Foreign Affairs and International Trade Canada
Affaires étrangères et Commerce international Canada

A Guide To CANADA'S EXPORT CONTROLS Part 2

April 2011

Canada

GROUP 3 – NUCLEAR NON-PROLIFERATION LIST

(All destinations. All destinations applies to all Group 3 Items.)

Note:

Terms in ‘single quotations’ are usually defined within each entry of the list.

Terms in “double quotations” are defined at the end of Group 4.

CANADIAN NUCLEAR SAFETY COMMISSION (CNSC) NOTE:

The export of nuclear and nuclear-related items is also controlled by the CNSC under the Nuclear Safety and Control Act (NSCA) and Regulations. Therefore, the export of nuclear and nuclear-related items, not listed in Group 3 or which meet the specific Group 3 decontrol notes may still require a license from the CNSC. Information on export licensing requirements under the NSCA may be obtained by contacting the CNSC.

NUCLEAR TECHNOLOGY NOTE:

The “technology” directly associated with any items controlled in Group 3 is controlled according to the provisions of Group 3.

“Technology” for the “development”, “production” or “use” of items under control remains under control even when applicable to non-controlled items.

The approval of items 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 items.

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

GENERAL SOFTWARE NOTE:

Group 3 does not control “software” which is either:

1. *Generally available to the public by being:*
   a. *Sold from stock at retail selling points, without restriction, by means of:*
      1. *Over-the-counter transactions;*
      2. *Mail order transactions;*
      3. *Electronic transactions;* ***or***
      4. *Telephone call transactions;* ***and***
   b. *Designed for installation by the user without further substantial support by the supplier;* ***or***
2. *“In the public domain”.*

3-1. SOURCE AND SPECIAL FISSIONABLE MATERIALS

3-1.1 “Source materials

Source materials in the form of metal, alloy, chemical compound, concentrate, or that are incorporated in any material or substance and in which the concentration of source material is **greater than 0.05 weight %**, as follows:

1. Natural uranium (i.e. containing the mixture of isotopes occurring in nature);
2. Depleted uranium (i.e. depleted in the isotope 235 below that occurring in nature); **and**
3. Thorium.

Note:

3-1.1. does not control the following:

a. Four grams or less of natural uranium or depleted uranium when contained in a sensing component in instruments;

b. Alloys containing less than 5% thorium;

c. Ceramic products containing thorium, which have been manufactured for non-nuclear use;

d. Medicinal substances;

e. Trace amounts found on contaminated items such as clothing, shielding or packaging; ***and***

f. Source material which the Government is satisfied is to be used only in civil non-nuclear applications, such as shielding, packaging, ballasts, counter-weights or the production of alloys and ceramics (For the purpose of export control, the Export Controls Division of Foreign Affairs and International Trade Canada will determine whether or not the exports of source material meeting the above specifications are for non-nuclear applications).

3-1.2 Special fissionable materials

1. Plutonium of all isotopes and any alloy, compound or material containing plutonium;
2. Uranium-233; uranium enriched in the isotopes 233 or 235; or any alloy, compound or material containing one or more of the foregoing;

Note:

3-1.2. does not control the following:

a. Four 'effective grams' or less of special fissionable material when contained in a sensing component in instruments;

b. Trace amounts found on contaminated items such as clothing, shielding or packaging; ***and***

c. Plutonium 238 that is contained in heart pacemakers.

Technical Note:

'Effective gram' means:

a. For plutonium isotopes and uranium-233, the isotope weight in grams;

b. For uranium enriched 1 percent or greater in the isotope uranium-235, the element weight in grams multiplied by the square of its enrichment expressed as a decimal weight fraction; and

c. For uranium enriched below 1 percent in the isotope uranium-235, the element weight in grams multiplied by 0.0001.

3-2. EQUIPMENT AND NON-NUCLEAR MATERIALS

3-2.1 Nuclear reactors and especially designed or prepared equipment and components therefor, including:

1. Complete nuclear reactors

   Nuclear reactors capable of operation so as to maintain a controlled self-sustaining fission chain reaction, excluding zero energy reactors, the latter being defined as reactors with a designed maximum rate of production of plutonium not exceeding 100 grams per year.

Explanatory Note:

A nuclear reactor basically includes the items within or attached directly to the reactor vessel, the equipment which controls the level of power in the core, and the components which normally contain or come in direct contact with or control the primary coolant of the reactor core.

It is not intended to exclude reactors which could reasonably be capable of modification to produce significantly more than 100 grams of plutonium per year. Reactors designed for sustained operation at significant power levels, regardless of their capacity for plutonium production, are not considered as zero energy reactors.

2. Nuclear reactor vessels

   Metal vessels, or major shop-fabricated parts therefor, especially designed or prepared to contain the core of a nuclear reactor as defined in item 3-2.1.1. above, as well as relevant reactor internals as defined in item 3-2.1.8. below.

   Explanatory Note:

   The reactor vessel head is covered by item 3-2.1.2. as a major shop-fabricated part of a reactor vessel.

3. Nuclear reactor fuel charging and discharging machines

   Manipulative equipment especially designed or prepared for inserting or removing fuel in a nuclear reactor as defined in item 3-2.1.1. above.

   Explanatory Note:

   The items noted above are capable of on-load operation or at employing technically sophisticated positioning or alignment features to allow complex off-load fueling operations such as those in which direct viewing of or access to the fuel is not normally available.

4. Nuclear reactor control rods and equipment

   Especially designed or prepared rods, support or suspension structures therefor, rod drive mechanisms or rod guide tubes to control the fission process in a nuclear reactor as defined in item 3-2.1.1. above.

5. Nuclear reactor pressure tubes

   Tubes which are especially designed or prepared to contain fuel elements and the primary coolant in a reactor as defined in item 3-2.1.1. above at an operating pressure in excess of 50 atmospheres.

6. Zirconium tubes

   Zirconium metal and alloys in the form of tubes or assemblies of tubes, especially designed or prepared for use in a reactor as defined in item 3-2.1.1. above, and in which the relation of hafnium to zirconium is less than 1:500 parts by weight.

7. Primary coolant pumps

   Pumps especially designed or prepared for circulating the primary coolant for nuclear reactors as defined in item 3-2.1.1. above.

   Explanatory Note:

   Especially designed or prepared pumps may include elaborate sealed or multi-sealed systems to prevent leakage of primary coolant, canned-driven pumps, and pumps with inertial mass systems. This definition encompasses pumps certified to Section III, Division I, Subsection NB (Class 1 components) of the American Society of Mechanical Engineers (ASME) Code, or equivalent standards.

8. Nuclear reactor internals

   'Nuclear reactor internals' especially designed or prepared for use in a nuclear reactor as defined in item 3-2.1.1. above, including support columns for the core, fuel channels, thermal shields, baffles, core grid plates, and diffuser plates.

   Explanatory Note:

   'Nuclear reactor internals' are major structures within a reactor vessel which have one or more functions such as supporting the core, maintaining fuel alignment, directing primary coolant flow, providing radiation shields for the reactor vessel, and guiding in-core instrumentation.

9. Heat exchangers

   Heat exchangers (steam generators) especially designed or prepared for use in the primary coolant circuit of a nuclear reactor as defined in item 3-2.1.1. above.

   Explanatory Note:

   Steam generators are especially designed or prepared to transfer the heat generated in the reactor (primary side) to the feed water (secondary side) for steam generation. In the case of a liquid metal fast breeder reactor for which an intermediate liquid metal coolant loop is also present, the heat exchangers for transferring heat from the primary side to the intermediate coolant circuit are understood to be within the scope of control in addition to the steam generator. The scope of control for this entry does not include heat exchangers for the emergency cooling system or the decay heat cooling system.

10. Neutron detection and measuring instruments

    Especially designed or prepared neutron detection and measuring instruments for determining neutron flux levels within the core of a reactor as defined in item 3-2.1.1. above.

    Explanatory Note:

    The scope of this entry encompasses in-core and ex-core instrumentation which measure flux levels in a large range, typically from 10^4 neutrons per cm^2 per second to 10^{10} neutrons per cm^2 per second or more. Ex-core refers to those instruments outside the core of a reactor as defined in item 3-2.1.1. above, but located within the biological shielding.

3-2.2 Non-nuclear materials for reactors;

1. Deuterium and heavy water

   Deuterium, heavy water (deuterium oxide) and any other deuterium compound in which the ratio of deuterium to hydrogen atoms exceeds 1:5000 for use in a nuclear reactor as defined in item 3-2.1.1. above.

   Explanatory Note:

   For the purpose of export control, the Export Controls Division of Foreign Affairs and International Trade Canada will determine whether or not the exports of deuterium and deuterium compounds meeting the above specifications are for nuclear reactor use.

2. Nuclear grade graphite

   Graphite having a purity level better (less) than 5 parts per million 'boron equivalent' and with a density greater than 1.50 g/cm^3 for use in a nuclear reactor as defined in item 3-2.1.1. above.

Explanatory Note:

For the purpose of export control, the Export Controls Division of Foreign Affairs and International Trade Canada will determine whether or not the exports of graphite meeting the above specifications are for nuclear reactor use.

'Boron equivalent' (BE) may be determined experimentally or is calculated as the sum of BE_Z for impurities (excluding BE_{carbon} since carbon is not considered an impurity) including boron, where:

BE_Z (ppm) = CF x concentration of element Z (in ppm);

CF is the conversion factor: (σ_Z x A_B) divided by (σ_B x A_Z);

σ_B and σ_Z are the thermal neutron capture cross sections (in barns) for naturally occurring boron and element Z respectively; ***and***

A_B and A_Z are the atomic masses of naturally occurring boron and element Z respectively.

3-2.3 Plants for the reprocessing of irradiated fuel elements, equipment and components especially designed or prepared therefor, including:

Introductory Note:

Reprocessing irradiated nuclear fuel separates plutonium and uranium from intensely radioactive fission products and other transuranic elements. Different technical processes can accomplish this separation. However, over the years Purex has become the most commonly used and accepted process. Purex involves the dissolution of irradiated nuclear fuel in nitric acid, followed by separation of the uranium, plutonium, and fission products by solvent extraction using a mixture of tributyl phosphate in an organic diluent.

Purex facilities have process functions similar to each other, including: irradiated fuel element chopping, fuel dissolution, solvent extraction, and process liquor storage. There may also be equipment for thermal denitration of uranium nitrate, conversion of plutonium nitrate to oxide or metal, and treatment of fission product waste liquor to a form suitable for long term storage or disposal. However, the specific type and configuration of the equipment performing these functions may differ between Purex facilities for several reasons, including the type and quantity of irradiated nuclear fuel to be reprocessed and the intended disposition of the recovered materials, and the safety and maintenance philosophy incorporated into the design of the facility.

A plant for the reprocessing of irradiated fuel elements includes the equipment and components which normally come in direct contact with and directly control the irradiated fuel and the major nuclear material and fission product processing streams.

These processes, including the complete systems for plutonium conversion and plutonium metal production, may be identified by the measures taken to avoid criticality (e.g. by geometry), radiation exposure (e.g. by shielding), and toxicity hazards (e.g. by containment).

Items of equipment that are considered to fall within the meaning of the phrase 'and equipment especially designed or prepared' for the reprocessing of irradiated fuel elements include:

1. Irradiated fuel element chopping machines

Introductory Note:

This equipment breaches the cladding of the fuel to expose the irradiated nuclear material to dissolution. Especially designed metal cutting shears are the most commonly employed, although advanced equipment, such as lasers, may be used.

Remotely operated equipment especially designed or prepared for use in a reprocessing plant as identified above and intended to cut, chop or shear irradiated nuclear fuel assemblies, bundles or rods.

2. Dissolvers

Introductory Note:

Dissolvers normally receive the chopped-up spent fuel. In these critically safe vessels, the irradiated nuclear material is dissolved in nitric acid and the remaining hulls removed from the process stream.

