuously producing, over a time period of 8 h~~ours~~, 100 V or greater with current output of 500 A or greater; and b. Current or voltage stability better than 0.1% over a time period of 8 h~~ours~~.
3.A.6. High-voltage direct current power supplies having both of the following characteristics: a. Capable of continuously producing, over a time period of 8 hours, 20 kV or greater with current output of 1 A or greater; and b. Current or voltage stability better than 0.1% over a time period of 8 hours.	3.A.6. High-voltage direct current power supplies having both of the following characteristics: a. Capable of continuously producing, over a time period of 8 h~~ours~~, 20 kV or greater with current output of 1 A or greater; and b. Current or voltage stability better than 0.1% over a time period of 8 h~~ours~~.
3.B.3. Centrifugal multiplane balancing machines, fixed or portable, horizontal or vertical, as follows: a. Centrifugal balancing machines designed for balancing flexible rotors having a length of 600 mm or more and having all of the following characteristics:	3.B.3. Centrifugal multiplane balancing machines, fixed or portable, horizontal or vertical, as follows: a. Centrifugal balancing machines designed for balancing flexible rotors having a length of 600 mm or more and having all of the following characteristics:

1. Swing or journal diameter greater than 75 mm; 2. Mass capability of from 0.9 to 23 kg; and 3. Capable of balancing speed of revolution greater than 5000 rpm; b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics: 1. Journal diameter greater than 75 mm; 2. Mass capability of from 0.9 to 23 kg; 3. Capable of balancing to a residual imbalance equal to or less than 0.010 kg x mm/kg per plane; and 4. Belt drive type.	1. Swing or journal diameter greater than 75 mm; 2. Mass capability of from 0.9 to 23 kg; and 3. Capable of balancing speed of revolution greater than 5000 rpm; b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics: 1. Journal diameter greater than 75 mm; 2. Mass capability of from 0.9 to 23 kg; 3. ~~Capable of balancing to a~~ **A minimum achievable** residual ~~imbalance~~ **specific unbalance** equal to or less than ~~0.010 kg x mm/kg~~ **10 g- mm/kg** per plane; and 4. Belt drive type.
3.B.4. Filament winding machines and related equipment, as follows: a. Filament winding machines having all of the following characteristics: 1. Having motions for positioning, wrapping, and winding fibers coordinated and programmed in two or more axes;	3.B.4. Filament winding machines and related equipment, as follows: a. Filament winding machines having all of the following characteristics: 1. Having motions for positioning, wrapping, and winding ~~fibers~~fibres coordinated and programmed in two or more axes;
3.B.6. Mass spectrometers capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, as follows, and ion	3.B.6. Mass spectrometers capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, as follows, and ion sources

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sources therefor: <u>N.B.</u>: Mass spectrometers especially designed or prepared for analyzing on-line samples of uranium hexafluoride are controlled under INFCIRC/254/Part 1 (as amended). a. Inductively coupled plasma mass spectrometers (ICP/MS); b. Glow discharge mass spectrometers (GDMS); c. Thermal ionization mass spectrometers (TIMS); d. Electron bombardment mass spectrometers having both of the following features: 1. A molecular beam inlet system that injects a collimated beam of analyte molecules into a region of the ion source where the molecules are ionized by an electron beam; <u>and</u> 2. One or more cold traps that can be cooled to a temperature of 193 K (-80 °C) or less in order to trap analyte molecules that are not ionized by the electron beam; e. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides. *<u>Technical Notes</u>: 1. Item 3.B.6.d describes mass spectrometers that are typically used for isotopic analysis of* UF^6 *gas samples.* *2. Electron bombardment mass*	therefor: *<u>N.B.</u>: Mass spectrometers especially designed or prepared for ~~analyzing~~ analysing on-line samples of uranium hexafluoride (*UF_6*) are controlled under INFCIRC/254/Part 1 (as amended).* a. Inductively coupled plasma mass spectrometers (ICP/MS); b. Glow discharge mass spectrometers (GDMS); c. Thermal ~~ionization~~ ionisation mass spectrometers (TIMS); d. Electron bombardment mass spectrometers having both of the following features: 3. A molecular beam inlet system that injects a collimated beam of analyte molecules into a region of the ion source where the molecules are ~~ionized~~ ionised by an electron beam; <u>and</u> 4. One or more cold traps that can be cooled to a temperature of 193 K (-80 °C) or less in order to trap analyte molecules that are not ~~ionized~~ ionised by the electron beam; e. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides. *<u>Technical Notes</u>: 1. Item 3.B.6.d. describes mass spectrometers that are typically used for isotopic analysis of ~~Uranium Hhexafluoride (~~*UF_6