Critically safe tanks (e.g. small diameter, annular or slab tanks) especially designed or prepared for use in a reprocessing plant as identified above, intended for dissolution of irradiated nuclear fuel and which are capable of withstanding hot, highly corrosive liquid, and which can be remotely loaded and maintained.

3. Solvent extractors and solvent extraction equipment

Introductory Note:

Solvent extractors both receive the solution of irradiated fuel from the dissolvers and the organic solution which separates the uranium, plutonium, and fission products. Solvent extraction equipment is normally designed to meet strict operating parameters, such as long operating lifetimes with no maintenance requirements or adaptability to easy replacement, simplicity of operation and control, and flexibility for variations in process conditions.

Especially designed or prepared solvent extractors such as packed or pulse columns, mixer settlers or centrifugal contactors for use in a plant for the reprocessing of irradiated fuel. Solvent extractors must be resistant to the corrosive effect of nitric acid. Solvent extractors are normally fabricated to extremely high standards (including special welding and inspection and quality assurance and quality control techniques) out of low carbon stainless steels, titanium, zirconium, or other high quality materials.

4. Chemical Holding or Storage Vessels

Introductory Note:

Three main process liquor streams result from the solvent extraction step. Holding or storage vessels are used in the further processing of all three streams, as follows:

a. The pure uranium nitrate solution is concentrated by evaporation and passed to a denitration process where it is converted to uranium oxide. This oxide is re-used in the nuclear fuel cycle.

b. The intensely radioactive fission products solution is normally concentrated by evaporation and stored as a liquor concentrate. This concentrate may be subsequently evaporated and converted to a form suitable for storage or disposal.

c. The pure plutonium nitrate solution is concentrated and stored pending its transfer to further process steps. In particular, holding or storage vessels for plutonium solutions are designed to avoid criticality problems resulting from changes in concentration and form of this stream.

Especially designed or prepared holding or storage vessels for use in a plant for the reprocessing of irradiated fuel. The holding or storage vessels must be resistant to the corrosive effect of nitric acid. The holding or storage vessels are normally fabricated of materials such as low carbon stainless steels, titanium or zirconium, or other high quality materials. Holding or storage vessels may be designed for remote operation and maintenance and may have the following features for control of nuclear criticality:

1. walls or internal structures with a boron equivalent of at least two per cent, **or**
2. a maximum diameter of 175 mm (7 in) for cylindrical vessels, **or**

3. a maximum width of 75 mm (3 in) for either a slab or annular vessel.

3-2.4 Plants for the fabrication of nuclear reactor fuel elements, equipment and components especially designed or prepared therefor:

Introductory Note:

Nuclear fuel elements are manufactured from one or more of the source or special fissionable materials mentioned in Item 3-1. For oxide fuels, the most common type of fuel, equipment for pressing pellets, sintering, grinding and grading will be present. Mixed oxide fuels are handled in glove boxes (or equivalent containment) until they are sealed in the cladding. In all cases, the fuel is hermetically sealed inside a suitable cladding which is designed to be the primary envelope encasing the fuel so as to provide suitable performance and safety during reactor operation. Also, in all cases, precise control of processes, procedures and equipment to extremely high standards is necessary in order to ensure predictable and safe fuel performance.

Explanatory Note:

Items of equipment that are considered to fall within the meaning of the phrase 'and equipment especially designed or prepared' for the fabrication of fuel elements include equipment which:

a. normally comes in direct contact with, or directly processes, or controls, the production flow of nuclear material;

b. seals the nuclear material within the cladding;

c. checks the integrity of the cladding or the seal; ***or***

d. checks the finish treatment of the sealed fuel.

Such equipment or systems of equipment may include, for example:

1. fully automatic pellet inspection stations especially designed or prepared for checking final dimensions and surface defects of the fuel pellets;

2. automatic welding machines especially designed or prepared for welding end caps onto the fuel pins (or rods);

3. automatic test and inspection stations especially designed or prepared for checking the integrity of completed fuel pins (or rods).

Item 3 typically includes equipment for: a) x-ray examination of pin (or rod) end cap welds, b) helium leak detection from pressurized pins (or rods), and c) gamma-ray scanning of the pins (or rods) to check for correct loading of the fuel pellets inside.

3-2.5 Plants for the separation of isotopes of natural uranium, depleted uranium or special fissionable material and equipment and components, other than analytical instruments, especially designed or prepared therefor, including:

3-2.5.1. Gas centrifuges and assemblies and components especially designed or prepared for use in gas centrifuges

Introductory Note:

The gas centrifuge normally consists of a thin-walled cylinder(s) of between 75 mm (3 in) and 400 mm (16 in) diameter contained in a vacuum environment and spun at high peripheral speed of the order of 300 m/s or more with its central axis vertical. In order to achieve high speed the materials of construction for the rotating components have to be of a high strength to density ratio and the rotor assembly, and hence its individual components, have to be manufactured to very close tolerances in order to minimize the unbalance. In contrast to other centrifuges, the gas centrifuge for uranium enrichment is characterized by having within the rotor chamber a rotating disc-shaped baffle(s) and a stationary tube arrangement for feeding and extracting the UF_6 gas and featuring at least 3 separate channels, of which 2 are connected to scoops extending from the rotor axis towards the periphery of the rotor chamber. Also contained within the vacuum environment are a number of critical items which do not rotate and which although they are especially designed are not difficult to fabricate nor are they fabricated out of unique materials. A centrifuge facility however requires a large number of these components, so that quantities can provide an important indication of end use.

1. Rotating components
   a. Complete rotor assemblies:

      Thin-walled cylinders, or a number of interconnected thin-walled cylinders, manufactured from one or more of the high strength to density ratio materials described in the Explanatory Note to this Section. If interconnected, the cylinders are joined together by flexible bellows or rings as described in section 3-2.5.1.1.c. following. The rotor is fitted with an internal baffle(s) and end caps, as described in section 3-2.5.1.1.d. and 3-2.5.1.1.e. following, if in final form. However the complete assembly may be delivered only partly assembled.

   b. Rotor tubes:

      Especially designed or prepared thin-walled cylinders with thickness of 12 mm (0.5 in) or less, a diameter of between 75 mm (3 in) and 400 mm (16 in), and manufactured from one or more of the high strength to density ratio materials described in the Explanatory Note to this Section.

   c. Rings or Bellows:

      Components especially designed or prepared to give localized support to the rotor tube or to join together a number of rotor tubes. The bellows is a short cylinder of wall thickness 3 mm (0.12 in) or less, a diameter of between 75 mm (3 in) and 400 mm (16 in), having a convolute, and manufactured from one of the high strength to density ratio materials described in the Explanatory Note to this Section.

   d. Baffles:

      Disc-shaped components of between 75 mm (3 in) and 400 mm (16 in) diameter especially designed or prepared to be mounted inside the centrifuge rotor tube, in order to isolate the take-off chamber from the main separation chamber and, in some cases, to assist the UF_6 gas circulation within the main separation chamber of the rotor tube, and manufactured from one of the high strength to density ratio materials described in the Explanatory Note to this Section.

e. Top caps/Bottom caps:

Disc-shaped components of between 75 mm (3 in) and 400 mm (16 in) diameter especially designed or prepared to fit to the ends of the rotor tube, and so contain the UF_6 within the rotor tube, and in some cases to support, retain or contain as an integrated part an element of the upper bearing (top cap) or to carry the rotating elements of the motor and lower bearing (bottom cap), and manufactured from one of the high strength to density ratio materials described in the Explanatory Note to this Section.

Explanatory Note:

The materials used for centrifuge rotating components are:

a. *Maraging steel capable of an ultimate tensile strength of 2.05 X 10^9 N/m^2 (300,000 psi) or more;*

b. *Aluminium alloys capable of an ultimate tensile strength of 0.46 X 10^9 N/m^2 (67,000 psi) or more;*

c. *"Fibrous or Filamentary materials" suitable for use in composite structures and having a 'specific modulus' of 3.18 X 10^6 m or greater and a 'specific ultimate tensile strength' of 7.62 x 10^4 m or greater ('Specific Modulus' is the Young's Modulus in N/m^2 divided by the specific weight in N/m^3; 'Specific Ultimate Tensile Strength' is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3).*

2. Static components

a. Magnetic suspension bearings:

Especially designed or prepared bearing assemblies consisting of an annular magnet suspended within a housing containing a damping medium. The housing will be manufactured from a UF_6-resistant material (see Explanatory Note to Section 3-2.5.2.). The magnet couples with a pole piece or a second magnet fitted to the top cap described in Section 3-2.5.1.1.e. The magnet may be ring-shaped with a relation between outer and inner diameter smaller or equal to 1.6:1. The magnet may be in a form having an initial permeability of 0.15 H/m (120,000 in CGS units) or more, or a remanence of 98.5% or more, or an energy product of greater than 80 kJ/m^3 (10^7 gauss-oersteds). In addition to the usual material properties, it is a prerequisite that the deviation of the magnetic axes from the geometrical axes is limited to very small tolerances (lower than 0.1 mm or 0.004 in) or that homogeneity of the material of the magnet is specially called for.

b. Bearings/Dampers:

Especially designed or prepared bearings comprising a pivot/cup assembly mounted on a damper. The pivot is normally a hardened steel shaft with a hemisphere at one end with a means of attachment to the bottom cap described in section 3-2.5.1.1.e. at the other. The shaft may however have a hydrodynamic bearing attached. The cup is pellet-shaped with a hemispherical indentation in one surface. These components are often supplied separately to the damper.

c. Molecular pumps:

Especially designed or prepared cylinders having internally machined or extruded helical grooves and internally machined bores. Typical dimensions are as follows: 75 mm (3 in) to 400 mm (16 in) internal diameter, 10 mm (0.4 in) or more wall thickness, with the length equal to or greater than the diameter. The grooves are typically rectangular in cross section and 2 mm (0.08 in) or more in depth.

d. Motor stators:

Especially designed or prepared ring-shaped stators for high speed multiphase AC hysteresis (or reluctance) motors for synchronous operation within a vacuum in the frequency range of 600 - 2000 Hz and a power range of 50 - 1000 VA. The stators consist of multi-phase windings on a laminated low loss iron core comprised of thin layers typically 2.0 mm (0.08 in) thick or less.

e. Centrifuge housing/recipients:

Components especially designed or prepared to contain the rotor tube assembly of a gas centrifuge. The housing consists of a rigid cylinder of wall thickness up to 30 mm (1.2 in) with precision machined ends to locate the bearings and with one or more flanges for mounting. The machined ends are parallel to each other and perpendicular to the cylinder's longitudinal axis to within 0.05 degrees or less. The housing may also be a honeycomb type structure to accommodate several rotor tubes. The housings are made of or protected by materials resistant to corrosion by UF_6.

f. Scoops:

Especially designed or prepared tubes of up to 12 mm (0.5 in) internal diameter for the extraction of UF_6 gas from within the rotor tube by a Pitot tube action (that is, with an aperture facing into the circumferential gas flow within the rotor tube, for example by bending the end of a radially disposed tube) and capable of being fixed to the central gas extraction system. The tubes are made of or protected by materials resistant to corrosion by UF_6.

3-2.5.2. Especially designed or prepared auxiliary systems, equipment and components for gas centrifuge enrichment plants

Introductory Note:

The auxiliary systems, equipment and components for a gas centrifuge enrichment plant are the systems of plant needed to feed UF_6 to the centrifuges, to link the individual centrifuges to each other to form cascades (or stages) to allow for progressively higher enrichments and to extract the product and tails UF_6 from the centrifuges, together with the equipment required to drive the centrifuges or to control the plant.

Normally UF_6 is evaporated from the solid using heated autoclaves and is distributed in gaseous form to the centrifuges by way of cascade header pipework. The product and tails UF_6 gaseous streams flowing from the centrifuges are also passed by way of cascade header pipework to cold traps (operating at about 203 K (-70° C)) where they are condensed prior to onward transfer into suitable containers for transportation or storage. Because an enrichment plant consists of many thousands of centrifuges arranged in cascades there are many kilometers of cascade header pipework, incorporating thousands of welds with a substantial amount of repetition of layout. The equipment, components and piping systems are fabricated to very high vacuum and cleanliness standards.

1. Feed systems/product and tails withdrawal systems

   Especially designed or prepared process systems including:

   a. Feed autoclaves (or stations), used for passing UF_6 to the centrifuge cascades at up to 100 kPa (15 psi) and at a rate of 1 kg/h or more;

   b. Desublimers (or cold traps) used to remove UF_6 from the cascades at up to 3 kPa (0.5 psi) pressure. The desublimers are capable of being chilled to 203 K (-70ºC) and heated to 343 K (70ºC);

   c. Product and Tails stations used for trapping UF_6 into containers.

   This plant, equipment and pipework is wholly made of or lined with UF_6 resistant materials (see Explanatory Note to this section) and is fabricated to very high vacuum and cleanliness standards.

2. Machine header piping systems

   Especially designed or prepared piping systems and header systems for handling UF_6 within the centrifuge cascades. The piping network is normally of the triple header system with each centrifuge connected to each of the headers. There is thus a substantial amount of repetition in its form. It is wholly made of UF_6-resistant materials (see Explanatory Note to this section) and is fabricated to very high vacuum and cleanliness standards.

3. Special shut-off and control valves

   Especially designed or prepared bellows-sealed valves, manual or automated, shut-off or control, made of or protected by materials resistant to corrosion by UF_6, with a diameter of 10 to 160 mm, for use in main or auxiliary systems of gas centrifuge enrichment plants.

4. UF_6 mass spectrometers/ion sources

   Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking on-line samples of feed, product or tails, from UF_6 gas streams and having all of the following characteristics:

   1. Unit resolution for atomic mass unit greater than 320;
   2. Ion sources constructed of or lined with nichrome or monel or nickel plated;
   3. Electron bombardment ionization sources;
   4. Having a collector system suitable for isotopic analysis.

5. Frequency changers

   Frequency changers (also known as converters or invertors) especially designed or prepared to supply motor stators as defined under 3-2.5.1.2.d., or parts, components and sub-assemblies of such frequency changers having all of the following characteristics:

   1. A multiphase output of 600 to 2000 Hz;
   2. High stability (with frequency control better than 0.1%);
   3. Low harmonic distortion (less than 2%); **and**
   4. An efficiency of greater than 80%.

   Explanatory Note:

   The items listed above either come into direct contact with the UF_6 process gas or directly control the centrifuges and the passage of the gas from centrifuge to centrifuge and cascade to cascade.

Materials resistant to corrosion by UF_6 include stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel.

3-2.5.3. Especially designed or prepared assemblies and components for use in gaseous diffusion enrichment

Introductory Note:

In the gaseous diffusion method of uranium isotope separation, the main technological assembly is a special porous gaseous diffusion barrier, heat exchanger for cooling the gas (which is heated by the process of compression), seal valves and control valves, and pipelines. In as much as gaseous diffusion technology uses uranium hexafluoride (UF_6), all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF_6. A gaseous diffusion facility requires a number of these assemblies, so that quantities can provide an important indication of end use.

1. Gaseous diffusion barriers
   a. Especially designed or prepared thin, porous filters, with a pore size of 100 - 1,000 Å (angstroms), a thickness of 5 mm (0.2 in) or less, and for tubular forms, a diameter of 25 mm (1 in) or less, made of metallic, polymer or ceramic materials resistant to corrosion by UF_6; and
   b. Especially prepared compounds or powders for the manufacture of such filters. Such compounds and powders include nickel or alloys containing 60% or more nickel, aluminium oxide, or UF_6-resistant fully fluorinated hydrocarbon polymers having a purity of 99.9% or more, a particle size less than 10 microns, and a high degree of particle size uniformity, which are especially prepared for the manufacture of gaseous diffusion barriers.
2. Diffuser housings

   Especially designed or prepared hermetically sealed cylindrical vessels greater than 300 mm (12 in) in diameter and greater than 900 mm (35 in) in length, or rectangular vessels of comparable dimensions, which have an inlet connection and two outlet connections all of which are greater than 50 mm (2 in) in diameter, for containing the gaseous diffusion barrier, made of or lined with UF_6-resistant materials and designed for horizontal or vertical installation.
3. Compressors and gas blowers

   Especially designed or prepared axial, centrifugal, or positive displacement compressors, or gas blowers with a suction volume capacity of 1 m^3/min or more of UF_6, and with a discharge pressure of up to several hundred kPa (100 psi), designed for long-term operation in the UF_6 environment with or without an electrical motor of appropriate power, as well as separate assemblies of such compressors and gas blowers. These compressors and gas blowers have a pressure ratio between 2:1 and 6:1 and are made of, or lined with, materials resistant to UF_6.
4. Rotary shaft seals

   Especially designed or prepared vacuum seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor or the gas blower rotor with the driver motor so as to ensure a reliable seal against in-leaking of air into the inner chamber of the compressor or gas blower which is filled with UF_6. Such seals are normally designed for a buffer gas in-leakage rate of less than 1000 cm^3/min (60 in^3/min).

5. Heat exchangers for cooling UF_6

   Especially designed or prepared heat exchangers made of or lined with UF_6-resistant materials (except stainless steel) or with copper or any combination of those metals, and intended for a leakage pressure change rate of less than 10 Pa (0.0015 psi) per hour under a pressure difference of 100 kPa (15 psi).

3-2.5.4. Especially designed or prepared auxiliary systems, equipment and components for use in gaseous diffusion enrichment

Introductory Note:

The auxiliary systems, equipment and components for gaseous diffusion enrichment plants are the systems of plant needed to feed UF_6 to the gaseous diffusion assembly, to link the individual assemblies to each other to form cascades (or stages) to allow for progressively higher enrichments and to extract the product and tails UF_6 from the diffusion cascades. Because of the high inertial properties of diffusion cascades, any interruption in their operation, and especially their shut-down, leads to serious consequences. Therefore, a strict and constant maintenance of vacuum in all technological systems, automatic protection from accidents, and precise automated regulation of the gas flow is of importance in a gaseous diffusion plant. All this leads to a need to equip the plant with a large number of special measuring, regulating and controlling systems.

Normally UF_6 is evaporated from cylinders placed within autoclaves and is distributed in gaseous form to the entry point by way of cascade header pipework. The product and tails UF_6 gaseous streams flowing from exit points are passed by way of cascade header pipework to either cold traps or to compression stations where the UF_6 gas is liquefied prior to onward transfer into suitable containers for transportation or storage. Because a gaseous diffusion enrichment plant consists of a large number of gaseous diffusion assemblies arranged in cascades, there are many kilometers of cascade header pipework, incorporating thousands of welds with substantial amounts of repetition of layout. The equipment, components and piping systems are fabricated to very high vacuum and cleanliness standards.

1. Feed systems/product and tails withdrawal systems

   Especially designed or prepared process systems, capable of operating at pressures of 300 kPa (45 psi) or less, including:

   a. Feed autoclaves (or systems), used for passing UF_6 to the gaseous diffusion cascades;

   b. Desublimers (or cold traps) used to remove UF_6 from diffusion cascades;

   c. Liquefaction stations where UF_6 gas from the cascade is compressed and cooled to form liquid UF_6;

   d. Product or tails stations used for transferring UF_6 into containers.

2. Header piping systems

   Especially designed or prepared piping systems and header systems for handling UF_6 within the gaseous diffusion cascades. This piping network is normally of the double header system with each cell connected to each of the headers.

3. Vacuum systems

   a. Especially designed or prepared large vacuum manifolds, vacuum headers and vacuum pumps having a suction capacity of 5 m^3/min (175 ft^3/min) or more.

b. Vacuum pumps especially designed for service in UF_6-bearing atmospheres made of, or lined with, aluminium, nickel, or alloys bearing more than 60% nickel. These pumps may be either rotary or positive, may have displacement and fluorocarbon seals, and may have special working fluids present.

4. Special shut-off and control valves

Especially designed or prepared manual or automated shut-off and control bellows valves made of UF_6-resistant materials with a diameter of 40 to 1500 mm (1.5 to 59 in) for installation in main and auxiliary systems of gaseous diffusion enrichment plants.

5. UF_6 mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking on-line samples of feed, product or tails, from UF_6 gas streams and having all of the following characteristics:

1. Unit resolution for atomic mass unit greater than 320;
2. Ion sources constructed of or lined with nichrome or monel or nickel plated;
3. Electron bombardment ionization sources;
4. Collector system suitable for isotopic analysis.

Explanatory Note:

The items listed above either come into direct contact with the UF_6 process gas or directly control the flow within the cascade. All surfaces which come into contact with the process gas are wholly made of, or lined with, UF_6-resistant materials. For the purposes of the sections relating to gaseous diffusion items the materials resistant to corrosion by UF_6 include stainless steel, aluminium, aluminium alloys, aluminium oxide, nickel or alloys containing 60% or more nickel and UF_6-resistant fully fluorinated hydrocarbon polymers.

3-2.5.5. Especially designed or prepared systems, equipment and components for use in aerodynamic enrichment plants

Introductory Note:

In aerodynamic enrichment processes, a mixture of gaseous UF_6 and light gas (hydrogen or helium) is compressed and then passed through separating elements wherein isotopic separation is accomplished by the generation of high centrifugal forces over a curved-wall geometry. Two processes of this type have been successfully developed: the separation nozzle process and the vortex tube process. For both processes the main components of a separation stage include cylindrical vessels housing the special separation elements (nozzles or vortex tubes), gas compressors and heat exchangers to remove the heat of compression. An aerodynamic plant requires a number of these stages, so that quantities can provide an important indication of end use. Since aerodynamic processes use UF_6, all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF_6.

Explanatory Note:

The items listed in this section either come into direct contact with the UF_6 process gas or directly control the flow within the cascade. All surfaces which come into contact with the process gas are wholly made of or protected by UF_6-resistant materials. For the purposes of the section relating to aerodynamic enrichment items, the materials resistant to corrosion by UF_6 include copper, stainless steel, aluminium, aluminium *alloys, nickel or alloys containing 60% or more nickel and UF_6-resistant fully fluorinated hydrocarbon polymers.*

1. Separation nozzles

   Especially designed or prepared separation nozzles and assemblies thereof. The separation nozzles consist of slit-shaped, curved channels having a radius of curvature less than 1 mm (typically 0.1 to 0.05 mm), resistant to corrosion by UF_6 and having a knife-edge within the nozzle that separates the gas flowing through the nozzle into two fractions.

2. Vortex tubes

   Especially designed or prepared vortex tubes and assemblies thereof. The vortex tubes are cylindrical or tapered, made of or protected by materials resistant to corrosion by UF_6, having a diameter of between 0.5 cm and 4 cm, a length to diameter ratio of 20:1 or less and with one or more tangential inlets. The tubes may be equipped with nozzle-type appendages at either or both ends.

   Explanatory Note:

   The feed gas enters the vortex tube tangentially at one end or through swirl vanes or at numerous tangential positions along the periphery of the tube.

3. Compressors and gas blowers

   Especially designed or prepared axial, centrifugal or positive displacement compressors or gas blowers made of or protected by materials resistant to corrosion by UF_6 and with a suction volume capacity of 2 m^3/min or more of UF_6/carrier gas (hydrogen or helium) mixture.

   Explanatory Note:

   These compressors and gas blowers typically have a pressure ratio between 1.2:1 and 6:1.

4. Rotary shaft seals

   Especially designed or prepared rotary shaft seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor rotor or the gas blower rotor with the driver motor so as to ensure a reliable seal against out-leakage of process gas or in leakage of air or seal gas into the inner chamber of the compressor or gas blower which is filled with a UF_6/carrier gas mixture.

5. Heat exchangers for gas cooling

   Especially designed or prepared heat exchangers made of or protected by materials resistant to corrosion by UF_6.