spectrometers in Item 3.B.6.d are also known as electron impact mass spectrometers or electron ionization mass spectrometers. 3. *In Item 3.B.6.d.2, a 'cold trap' is a device that traps gas molecules by condensing or freezing them on cold surfaces. For the purposes of this entry, a closed-loop gaseous helium cryogenic vacuum pump is not a cold trap.*	*gas samples.* 2. *Electron bombardment mass spectrometers in Item 3.B.6.d. are also known as electron impact mass spectrometers or electron ~~ionization~~ ionisation mass spectrometers.* 3. *In Item 3.B.6.d.2., a 'cold trap' is a device that traps gas molecules by condensing or freezing them on cold surfaces. For the purposes of this entry, a closed-loop gaseous helium cryogenic vacuum pump is not a cold trap.*
4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT (Other Than Trigger List Items) 4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS 4.A.1. Specialized packings which may be used in separating heavy water from ordinary water, having both of the following characteristics: a. Made of phosphor bronze mesh chemically treated to improve wettability; <u>and</u> b. Designed to be used in vacuum distillation towers.	4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT (Other ~~Than~~ than Trigger List ~~Items~~items) 4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS 4.A.1. ~~Specialized~~ Specialised packings which may be used in separating heavy water from ordinary water, having both of the following characteristics: a. Made of phosphor bronze mesh chemically treated to improve wettability; <u>and</u> b. Designed to be used in vacuum distillation towers.
4.B.1. Water-hydrogen sulfide exchange tray columns and	4.B.1. Water-hydrogen ~~sulfide~~sulphide exchange tray columns

	internal contactors, as follows: <u>N.B.:</u> For columns which are especially designed or prepared for the production of heavy water, see INFCIRC/254/Part 1 (as amended). a. Water-hydrogen sulfide exchange tray columns, having all of the following characteristics: 1. Can operate at pressures of 2 MPa or greater; 2. Constructed of carbon steel having an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; <u>and</u> 3. With a diameter of 1.8 m or greater; b. Internal contactors for the water-hydrogen sulfide exchange tray columns specified in Item 4.B.1.a.		and internal contactors, as follows: *<u>N.B.:</u> For columns which are especially designed or prepared for the production of heavy water, see INFCIRC/254/Part 1 (as amended).* a. Water-hydrogen ~~sulfide~~<u>sulphide</u> exchange tray columns, having all of the following characteristics: 1. Can operate at pressures of 2 MPa or greater; 2. Constructed of carbon steel having an austenitic <u>~~American Society for Testing and Materials~~</u> <u>~~(~~</u>ASTM<u>~~)~~</u> (or equivalent standard) grain size number of 5 or greater; <u>and</u> 3. With a diameter of 1.8 m or greater; b. Internal contactors for the water-hydrogen ~~sulfide~~<u>sulphide</u> exchange tray columns specified in Item 4.B.1.a.
4.B.2.	Hydrogen-cryogenic distillation columns having all of the following characteristics: a. Designed for operation at internal temperatures of 35 K (-238 ºC) or less; b. Designed for operation at internal pressures of 0.5 to 5 MPa; c. Constructed of either: 1. Stainless steel of the 300 series with low sulfur content and with an austenitic ASTM (or equivalent standard) grain size number of	4.B.2.	Hydrogen-cryogenic distillation columns having all of the following characteristics: a. Designed for operation at internal temperatures of 35 K (-238 ºC) or less; b. Designed for operation at internal pressures of 0.5 to 5 MPa; c. Constructed of either: 1. Stainless steel of the <u>Society of Automotive Engineers International (SAE)</u> 300 series with low ~~sulfur~~<u>sulphur</u> content and with an austenitic