6. Separation element housings

   Especially designed or prepared separation element housings, made of or protected by materials resistant to corrosion by UF_6, for containing vortex tubes or separation nozzles.

   Explanatory Note:

   These housings may be cylindrical vessels greater than 300 mm in diameter and greater than 900 mm in length, or may be rectangular vessels of comparable dimensions, and may be designed for horizontal or vertical installation.

7. Feed systems/product and tails withdrawal systems

   Especially designed or prepared process systems or equipment for enrichment plants made of or protected by materials resistant to corrosion by UF_6, including:

   a. Feed autoclaves, ovens, or systems used for passing UF_6 to the enrichment process;

   b. Desublimers (or cold traps) used to remove UF_6 from the enrichment process for subsequent transfer upon heating;

   c. Solidification or liquefaction stations used to remove UF_6 from the enrichment process by compressing and converting UF_6 to a liquid or solid form;

   d. Product or tails stations used for transferring UF_6 into containers.

8. Header piping systems

   Especially designed or prepared header piping systems, made of or protected by materials resistant to corrosion by UF_6, for handling UF_6 within the aerodynamic cascades. This piping network is normally of the double header design with each stage or group of stages connected to each of the headers.

9. Vacuum systems and pumps

   a. Especially designed or prepared vacuum systems having a suction capacity of 5 m^3/min or more, consisting of vacuum manifolds, vacuum headers and vacuum pumps, and designed for service in UF_6-bearing atmospheres;

   b. Vacuum pumps especially designed or prepared for service in UF_6-bearing atmospheres and made of or protected by materials resistant to corrosion by UF_6. These pumps may use fluorocarbon seals and special working fluids.

10. Special shut-off and control valves

    Especially designed or prepared manual or automated shut-off and control bellows valves made of or protected by materials resistant to corrosion by UF_6 with a diameter of 40 to 1500 mm for installation in main and auxiliary systems of aerodynamic enrichment plants.

11. UF_6 mass spectrometers/Ion sources

    Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking on-line samples of feed, product or tails, from UF_6 gas streams and having all of the following characteristics:

    1. Unit resolution for mass greater than 320;
    2. Ion sources constructed of or lined with nichrome or monel or nickel plated;
    3. Electron bombardment ionization sources;
    4. Collector system suitable for isotopic analysis.

12. UF_6/carrier gas separation systems

    Especially designed or prepared process systems for separating UF_6 from carrier gas (hydrogen or helium).

Explanatory Note:

These systems are designed to reduce the UF_6 content in the carrier gas to 1 ppm or less and may incorporate equipment such as:

a. *Cryogenic heat exchangers and cryoseparators capable of temperatures of -120° C or less;* ***or***

b. *Cryogenic refrigeration units capable of temperatures of -120° C or less;* ***or***

c. *Separation nozzle or vortex tube units for the separation of UF_6 from carrier gas;* ***or***

d. *UF_6 cold traps capable of temperatures of -20° C or less.*

3-2.5.6. Especially designed or prepared systems, equipment and components for use in chemical exchange or ion exchange enrichment plants.

Introductory Note:

The slight difference in mass between the isotopes of uranium causes small changes in chemical reaction Equilibria that can be used as a basis for separation of the isotopes. Two processes have been successfully developed: liquid-liquid chemical exchange and solid-liquid ion exchange.

In the liquid-liquid chemical exchange process, immiscible liquid phases (aqueous and organic) are counter currently contacted to give the cascading effect of thousands of separation stages. The aqueous phase consists of uranium chloride in hydrochloric acid solution; the organic phase consists of an extractant containing uranium chloride in an organic solvent. The contactors employed in the separation cascade can be liquid-liquid exchange columns (such as pulsed columns with sieve plates) or liquid centrifugal contactors. Chemical conversions (oxidation and reduction) are required at both ends of the separation cascade in order to provide for the reflux requirements at each end. A major design concern is to avoid contamination of the process streams with certain metal ions. Plastic, plastic-lined (including use of fluorocarbon polymers) and/or glass-lined columns and piping are therefore used.

In the solid-liquid ion-exchange process, enrichment is accomplished by uranium adsorption/desorption on a special, very fast-acting, ion-exchange resin or adsorbent. A solution of uranium in hydrochloric acid and other chemical agents is passed through cylindrical enrichment columns containing packed beds of the adsorbent. For a continuous process, a reflux system is necessary to release the uranium from the adsorbent back into the liquid flow so that product and tails can be collected. This is accomplished with the use of suitable reduction/oxidation chemical agents that are fully regenerated in separate external circuits and that may be partially regenerated within the isotopic separation columns themselves. The presence of hot concentrated hydrochloric acid solutions in the process requires that the equipment be made of or protected by special corrosion-resistant materials.

1. Liquid-liquid exchange columns (Chemical exchange)

   Countercurrent liquid-liquid exchange columns having mechanical power input (i.e., pulsed columns with sieve plates, reciprocating plate columns, and columns with internal turbine mixers), especially designed or prepared for uranium enrichment using the chemical exchange process. For corrosion resistance to concentrated hydrochloric acid solutions, these columns, and their internals are made of or protected by suitable plastic materials (such as fluorocarbon polymers) or glass. The stage residence time of the columns is designed to be short (30 seconds or less).

2. Liquid-liquid centrifugal contactors (Chemical exchange)

   Liquid-liquid centrifugal contactors especially designed or prepared for uranium enrichment using the chemical exchange process. Such contactors use rotation to achieve dispersion of the organic and aqueous streams and then centrifugal force to separate the phases. For corrosion resistance to concentrated hydrochloric acid solutions, the contactors are made of or are lined with suitable plastic materials (such as fluorocarbon polymers) or are lined with glass. The stage residence time of the centrifugal contactors is designed to be short (30 seconds or less).

3. Uranium reduction systems and equipment (Chemical exchange)

   a. Especially designed or prepared electrochemical reduction cells to reduce uranium from one valence state to another for uranium enrichment using the chemical exchange process. The cell materials in contact with process solutions must be corrosion resistant to concentrated hydrochloric acid solutions.

      Explanatory Note:

      The cell cathodic compartment must be designed to prevent re-oxidation of uranium to its higher valence state. To keep the uranium in the cathodic compartment, the cell may have an impervious diaphragm membrane constructed of special cation exchange material. The cathode consists of a suitable solid conductor such as graphite.

   b. Especially designed or prepared systems at the product end of the cascade for taking the U^{+4} out of the organic stream, adjusting the acid concentration and feeding to the electrochemical reduction cells.

      Explanatory Note:

      These systems consist of solvent extraction equipment for stripping the U^{+4} from the organic stream into an aqueous solution, evaporation and/or other equipment to accomplish solution pH adjustment and control, and pumps or other transfer devices for feeding to the electrochemical reduction cells. A major design concern is to avoid contamination of the aqueous stream with certain metal ions. Consequently, for those parts in contact with the process stream, the system is constructed of equipment made of or protected by suitable materials (such as glass, fluorocarbon polymers, polyphenyl sulfate, polyether sulfone, and resin-impregnated graphite).

4. Feed preparation systems (Chemical exchange)

   Especially designed or prepared systems for producing high-purity uranium chloride feed solutions for chemical exchange uranium isotope separation plants.

   Explanatory Note:

   These systems consist of dissolution, solvent extraction and/or ion exchange equipment for purification and electrolytic cells for reducing the uranium U^{+6} or U^{+4} to U^{+3}. These systems produce uranium chloride solutions having only a few parts per million of metallic impurities such as chromium, iron, vanadium, molybdenum and other bivalent or higher multi-valent cations. Materials of construction for portions of the system processing high purity U^{+3} include glass, fluorocarbon polymers, polyphenyl sulfate or polyether sulfone plastic-lined and resin impregnated graphite.

5. Uranium oxidation systems (Chemical exchange)

   Especially designed or prepared systems for oxidation of U^{+3} to U^{+4} for return to the uranium isotope separation cascade in the chemical exchange enrichment process.

   Explanatory Note:

   These systems may incorporate equipment such as:

   a. *Equipment for contacting chlorine and oxygen with the aqueous effluent from the isotope separation equipment and extracting the resultant U^{+4} into the stripped organic stream returning from the product end of the cascade,*
   b. *Equipment that separates water from hydrochloric acid so that the water and the concentrated hydrochloric acid may be reintroduced to the process at the proper locations.*

6. Fast-reacting ion exchange resins/adsorbents (Ion exchange)

   Fast-reacting ion-exchange resins or adsorbents especially designed or prepared for uranium enrichment using the ion exchange process, including porous macroreticular resins, and/or pellicular structures in which the active chemical exchange groups are limited to a coating on the surface of an inactive porous support structure, and other composite structures in any suitable form including particles or fibers. These ion exchange resins/adsorbents have diameters of 0.2 mm or less and must be chemically resistant to concentrated hydrochloric acid solutions as well as physically strong enough so as not to degrade in the exchange columns. The resins/adsorbents are especially designed to achieve very fast uranium isotope exchange kinetics (exchange rate half-time of less than 10 seconds) and are capable of operating at a temperature in the range of 100° C to 200° C.

7. Ion exchange columns (Ion exchange)

   Cylindrical columns greater than 1000 mm in diameter for containing and supporting packed beds of ion exchange resin/adsorbent, especially designed or prepared for uranium enrichment using the ion exchange process. These columns are made of or protected by materials (such as titanium or fluorocarbon plastics) resistant to corrosion by concentrated hydrochloric acid solutions and are capable of operating at a temperature in the range of 100° C to 200° C and pressures above 0.7 MPa (102 psi).

8. Ion exchange reflux systems (Ion exchange)

   a. Especially designed or prepared chemical or electrochemical reduction systems for regeneration of the chemical reducing agent(s) used in ion exchange uranium enrichment cascades.
   b. Especially designed or prepared chemical or electrochemical oxidation systems for regeneration of the chemical oxidizing agent(s) used in ion exchange uranium enrichment cascades.

   Explanatory Note:

   The ion exchange enrichment process may use, for example, trivalent titanium (Ti^{+3}) as a reducing cation in which case the reduction system would regenerate Ti^{+3} by reducing Ti^{+4}.

   The process may use, for example, trivalent iron (Fe^{+3}) as an oxidant in which case the oxidation system would regenerate Fe^{+3} by oxidizing Fe^{+2}.

3-2.5.7. Especially designed or prepared systems, equipment and components for use in laser-based enrichment plants.

Introductory Note:

Present systems for enrichment processes using lasers fall into two categories: those in which the process medium is atomic uranium vapor and those in which the process medium is the vapor of a uranium compound. Common nomenclature for such processes include: first category - atomic vapor laser isotope separation (AVLIS or SILVA); second category - molecular laser isotope separation (MLIS or MOLIS) and chemical reaction by isotope selective laser activation (CRISLA). The systems, equipment and components for laser enrichment plants embrace:

a. devices to feed uranium-metal vapor (for selective photo-ionization) or devices to feed the vapor of a uranium compound (for photo-dissociation or chemical activation);

b. devices to collect enriched and depleted uranium metal as product and tails in the first category, and devices to collect dissociated or reacted compounds as product and unaffected material as tails in the second category;

c. process laser systems to selectively excite the uranium-235 species; ***and***

d. feed preparation and product conversion equipment.

The complexity of the spectroscopy of uranium atoms and compounds may require incorporation of any of a number of available laser technologies.

Explanatory Note:

Many of the items listed in this section come into direct contact with uranium metal vapor or liquid or with process gas consisting of UF_6 or a mixture of UF_6 and other gases. All surfaces that come into contact with the uranium or UF_6 are wholly made of or protected by corrosion-resistant materials. For the purposes of the section relating to laser-based enrichment items, the materials resistant to corrosion by the vapor or liquid of uranium metal or uranium alloys include yttria-coated graphite and tantalum; and the materials resistant to corrosion by UF_6 include copper, stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel and UF_6-resistant fully fluorinated hydrocarbon polymers.

1. Uranium vaporization systems (AVLIS)

   Especially designed or prepared uranium vaporization systems which contain high-power strip or scanning electron beam guns with a delivered power on the target of more than 2.5 kW/cm.

2. Liquid uranium metal handling systems (AVLIS)

   Especially designed or prepared liquid metal handling systems for molten uranium or uranium alloys, consisting of crucibles and cooling equipment for the crucibles.

   Explanatory Note:

   The crucibles and other parts of this system that come into contact with molten uranium or uranium alloys are made of or protected by materials of suitable corrosion and heat resistance. Suitable materials include tantalum, yttria-coated graphite, graphite coated with other rare earth oxides (see Group 4) or mixtures thereof.

3. Uranium metal product and tails collector assemblies (AVLIS)

   Especially designed or prepared product and tails collector assemblies for uranium metal in liquid or solid form.

Explanatory Note:

Components for these assemblies are made of or protected by materials resistant to the heat and corrosion of uranium metal vapor or liquid (such as yttria-coated graphite or tantalum) and may include pipes, valves, fittings, gutters, feed-throughs, heat exchangers and collector plates for magnetic, electrostatic or other separation methods.

4. Separator module housings (AVLIS)

   Especially designed or prepared cylindrical or rectangular vessels for containing the uranium metal vapour source, the electron beam gun, and the product and tails collectors.

   Explanatory Note:

   These housings have multiplicity of ports for electrical and water feed-throughs, laser beam windows, vacuum pump connections and instrumentation diagnostics and monitoring. They have provisions for opening and closure to allow refurbishment of internal components.

5. Supersonic expansion nozzles (MLIS)

   Especially designed or prepared supersonic expansion nozzles for cooling mixtures of UF_6 and carrier gas to 150 K or less and which are corrosion resistant to UF_6.

6. Uranium pentafluoride product collectors (MLIS)

   Especially designed or prepared uranium pentafluoride (UF_5) solid product collectors consisting of filter, impact, or cyclone-type collectors, or combinations thereof, and which are corrosion resistant to the UF_5 /UF_6 environment.

7. UF_6/carrier gas compressors (MLIS)

   Especially designed or prepared compressors for UF_6/carrier gas mixtures, designed for long term operation in a UF_6 environment. The components of these compressors that come into contact with process gas are made of or protected by materials resistant to corrosion by UF_6.

8. Rotary shaft seals (MLIS)

   Especially designed or prepared rotary shaft seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor rotor with the driver motor so as to ensure a reliable seal against out-leakage of process gas or in-leakage of air or seal gas into the inner chamber of the compressor which is filled with a UF_6/carrier gas mixture.

9. Fluorination systems (MLIS)

   Especially designed or prepared systems for fluorinating UF_5 (solid) to UF_6 (gas).

   Explanatory Note:

   These systems are designed to fluorinate the collected UF_5 powder to UF_6 for subsequent collection in product containers or for transfer as feed to MLIS units for additional enrichment. In one approach, the fluorination reaction may be accomplished within the isotope separation system to react and recover directly off the product collectors. In another approach, the UF_5 powder may be removed/transferred from the product collectors into a suitable reaction vessel (e.g., fluidized-bed reactor, screw reactor or flame tower) for fluorination. In both approaches, equipment for storage and transfer of fluorine (or other suitable fluorinating agents) and for collection and transfer of UF_6 are used.

10. UF_6 mass spectrometers/ion sources (MLIS)

    Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking on-line samples of feed, product or tails, from UF_6 gas streams and having all of the following characteristics:

    1. Unit resolution for mass greater than 320;
    2. Ion sources constructed of or lined with nichrome or monel or nickel plated;
    3. Electron bombardment ionization sources;
    4. Collector system suitable for isotopic analysis.

11. Feed systems/product and tails withdrawal systems (MLIS)

    Especially designed or prepared process systems or equipment for enrichment plants made of or protected by materials resistant to corrosion by UF_6, including:

    a. Feed autoclaves, ovens, or systems used for passing UF_6 to the enrichment process;

    b. Desublimers (or cold traps) used to remove UF_6 from the enrichment process for subsequent transfer upon heating;

    c. Solidification or liquefaction stations used to remove UF_6 from the enrichment process by compressing and converting UF_6 to a liquid or solid form;

    d. Product or tails stations used for transferring UF_6 into containers.

12. UF_6/carrier gas separation systems (MLIS)

    Especially designed or prepared process systems for separating UF_6 from carrier gas. The carrier gas may be nitrogen, argon, or other gas.

    Explanatory Note:

    These systems may incorporate equipment such as:

    a. Cryogenic heat exchangers or cryoseparators capable of temperatures of -120° C or less; ***or***

    b. Cryogenic refrigeration units capable of temperatures of -120° C or less; ***or***

    c. UF_6 cold traps capable of temperatures of -20° C or less.

13. Laser systems (AVLIS, MLIS and CRISLA)

    Lasers or laser systems especially designed or prepared for the separation of uranium isotopes.

    Explanatory Note:

    The lasers and laser components of importance in laser-based enrichment processes include those identified in Group 4. The laser system for the AVLIS process usually consists of two lasers: a copper vapor laser and a dye laser. The laser system for MLIS usually consists of a CO_2 or excimer laser and a multi-pass optical cell with revolving mirrors at both ends. Lasers or laser systems for both processes require a spectrum frequency stabilizer for operation over extended periods of time.

3-2.5.8. Especially designed or prepared systems, equipment and components for use in plasma separation enrichment plants.

Introductory Note:

In the plasma separation process, a plasma of uranium ions passes through an electric field tuned to the U-235 ion resonance frequency so that they preferentially absorb energy and increase the diameter of their corkscrew-like orbits. Ions with a large diameter path are trapped to produce a product enriched in U-235. The plasma, which is made by ionizing uranium vapor, is contained in a vacuum chamber with a high-strength magnetic field produced by a superconducting magnet. The main technological systems of the process include the uranium plasma generation system, the separator module with superconducting magnet (see Group 4), and metal removal systems for the collection of product and tails.

1. Microwave power sources and antennae

   Especially designed or prepared microwave power sources and antennae for producing or accelerating ions and having the following characteristics: greater than 30 GHz frequency and greater than 50 kW mean power output for ion production.

2. Ion excitation coils

   Especially designed or prepared radio frequency ion excitation coils for frequencies of more than 100 kHz and capable of handling more than 40 kW mean power.

3. Uranium plasma generation systems

   Especially designed or prepared systems for the generation of uranium plasma, which may contain high-power strip or scanning electron beam guns with a delivered power on the target of more than 2.5 kW/cm.

4. Liquid uranium metal handling systems

   Especially designed or prepared liquid metal handling systems for molten uranium or uranium alloys, consisting of crucibles and cooling equipment for the crucibles.

   Explanatory Note:

   The crucibles and other parts of this system that come into contact with molten uranium or uranium alloys are made of or protected by materials of suitable corrosion and heat resistance. Suitable materials include tantalum, yttria-coated graphite, graphite coated with other rare earth oxides (see Group 4) or mixtures thereof.

5. Uranium metal product and tails collector assemblies

   Especially designed or prepared product and tails collector assemblies for uranium metal in solid form. These collector assemblies are made of or protected by materials resistant to the heat and corrosion of uranium metal vapor, such as yttria-coated graphite or tantalum.

6. Separator module housings

   Cylindrical vessels especially designed or prepared for use in plasma separation enrichment plants for containing the uranium plasma source, radio-frequency drive coil and the product and tails collectors.

   Explanatory Note:

   These housings have a multiplicity of ports for electrical feed-throughs, diffusion pump connections and instrumentation diagnostics and monitoring. They have provisions for opening and closure to allow for refurbishment of internal *components and are constructed of a suitable non-magnetic material such as stainless steel.*

3-2.5.9. Especially designed or prepared systems, equipment and components for use in electromagnetic enrichment plants.

Introductory Note:

In the electromagnetic process, uranium metal ions produced by ionization of a salt feed material (typically UCl_4) are accelerated and passed through a magnetic field that has the effect of causing the ions of different isotopes to follow different paths. The major components of an electromagnetic isotope separator include: a magnetic field for ion-beam diversion/separation of the isotopes, an ion source with its acceleration system, and a collection system for the separated ions. Auxiliary systems for the process include the magnet power supply system, the ion source high-voltage power supply system, the vacuum system, and extensive chemical handling systems for recovery of product and cleaning/recycling of components.

1. Electromagnetic isotope separators

   Electromagnetic isotope separators especially designed or prepared for the separation of uranium isotopes, and equipment and components therefor, including:

   a. Ion sources

      Especially designed or prepared single or multiple uranium ion sources consisting of a vapour source, ionizer, and beam accelerator, constructed of suitable materials such as graphite, stainless steel, or copper, and capable of providing a total ion beam current of 50 mA or greater.

   b. Ion collectors

      Collector plates consisting of two or more slits and pockets especially designed or prepared for collection of enriched and depleted uranium ion beams and constructed of suitable materials such as graphite or stainless steel.

   c. Vacuum housings

      Especially designed or prepared vacuum housings for uranium electromagnetic separators, constructed of suitable non-magnetic materials such as stainless steel and designed for operation at pressures of 0.1 Pa or lower.

      Explanatory Note:

      The housings are specially designed to contain the ion sources, collector plates and water-cooled liners and have provision for diffusion pump connections and opening and closure for removal and reinstallation of these components.

   d. Magnet pole pieces

      Especially designed or prepared magnet pole pieces having a diameter greater than 2 m used to maintain a constant magnetic field within an electromagnetic isotope separator and to transfer the magnetic field between adjoining separators.

2. High voltage power supplies

   Especially designed or prepared high-voltage power supplies for ion sources, having all of the following characteristics: capable of continuous operation, output voltage of 20,000 V or greater, output current of 1 A or greater, and voltage regulation of better than 0.01% over a time period of 8 hours.

3. Magnet power supplies

Especially designed or prepared high-power, direct current magnet power supplies having all of the following characteristics: capable of continuously producing a current output of 500 A or greater at a voltage of 100 V or greater and with a current or voltage regulation better than 0.01% over a period of 8 hours.

3-2.6 Plants for the production or concentration of heavy water, deuterium and deuterium compounds and equipment and components especially designed or prepared therefor, including:

Introductory Note:

Heavy water can be produced by a variety of processes. However, the two processes that have proven to be commercially viable are the water-hydrogen sulphide exchange process (GS process) and the ammonia-hydrogen exchange process.

The GS process is based upon the exchange of hydrogen and deuterium between water and hydrogen sulphide within a series of towers which are operated with the top section cold and the bottom section hot. Water flows down the towers while the hydrogen sulphide gas circulates from the bottom to the top of the towers. A series of perforated trays are used to promote mixing between the gas and the water. Deuterium migrates to the water at low temperatures and to the hydrogen sulphide at high temperatures. Gas or water, enriched in deuterium, is removed from the first stage towers at the junction of the hot and cold sections and the process is repeated in subsequent, stage towers. The product of the last stage, water enriched up to 30% in deuterium, is sent to a distillation unit to, produce reactor grade heavy water; i.e., 99.75% deuterium oxide.

The ammonia-hydrogen exchange process can extract deuterium from synthesis gas through contact with liquid ammonia in the presence of a catalyst. The synthesis gas is fed into exchange towers and to an ammonia converter. Inside the towers the gas flows from the bottom to the top while the liquid ammonia flows from the top to the bottom. The deuterium is stripped from the hydrogen in the synthesis gas and concentrated in the ammonia. The ammonia then flows into an ammonia cracker at the bottom of the tower while the gas flows into an ammonia converter at the top. Further enrichment takes place in subsequent stages and reactor grade heavy water is produced through final distillation. The synthesis gas feed can be provided by an ammonia plant that, in turn, can be constructed in association with a heavy water ammonia-hydrogen exchange plant. The ammonia-hydrogen exchange process can also use ordinary water as a feed source of deuterium.