5 or greater; or 2. Equivalent materials which are both cryogenic and H_2-compatible; and d. With internal diameters of 30 cm or greater and 'effective lengths' of 4 m or greater.	ASTM (or equivalent standard) grain size number of 5 or greater; or 2. Equivalent materials which are both cryogenic and hydrogen (H_2)~~-~~compatible; and d. With internal diameters of 30 cm or greater and 'effective lengths' of 4 m or greater.
5.B.1. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics: a. 1. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and 2. With a figure of merit (K) of 0.25 or greater; or b. 1. An accelerator peak electron energy of 25 MeV or greater; and 2. A peak power greater than 50 MW. Note: Item 5.B.1. does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes. *Technical Notes:* *1. The figure of merit K is defined as:* $K=1.7 \times 10^3 V^{2.65}Q$. *V is the peak electron energy in million electron volts. If the accelerator beam pulse duration is less than or equal to 1µs, then Q is the total*	5.B.1. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics: a. 1. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and 2. With a figure of merit (K) of 0.25 or greater; or b. 1. An accelerator peak electron energy of 25 MeV or greater; and 2. A peak power greater than 50 MW. Note: Item 5.B.1. does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes. *Technical Notes:* *1. The figure of merit* ~~(-272 ºC)K~~*K* *is defined as:* $K=1.7 \times 10^3 V^{2.65}Q$. *V is the peak electron energy in million electron volts. If the accelerator beam pulse duration is less than or equal to 1µs, then Q is the total accelerated charge in Coulombs.*

accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1 μs, then Q is the maximum accelerated charge in 1 μs. Q equals the integral of i with respect to t, over the lesser of 1 μs or the time duration of the beam pulse ($Q=\int idt$) where i is beam current in amperes and t is the time in seconds.	*If the accelerator beam pulse duration is greater than 1 μs, then Q is the maximum accelerated charge in 1 μs. Q equals the integral of i with respect to t, over the lesser of 1 μs or the time duration of the beam pulse ($Q=\int idt$) where i is beam current in amperes and t is the time in seconds.*
5.B.5. Specialized instrumentation for hydrodynamic experiments, as follows: a. Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 μs; b. Shock pressure gauges capable of measuring pressures greater than 10 GPa, including gauges made with manganin, ytterbium, and polyvinylidene bifluoride (PVBF, PVF_2);	5.B.5. ~~Specialized~~ Specialised instrumentation for hydrodynamic experiments, as follows: a. Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 μs; b. Shock pressure gauges capable of measuring pressures greater than 10 GPa, including gauges made with manganin, ytterbium, and ~~polyvinylidene bifluoride~~ **polyvinylidene fluoride (PVDF) / polyvinyl difluoride (**PVF_2);
5.B.6. High-speed pulse generators, and pulse heads therefor, having both of the following characteristics: a. Output voltage greater than 6 V into a resistive load of less than 55 ohms; and b. 'Pulse transition time' less than 500 ps.	5.B.6. High-speed pulse generators, and pulse heads therefor, having both of the following characteristics: a. Output voltage greater than 6 V into a resistive load of less than 55 Ω~~ohms~~; and b. 'Pulse transition time' less than 500 ps.
5.B.7. High explosive containment vessels, chambers,	5.B.7. High explosive containment vessels, chambers,