Many of the key equipment items for heavy water production plants using GS or the ammonia-hydrogen exchange processes are common to several segments of the chemical and petroleum industries. This is particularly so for small plants using the GS process. However, few of the items are available off-the-shelf. The GS and ammonia hydrogen processes require the handling of large quantities of flammable, corrosive and toxic fluids at elevated pressures.

Accordingly, in establishing the design and operating standards for plants and equipment using these processes, careful attention to the materials selection and specifications is required to ensure long service life with high safety and reliability factors. The choice of scale is primarily a function of economics and need. Thus, most of the equipment items would be prepared according to the requirements of the customer.

Finally, it should be noted that, in both the GS and the ammonia-hydrogen exchange processes, items of equipment which individually are not especially designed or prepared for heavy water production can be assembled into systems which are especially designed or prepared for producing heavy water. The catalyst production system used in the ammonia-hydrogen exchange process and water distillation systems used for the final concentration of heavy water to reactor-grade in either process are examples of such systems.

The items of equipment which are especially designed or prepared for the production of heavy water utilizing either the water-hydrogen sulphide exchange process or the ammonia-hydrogen exchange process include the following:

1. Water - Hydrogen Sulphide Exchange Towers

   Exchange towers fabricated from fine carbon steel (such as ASTM A516) with diameters of 6 m (20 ft) to 9 m (30 ft), capable of operating at pressures greater than or equal to 2 MPa (300 psi) and with a corrosion allowance of 6 mm or greater, especially designed or prepared for heavy water production utilizing the water-hydrogen sulphide exchange process.

2. Blowers and Compressors

   Single stage, low head (i.e., 0.2 MPa or 30 psi) centrifugal blowers or compressors for hydrogen-sulphide gas circulation (i.e., gas containing more than 70% H_2S) especially designed or prepared for heavy water production utilizing the water-hydrogen sulphide exchange process. These blowers or compressors have a throughput capacity greater than or equal to 56 m^3/second (120,000 SCFM) while operating at pressures greater than or equal to 1.8 MPa (260 psi) suction and have seals designed for wet H_2S service.

3. Ammonia-Hydrogen Exchange Towers

   Ammonia-hydrogen exchange towers greater than or equal to 35 m (114.3 ft) in height with diameters of 1.5 m (4.9 ft) to 2.5 m (8.2 ft) capable of operating at pressures greater than 15 MPa (2225 psi) especially designed or prepared for heavy water production utilizing the ammonia-hydrogen exchange process. These towers also have at least one flanged, axial opening of the same diameter as the cylindrical part through which the tower internals can be inserted or withdrawn.

4. Tower Internals and Stage Pumps

   Tower internals and stage pumps especially designed or prepared for towers for heavy water production utilizing the ammonia-hydrogen exchange process. Tower internals include especially designed stage contactors which promote intimate gas/liquid contact. Stage pumps include especially designed submersible pumps for circulation of liquid ammonia within a contacting stage internal to the stage towers.

5. Ammonia Crackers

   Ammonia crackers with operating pressures greater than or equal to 3 MPa (450 psi) especially designed or prepared for heavy water production utilizing the ammonia-hydrogen exchange process.

6. Infrared Absorption Analyzers

   Infrared absorption analyzers capable of on-line hydrogen/deuterium ratio analysis where deuterium concentrations are equal to or greater than 90%.

7. Catalytic Burners

   Catalytic burners for the conversion of enriched deuterium gas into heavy water especially designed or prepared for heavy water production utilizing the ammonia-hydrogen exchange process.

8. Complete heavy water upgrade systems or columns therefor

   Complete heavy water upgrade systems, or columns therefor, especially designed or prepared for the upgrade of heavy water to reactor-grade deuterium concentration.

Explanatory Note:

These systems, which usually employ water distillation to separate heavy water from light water, are especially designed or prepared to produce reactor-grade heavy water (i.e., typically 99.75% deuterium oxide) from heavy water feedstock of lesser concentration.

3-2.7. Plants for the conversion of uranium and plutonium for use in the fabrication of fuel elements and the separation of uranium isotopes as defined in Items 3-2.4. and 3-2.5. respectively, and equipment and components especially designed or prepared therefor, including:

3-2.7.1. Plants for the conversion of uranium and equipment especially designed or prepared therefor

Introductory Note:

Uranium conversion plants and systems may perform one or more transformations from one uranium chemical species to another, including: conversion of uranium ore concentrates to UO_3, conversion of UO_3 to UO_2, conversion of uranium oxides to UF_4, UF_6, or UCl_4, conversion of UF_4 to UF_6, conversion of UF_6 to UF_4, conversion of UF_4 to uranium metal, and conversion of uranium fluorides to UO_2.

Many of the key equipment items for uranium conversion plants are common to several segments of the chemical process industry. For example, the types of equipment employed in these processes may include: furnaces, rotary kilns, fluidized bed reactors, flame tower reactors, liquid centrifuges, distillation columns and liquid-liquid extraction columns. However, few of the items are available "off-the-shelf", most would be prepared according to the requirements and specifications of the customer. In some instances, special design and construction considerations are required to address the corrosive properties of some of the chemicals handled (HF, F_2, ClF_3, and uranium fluorides) as well as nuclear criticality concerns. Finally, it should be noted that, in all of the uranium conversion processes, items of equipment which individually are not especially designed or prepared for uranium conversion can be assembled into systems which are especially designed or prepared for use in uranium conversion.

1. Especially designed or prepared systems for the conversion of uranium ore concentrates to UO_3

   Explanatory Note:

   Conversion of uranium ore concentrates to UO_3 can be performed by first dissolving the ore in nitric acid and extracting purified uranyl nitrate using a solvent such as tributyl phosphate. Next, the uranyl nitrate is converted to UO_3 either by concentration and denitration or by neutralization with gaseous ammonia to produce ammonium diuranate with subsequent filtering, drying, and calcining.

2. Especially designed or prepared systems for the conversion of UO_3 to UF_6

   Explanatory Note:

   Conversion of UO_3 to UF_6 can be performed directly by fluorination. The process requires a source of fluorine gas or chlorine trifluoride.

3. Especially designed or prepared systems for the conversion of UO_3 to UO_2

   Explanatory Note:

   Conversion of UO_3 to UO_2 can be performed through reduction of UO_3 with cracked ammonia gas or hydrogen.

4. Especially designed or prepared systems for the conversion of UO_2 to UF_4

Explanatory Note:

Conversion of UO_2 to UF_4 can be performed by reacting UO_2 with hydrogen fluoride gas (HF) at 300-500° C.

5. Especially designed or prepared systems for the conversion of UF_4 to UF_6

Explanatory Note:

Conversion of UF_4 to UF_6 is performed by exothermic reaction with fluorine in a tower reactor. UF_6 is condensed from the hot effluent gases by passing the effluent stream through a cold trap cooled to -10° C. The process requires a source of fluorine gas.

6. Especially designed or prepared systems for the conversion of UF_4 to U metal

Explanatory Note:

Conversion of UF_4 to U metal is performed by reduction with magnesium (large batches) or calcium (small batches). The reaction is carried out at temperatures above the melting point of uranium (1130° C).

7. Especially designed or prepared systems for the conversion of UF_6 to UO_2

Explanatory Note:

Conversion of UF_6 to UO_2 can be performed by one of three processes. In the first, UF_6 is reduced and hydrolyzed to UO_2 using hydrogen and steam. In the second, UF_6 is hydrolyzed by solution in water, ammonia is added to precipitate ammonium diuranate, and the diuranate is reduced to UO_2 with hydrogen at 820° C. In the third process, gaseous UF_6, CO_2, and NH_3 are combined in water, precipitating ammonium uranyl carbonate. The ammonium uranyl carbonate is combined with steam and hydrogen at 500-600° C to yield UO_2. UF_6 to UO_2 conversion is often performed as the first stage of a fuel fabrication plant.

8. Especially designed or prepared systems for the conversion of UF_6 to UF_4

Explanatory Note:

Conversion of UF_6 to UF_4 is performed by reduction with hydrogen.

9. Especially designed or prepared systems for the conversion of UO_2 to UCl_4

Explanatory Note:

Conversion of UO_2 to UCl_4 can be performed by one of two processes. In the first, UO_2 is reacted with carbon tetrachloride (CCl_4) at approximately 400° C. In the second, UO_2 is reacted at approximately 700° C in the presence of carbon black (CAS 1333-86-4), carbon monoxide, and chlorine to yield UCl_4.

3-2.7.2. Plants for the conversion of plutonium and equipment especially designed or prepared therefor

Introductory Note:

Plutonium conversion plants and systems perform one or more transformations from one plutonium chemical species to another, including: conversion of plutonium nitrate to PuO_2, conversion of PuO_2 to PuF_4, and conversion of PuF_4 to plutonium metal. Plutonium conversion plants are usually associated with reprocessing facilities, but may also be associated with plutonium fuel fabrication facilities. Many of the key equipment items for plutonium conversion plants are common to several segments of the chemical process industry. For example, the types of equipment employed in these processes may include: furnaces, rotary kilns, fluidized bed reactors, flame tower reactors, liquid *centrifuges, distillation columns and liquid-liquid extraction columns. Hot cells, glove boxes and remote manipulators may also be required. However, few of the items are available off-the-shelf; most would be prepared according to the requirements and specifications of the customer. Particular care in designing for the special radiological, toxicity and criticality hazards associated with plutonium is essential.*

In some instances, special design and construction considerations are required to address the corrosive properties of some of the chemicals handled (e.g. HF). Finally, it should be noted that, for all plutonium conversion processes, items of equipment which individually are not especially designed or prepared for plutonium conversion can be assembled into systems which are especially designed or prepared for use in plutonium conversion.

1. Especially designed or prepared systems for the conversion of plutonium nitrate to oxide

   Explanatory Note:

   The main functions involved in this process are: process feed storage and adjustment, precipitation and solid/liquor separation, calcination, product handling, ventilation, waste management, and process control. The process systems are particularly adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards. In most reprocessing facilities, this process involves the conversion of plutonium nitrate to plutonium dioxide. Other processes can involve the precipitation of plutonium oxalate or plutonium peroxide.

2. Especially designed or prepared systems for plutonium metal production

   Explanatory Note:

   This process usually involves the fluorination of plutonium dioxide, normally with highly corrosive hydrogen fluoride, to produce plutonium fluoride which is subsequently reduced using high purity calcium metal to produce metallic plutonium and a calcium fluoride slag. The main functions involved in this process are fluorination (e.g. involving equipment fabricated or lined with a precious metal), metal reduction (e.g. employing ceramic crucibles), slag recovery, product handling, ventilation, waste management and process control. The process systems are, particularly adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards. Other, processes include the fluorination of plutonium oxalate or plutonium peroxide followed by a reduction to metal.

3-3. SOFTWARE

"Software" especially designed or modified for the "development", "production", or "use" of items specified in Group 3.

3-4. TECHNOLOGY

"Technology" according to the Nuclear Technology Note for the "development", "production", or "use" of items specified in Group 3.

GROUP 4 – NUCLEAR-RELATED DUAL-USE LIST

(All destinations. All destinations applies to all Group 4 Items.)

Note:

Terms in 'single quotations' are usually defined within each entry of the list.

Terms in "double quotations" are defined at the end of Group 4.

CANADIAN NUCLEAR SAFETY COMMISSION (CNSC) NOTE:

The export of nuclear and nuclear-related items is also controlled by the CNSC under the Nuclear Safety and Control Act (NSCA) and Regulations. Therefore, the export of nuclear and nuclear-related items, not listed in Group 4 or which meet the specific Group 4 decontrol notes may still require a license from the CNSC. Information on export licensing requirements under the NSCA may be obtained by contacting the CNSC.

GENERAL TECHNOLOGY NOTE:

The export of "technology" required for the "development", "production" or "use" of items controlled in Group 4, is controlled according to the provisions of Group 4. This "technology" remains under control even when applicable to non-controlled items.

The approval of items 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 items.

Controls on "technology" transfer, do not apply to information "in the public domain" or to "basic scientific research".

GENERAL SOFTWARE NOTE:

The export of "software" is controlled according to the provisions of Group 4. Group 4 does not control "software" which is either:

1. *Generally available to the public by being:*
   a. *Sold from stock at retail selling points, without restriction, by means of:*
      1. *Over-the-counter transactions;*
      2. *Mail order transactions;*
      3. *Electronic Transactions;* ***or***
      4. *Telephone call transactions;* ***and***
   b. *Designed for installation by the user without further substantial support by the supplier;* ***or***
2. *"In the public domain".*

4-1. INDUSTRIAL EQUIPMENT

4-1.A Equipment, Assemblies and Components

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; **and**
   c. A thickness of 100 mm or greater.

   Technical Note:

   In Item 4-1.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.

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.

   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.

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 4-1.A.3.a.

   Note:

   Item 4-1.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 4-1.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 4-1.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.

N.B.:

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

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); **or**

   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).

Technical Note:

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.

4-1.B. Test and Production Equipment

4-1.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); **and**

   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.

Note:

Item 4-1.B.1. 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.

4-1.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 4-1.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 4-1.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 4-1.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 4-1.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).

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" 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 (Âx, Ây...);

e. Since Item 4-1.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 4-1.B.2.a., 4-1.B.2.b., or 4-1.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 4-1.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 International Standard ISO 841, '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 centerline of which is parallel to the primary rotary axis).

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

4. For the purposes of 4-1.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, 4-1.B.2.a., 4-1.B.2.b. and 4-1.B.2.c.

6. Items 4-1.B.2.b.3. and 4-1.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.

4-1.B.3. Dimensional inspection machines, instruments, or systems, as follows:

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

1. Two or more axes; **and**
2. A maximum permissible error of length measurement ($E_{0,MPE}$) along any axis (one dimensional), identified as E_{0X}, E_{0Y} or E_{0Z}, 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), tested according to ISO 10360-2(2009).

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. “Linearity” equal to or better (less) than 0.1% within a measuring range up to 5 mm; **and**
   b. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature ±1 K;
3. Measuring systems having both of the following characteristics:
   a. Contain 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);

Note:

Item 4-1.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 4-1.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 4-1.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 4-1.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.

2. Machines described in Item 4-1.B.3. are controlled if they exceed the threshold specified anywhere within their operating range.

Technical Notes:

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

4-1.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 4-1.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 4-1.B.4.a.

4-1.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; **and**

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 4-1.B.5.a.

Technical Notes:

1. In Item 4-1.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.

2. In Item 4-1.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.

4-1.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; **and**
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 4-1.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 4-1.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 4-1.B.6.a.

Technical Note:

In Item 4-1.B.6. ‘bare table’ means a flat table, or surface, with no fixtures or fittings.

4-1.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 20,000 cm^3; **and**
2. Capable of operating with melting temperatures above 1973 K (1700° C);

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 4-1.B.7.a. or 4-1.B.7.b.

4-1.C. Materials

None

4-1.D. Software

1. “Software” specially designed for the “use” of equipment specified in Item 4-1.A.3., 4-1.B.1., 4-1.B.3., 4-1.B.5., 4-1.B.6.a., 4-1.B.6.b., 4-1.B.6.d., or 4-1.B.7.

   Note:

   “Software” specially designed for systems specified in Item 4-1.B.3.d. includes “software” for simultaneous measurements of wall thickness and contour.

2. “Software” specially designed or modified for the “development”, “production”, or “use” of equipment specified in Item 4-1.B.2.
3. “Software” for any combination of electronic devices or system enabling such device(s) to function as a “numerical control” unit 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 4-1.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 4-1.B.2.*

4-1.E. Technology

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

4-2. MATERIALS

4-2.A. Equipment, Assemblies and Components

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 liters); **and**
      2. Made of or coated with any of the following materials, having a purity of 98% or greater by weight:
         a. Calcium fluoride (CaF_2);
         b. Calcium zirconate (metazirconate) ($CaZrO_3$);
         c. Cerium sulfide (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 liters); **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 liters);
      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. 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.
3. Composite structures in the form of tubes having both of the following characteristics:

a. An inside diameter of between 75 and 400 mm; **and**

b. Made with any of the “fibrous or filamentary materials” specified in Item 4-2.C.7.a. or carbon prepreg materials specified in Item 4-2.C.7.c.

4-2.B. Test and Production Equipment

1. Tritium facilities or plants, for the production, recovery, extraction, concentration or handling of tritium, tritium compounds or mixtures, and equipment especially designed or prepared, including equipment for:

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

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

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

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

   b. Equipment for the separation of lithium isotopes, 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.

4-2.C. Materials

4-2.C.1. Aluminum alloys having both of the following characteristics:

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

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

Technical Note:

In Item 4-2.C.1. the phrase ‘capable of’ encompasses aluminium alloys before or after heat treatment.

4-2.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 4-2.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 aluminum) in the form of emeralds or aquamarines.

4-2.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 parts per million by weight of silver.

4-2.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 4-2.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).

4-2.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; **and**

b. Containing less than 10 parts per million by weight of boron.

4-2.C.6. Chlorine trifluoride (ClF_3).

4-2.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 4-2.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 Item 4-2.C.7.a. or Item 4-2.C.7.b.

Technical Note:

The resin forms the matrix of the composite.

Technical Notes:

1. *In Item 4-2.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 4-2.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%.*

4-2.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.

4-2.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.

Note:

Item 4-2.C.9. does not control thermoluminescent dosimeters.

Technical Note:

The natural isotopic abundance of lithium-6 is approximately 6.5 weight percent (7.5 atom percent).

4-2.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; **and**

b. Containing less than 10 parts per million by weight of boron.

4-2.C.11. Maraging steel ‘capable of’ an ultimate tensile strength of 2050 MPa or more at 293 K (20° C).

Note:

Item 4-2.C.11. does not control forms in which all linear dimensions are 75 mm or less.

Technical Note:

In Item 4-2.C.11. the phrase ‘capable of’ encompasses maraging steel before or after heat treatment.

4-2.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.

Note:

Item 4-2.C.12. does not control the following:

a. Medical applicators;

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

4-2.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); **and**

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

Technical Note:

In Item 4-2.C.13 the phrase ‘capable of’ encompasses titanium alloys before or after heat treatment.

4-2.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; **and**

b. A mass greater than 20 kg.

Note:

Item 4-2.C.14. does not control manufactures specially designed as weights or gamma-ray collimators.

4-2.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.

Note:

Item 4-2.C.15. does not control zirconium in the form of foil having a thickness of 0.10 mm or less.

4-2.C.16. Nickel powder and porous nickel metal, as follows:

N.B.:

For nickel powders which are especially prepared for the manufacture of gaseous diffusion barriers see Group 3, Item 3-2.5.3.

a. Nickel powder having both of the following characteristics:

1. A nickel purity content of 99.0% or greater by weight; **and**
2. A mean particle size of less than 10 µm measured by the ASTM B 330 standard;

b. Porous nickel metal produced from materials specified in Item 4-2.C.16.a.

Technical Note:

Item 4-2.C.16.b. refers to porous metal formed by compacting and sintering the material in Item 4-2.C.16.a. to form a metal material with fine pores interconnected throughout the structure.

Note:

Item 4-2.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.

4-2.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 4-2.C.17. does not control a product or device containing less than 1.48×10^3 GBq of tritium.

4-2.C.18. Helium-3 (^3He), mixtures containing helium-3, and products or devices containing any of the foregoing.

Note:

Item 4-2.C.18. does not control a product or device containing less than 1 g of helium-3.

4-2.C.19. Alpha-emitting radionuclides having an alpha half-life of 10 days or greater but less than 200 years, in the following forms:

a. Elemental;

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

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

d. Products or devices containing any of the foregoing.

Note:

Item 4-2.C.19. does not control a product or device containing less than 3.7 GBq of alpha activity.

4-2.D. Software

None

4-2.E. Technology

1. “Technology” according to the General Technology Note for the “development”, “production” or “use” of equipment, material or “software” specified in 4-2.A. through 4-2.D.

4-3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS (OTHER THAN LISTED IN GROUP 3)

4-3.A. Equipment, Assemblies and Components

4-3.A.1. Frequency changers or generators having all of the following characteristics:

N.B.:

Frequency changers and generators especially designed or prepared for the gas centrifuge process are controlled under Group 3, Item 3-2.5.1.

a. Multiphase output capable of providing a power of 40 W or greater;

b. Capable of operating in the frequency range between 600 and 2000 Hz;

c. Total harmonic distortion better (less) than 10%; **and**

d. Frequency control better (less) than 0.1%.

Technical Note:

Frequency changers in Item 4-3.A.1. are also known as converters or inverters.

4-3.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 40 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 4-3.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 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 4-3.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.

4-3.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 4-3.A.3.a. refers to the smallest diameter.

4-3.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 4-3.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.

4-3.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.

4-3.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.

4-3.A.7. Pressure transducers capable of measuring absolute pressures at any point in the range 0 to 13 kPa and having both of the following characteristics:

a. Pressure sensing elements made of or protected by aluminium, aluminium alloy, nickel, or nickel alloy with more than 60% nickel by weight; **and**

b. 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.

Technical Notes:

1. *In Item 4-3.A.7. pressure transducers are devices that convert pressure measurements into an electrical signal.*
2. *In Item 4-3.A.7. "accuracy" includes non-linearity, hysteresis and repeatability at ambient temperature.*

4-3.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.*

4-3.B. Test and Production Equipment

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

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 4-3.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 4-3.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 4-3.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. 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.
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;
      2. Specially designed to fabricate composite structures or laminates from "fibrous or filamentary materials"; **and**
      3. Capable of winding cylindrical rotors of diameter between 75 and 400 mm and lengths of 600 mm or greater;
   b. Coordinating and programming controls for the filament winding machines specified in Item 4-3.B.4.a.;
   c. Precision mandrels for the filament winding machines specified in Item 4-3.B.4.a.

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 4-3.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 4-3.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.

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 analyzing on-line samples of uranium hexafluoride are controlled under Group 3.

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 which have a source chamber constructed from, lined with or plated with materials resistant to UF_6;
e. Molecular beam mass spectrometers having either of the following characteristics:
   1. A source chamber constructed from, lined with or plated with stainless steel or molybdenum, and equipped with a cold trap capable of cooling to 193 K (-80° C) or less; **or**
   2. A source chamber constructed from, lined with or plated with materials resistant to UF_6;
f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

4-3.C. Materials

None

4-3.D. Software

1. "Software" specially designed for the "use" of equipment specified in Item 4-3.B.3. or 4-3.B.4.

4-3.E. Technology

1. "Technology" according to the General Technology Note for the "development", "production" or "use" of equipment, material or "software" specified in 4-3.A. through 4-3.D.

4-4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT (OTHER THAN LISTED IN GROUP 3)

4-4.A. Equipment, Assemblies and Components

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; **and**
   b. Designed to be used in vacuum distillation towers.
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; **and**
   c. Either of the following characteristics:
      1. For concentrated potassium amide solutions (1% or greater), an operating pressure of 1.5 to 60 MPa; **or**
      2. For dilute potassium amide solutions (less than 1%), an operating pressure of 20 to 60 MPa.
3. Turboexpanders or turboexpander-compressor sets having both of the following characteristics:
   a. Designed for operation with an outlet temperature of 35 K (-238° C) or less; **and**
   b. Designed for a throughput of hydrogen gas of 1000 kg/h or greater.

4-4.B. Test and Production Equipment

1. Water-hydrogen sulfide exchange tray columns and internal contactors, as follows:

   N.B.:

   For columns which are especially designed or prepared for the production of heavy water, see Group 3.

   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; **and**
      3. With a diameter of 1.8 m or greater;
   b. Internal contactors for the water-hydrogen sulfide exchange tray columns specified in Item 4-4.B.1.a.

      Technical Note:

      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.