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containers and other similar containment devices designed for the testing of high explosives or explosive devices and having both of the following characteristics: a. Designed to fully contain an explosion equivalent to 2 kg of TNT or greater; and	containers and other similar containment devices designed for the testing of high explosives or explosive devices and having both of the following characteristics: a. Designed to fully contain an explosion equivalent to 2 kg of t~~T~~rinitrotoluene (TNT) or greater; and
Note: Item 6.A.1. does not control detonators using only primary explosives, such as lead azide. *Technical Note:* *In Item 6.A.1. the detonators of concern all utilize a small electrical conductor (bridge, bridge wire, or foil) that explosively vaporizes when a fast, high-current electrical pulse is passed through it. In nonslapper types, the exploding conductor starts a chemical detonation in a contacting high-explosive material such as PETN (pentaerythritoltetranitrate). In slapper detonators, the explosive vaporization of the electrical conductor drives a flyer or slapper across a gap, and the impact of the slapper on an explosive starts a chemical detonation. The slapper in some designs is driven by magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator. Also, the word initiator*	Note: Item 6.A.1. does not control detonators using only primary explosives, such as lead azide. *Technical Note:* *In Item 6.A.1. the detonators of concern all ~~utilize~~ utilise a small electrical conductor (bridge, bridge wire, or foil) that explosively ~~vapor~~vapouri~~z~~ses when a fast, high-current electrical pulse is passed through it. In nonslapper types, the exploding conductor starts a chemical detonation in a contacting high-explosive material such as PETN (pentaerythritoltetranitrate). In slapper detonators, the explosive vapouris~~z~~ation of the electrical conductor drives a flyer or slapper across a gap, and the impact of the slapper on an explosive starts a chemical detonation. The slapper in some designs is driven by magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator. Also, the word initiator is sometimes used in place of the word detonator.*

is sometimes used in place of the word detonator.	
6.A.2. Firing sets and equivalent high-current pulse generators, as follows: a. Detonator firing sets (initiation systems, firesets), including electronically-charged, explosively-driven and optically-driven firing sets designed to drive multiple controlled detonators specified by Item 6.A.1. above; b. Modular electrical pulse generators (pulsers) having all of the following characteristics: 1. Designed for portable, mobile, or ruggedized-use; 2. Capable of delivering their energy in less than 15 µs into loads of less than 40 ohms; 3. Having an output greater than 100 A; 4. No dimension greater than 30 cm; 5. Weight less than 30 kg ; and 6. Specified to operate over an extended temperature range of 223 to 373 K (-50 ºC to 100 ºC) or specified as suitable for aerospace applications.	6.A.2. Firing sets and equivalent high-current pulse generators, as follows: a. Detonator firing sets (initiation systems, firesets), including electronically-charged, explosively-driven and optically-driven firing sets designed to drive multiple controlled detonators specified by Item 6.A.1. above; b. Modular electrical pulse generators (pulsers) having all of the following characteristics: 1. Designed for portable, mobile, or ~~ruggedized~~ruggedised-use; 2. Capable of delivering their energy in less than 15 µs into loads of less than 40 Ω~~ohms~~; 3. Having an output greater than 100 A; 4. No dimension greater than 30 cm; 5. Weight less than 30 kg ; and 6. Specified to operate over an extended temperature range of 223 to 373 K (-50 ~~ºC~~ to 100 ºC) or specified as suitable for aerospace applications.
6.A.5. Neutron generator systems, including tubes, having both of the following characteristics:	6.A.5. Neutron generator systems, including tubes, having both of the following characteristics:

a. Designed for operation without an external vacuum system; and b. 1. Utilizing electrostatic acceleration to induce a tritium-deuterium nuclear reaction; or 2. Utilizing electrostatic acceleration to induce a deuterium-deuterium nuclear reaction and capable of an output of 3 x 10^9 neutrons/s or greater.	a. Designed for operation without an external vacuum system; and b. 1. ~~Utilizing~~ Utilising electrostatic acceleration to induce a tritium-deuterium nuclear reaction; or 2. ~~Utilizing~~ Utilising electrostatic acceleration to induce a deuterium-deuterium nuclear reaction and capable of an output of 3 x 10^9 neutrons/s or greater.