2. Hydrogen-cryogenic distillation columns having all of the following characteristics:
   a. Designed for operation at internal temperatures of 35 K (-238° C) 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 5 or greater; **or**
      2. Equivalent materials which are both cryogenic and H_2-compatible; **and**
   d. With internal diameters of 1 m or greater and effective lengths of 5 m or greater.
3. Ammonia synthesis converters or synthesis units, in which the synthesis gas (nitrogen and hydrogen) is withdrawn from an ammonia/hydrogen high-pressure exchange column and the synthesized ammonia is returned to said column.

4-4.C. Materials

None

4-4.D. Software

None

4-4.E. Technology

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

4-5. TEST AND MEASUREMENT EQUIPMENT FOR THE DEVELOPMENT OF NUCLEAR EXPLOSIVE DEVICES

4-5.A. Equipment, Assemblies and Components

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.

4-5.B. Test and Production Equipment

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 4-5.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 1 µs, 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.*

2. Multistage light gas guns or other high-velocity gun systems (coil, electromagnetic, and electrothermal types, and other advanced systems) capable of accelerating projectiles to 2 km/s or greater.
3. Mechanical rotating mirror cameras, as follows, and specially designed components therefor:
   a. Framing cameras with recording rates greater than 225,000 frames per second;
   b. Streak cameras with writing speeds greater than 0.5 mm/µs.

   Note:

   In Item 4-5.B.3. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors, and bearings.
4. Electronic streak cameras, electronic framing cameras, tubes and devices, as follows:
   a. Electronic streak cameras capable of 50 ns or less time resolution;
   b. Streak tubes for cameras specified in Item 4-5.B.4.a.;
   c. Electronic or electronically shuttered framing cameras capable of 50 ns or less frame exposure time;
   d. Framing tubes and solid-state imaging devices for use with cameras specified in Item 4-5.B.4.c., as follows:
      1. Proximity focused image intensifier tubes having the photocathode deposited on a transparent conductive coating to decrease photocathode sheet resistance;
      2. Gate silicon intensifier target (SIT) vidicon tubes, where a fast system allows gating the photoelectrons from the photocathode before they impinge on the SIT plate;
      3. Kerr or Pockels cell electro-optical shuttering;
      4. Other framing tubes and solid-state imaging devices having a fast image gating time of less than 50 ns specially designed for cameras specified in Item 4-5.B.4.c.
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;

Note:

Item 4-5.B.5.a. includes velocity interferometers such as VISARs (Velocity interferometer systems for any reflector) and DLIs (Doppler laser interferometers).

b. Manganin gauges for pressures greater than 10 GPa;

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

6. High-speed pulse generators 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.

Technical Note:

In Item 4-5.B.6.b. 'pulse transition time' is defined as the time interval between 10% and 90% voltage amplitude.

4-5.C. Materials

None

4-5.D. Software

None

4-5.E. Technology

"Technology" according to the General Technology Note for the "development", "production" or "use" of equipment, material or "software" specified in 4-5.A. through 4-5.D.

4-6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES

4-6.A. Equipment, Assemblies and Components

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 4-6.A.1. does not control detonators using only primary explosives, such as lead azide.

Technical Note:

In Item 4-6.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 is sometimes used in place of the word detonator.*

2. Firing sets and equivalent high-current pulse generators, as follows:
   a. Explosive detonator firing sets designed to drive multiple controlled detonators specified by Item 4-6.A.1. above;
   b. Modular electrical pulse generators (pulsers) having all of the following characteristics:
      1. Designed for portable, mobile, or ruggedized-use;
      2. Enclosed in a dust-tight enclosure;
      3. Capable of delivering their energy in less than 15 µs;
      4. Having an output greater than 100 A;
      5. Having a ‘rise time’ of less than 10 µs into loads of less than 40 ohms;
      6. No dimension greater than 25.4 cm;
      7. Weight less than 25 kg; **and**
      8. Specified to operate over an extended temperature range of 223 to 373 K (-50° C to 100° C) or specified as suitable for aerospace applications.

      Note:

      Item 4-6.A.2.b. includes xenon flashlamp drivers.

      Technical Note:

      In Item 4-6.A.2.b.5. ‘rise time’ is defined as the time interval from 10% to 90% current amplitude when driving a resistive load.
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 4-6.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.
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.

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

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

b. Utilizing electrostatic acceleration to induce a tritium-deuterium nuclear reaction.

4-6.B. Test and Production Equipment

None

4-6.C. Materials

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

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

4-6.D. Software

None

4-6.E. Technology

1. “Technology” according to the General Technology Note for the “development”, “production” or “use” of equipment, material or “software” specified in 4-6.A. through 4-6.D.

DEFINITIONS OF TERMS USED IN GROUPS 3 AND 4

"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. (Ref.: VID/VDE 2617, Draft: 'Rotary table on coordinate measuring machines').

"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.: ISO/DIS 2806-1980 as amended).

"Development"

Is related to all phases prior to "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 'filament', 'monofilaments', 'yarns', 'rovings', 'tows', or 'tapes'.

N.B.: *'Filament' or 'monofilament' is the smallest increment of fibre, usually several µm in diameter.*

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

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

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

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

'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 nonlinearity) 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.

"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 (Ref.: VDI/VDE 2617).

"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).

"Positioning accuracy"

Of "numerically controlled" machine tools is to be determined and presented in accordance with Item 4-1.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 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:
        a. Line voltage variation shall not be greater than ±10% of nominal rated voltage;
        b. Frequency variation shall not be greater than ±2 Hz of normal frequency;
        c. 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 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, and 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.: ANSI B-89.1.12)

“Roving”

See “Fibrous and 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”

May take forms, such as: instruction, skills, training, working knowledge, consulting services.

N.B.: *“Technical assistance” may involve transfer of “technical data”.*

“Technical data”

May take forms such as blueprints, plans, drawings, photoprints or negatives, diagrams, models, formulae, tables, engineering designs and specifications, manuals and instructions, whether in written form or recorded on other media or devices such as disk, tape, read-only memories.

“Technology”

Specific information required for the “development”, “production” or “use”, of an item. This information may take the form of “technical data” or “technical assistance”.

"Tow"

See "Fibrous and filamentary materials".

"Use"

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

"Yarn"

See "Fibrous and filamentary materials".

GROUP 5 – MISCELLANEOUS GOODS AND TECHNOLOGY

Forest Products

5101. Logs of all species of wood *(All destinations)*

5102. Pulpwood of all species of wood *(All destinations)*

5103. Blocks, bolts, blanks, boards and any other material or product of red cedar that is suitable for use in the manufacture of shakes or shingles. *(All destinations)*

5104. Softwood Lumber Products *(United States)*

1. Softwood lumber products set out in Annex 1A to the softwood lumber agreement, excluding item 5(e).
2. The references to the Harmonized Tariff Schedule of the United States (HTSUS) tariff classifications in Annex 1A to the softwood lumber agreement are to be read as references to the corresponding tariff classifications according to the Canadian Table of Concordance in Annex 1B to that agreement.
3. The references to “imported” and “importation” in Annex 1A to the softwood lumber agreement are to be read as “exported” and “exportation”, respectively, and the reference to “importés” in Annex 1B to the French version of that agreement is to be read as “exportés”.

Agriculture and Food Products

5201. Peanut Butter that is classified under tariff item No. 2008.11.10 in the list of Tariff Provisions set out in the schedule to the Customs Tariff. *(All destinations)*

5203. Sugar-containing Products *(United States)*

Sugar-containing products that are classified under subheadings 1701.91.54, 1704.90.74, 1806.20.75, 1806.20.95, 1806.90.55, 1901.90.56, 2101.10.54, 2101.20.54, 2106.90.78 and 2106.90.95 of *Harmonised Tariff Schedule of the United States* (1995) (United States International Trade Commission Pub. 2831, 19 U.S.C. § 1202 (1988)).

5204. Sugars, Syrups and Molasses *(United States)*

Sugars, Syrups and Molasses that are classified under subheadings 1701.12.10, 1701.91.10, 1701.99.10, 1702.90.10, and 2106.90.44 of *Harmonised Tariff Schedule of the United States* (1995) (United States International Trade Commission Pub. 2831, 19 U.S.C. § 1202 (1988)).

Foreign Origin Goods and Technology

United States Origin Goods and Technology

5400. United States Origin Goods and Technology

All goods and technology of United States origin, unless they are included elsewhere in this List, whether in bond or cleared by the Canada Border Services Agency, other than goods or technology that have been further processed or manufactured outside the United States so as to result in a substantial change in value, form or use of the goods or technology or in the production of new goods or technology.

(All destinations other than the United States)

Goods and Technology in Transit

5401. Goods and Technology in Transit

1. All goods and technology that originate outside Canada that are included in this List, whether in bond or cleared by the Canada Border Services Agency, other than goods or technology that are in transit on a through journey on a billing that originates outside Canada if the billing
   a. indicates that the ultimate destination of the goods or technology is a country other than Canada; *(All destinations other than the United States)* **and**
   b. in the case of goods or technology that are shipped from the United States, is accompanied by a certified true copy of the United States *Shipper's Export Declaration*, and that Declaration does not contain terms which conflict with those of the billing and is presented to the Canada Border Services Agency. *(All destinations other than the United States)*

Other Military and Strategic Goods and Technology

5501. Blinding Laser Weapons *(All destinations)*

Laser weapons that are specifically designed, as their sole combat function or as one of their combat functions, to cause permanent blindness to the naked eye or to the eye with corrective eyesight devices.

5502. Nuclear Fusion Reactors

1. Subject to sub-item 2., systems, equipment, material, components, software and technology for use in research, development, design, testing, demonstration, or training related to nuclear fusion or the construction and operation of a nuclear fusion reactor, including:
   a. reactor assemblies incorporating toroidal and poloidal field coils;
   b. independent electrical and magnet power supply systems;
   c. high-power microwave radio frequency systems; **and**
   d. feedback, control and data acquisition systems.

(All destinations)

2. This item does not apply to data:
   a. that is contained in published books or periodicals or that is otherwise available to the public; **or**
   b. that has been made available without restrictions on its further dissemination.

5503. Anti-personnel Mines *(All destinations)*

Anti-personnel mines as defined in section 2 of the *Anti-Personnel Mines Convention Implementation Act*.

5504. Strategic Goods and Technology

1. In this item the terms “development”, “production”, “software”, “spacecraft”, “technology” and “use” have the same meaning as in the “Definitions for Terms Used in Groups 1 and 2” of the Guide.
2. Strategic goods and technology as follows:
   a. goods and technology referred to in Group 1 of the Guide as follows:
      i. Global navigation satellite systems receiving equipment referred to in item 1-7.A.5. of the Guide, the associated software referred to in item 1-7.D. of the Guide, and the associated technology referred to in item 1-7.E. of the Guide; **and**
      ii. propulsion and space-related equipment referred to in items 1-9.A.4. to 1-9.A.11. of the Guide, the associated software referred to in item 1-9.D. of the Guide, and the associated technology referred to in item 1-9.E. of the Guide;
   b. subject to the General Software Note in Group 1 of the Guide, software that is specially designed or modified for the development or use of the goods or technology referred to in paragraphs d. to i.;
   c. subject to the General Technology Note in Group 1 of the Guide, technology that is specially designed or modified for the development or production of the goods or technology referred to in paragraphs d. to i.;
   d. payloads specially designed or modified for “spacecraft”, and specially designed components therefor not controlled elsewhere by Group 1 of the Guide;
   e. ground control stations for telemetry, tracking and control of space launch vehicles or “spacecraft”, and specially designed components therefor;
   f. chemiluminescent compounds specially designed or modified for military use, and specially designed components therefor;
   g. radiation-hardened microelectronic circuits that meet or exceed all of the following, and specially designed components therefor, namely:
      i. a total dose of 5×10^5 Rads (SI);
      ii. a dose rate upset of 5×10^8 Rads (SI)/s;
      iii. a neutron dose of 1×10^{14} N/cm^2;
      iv. a single event upset of 1×10^{-7} or less error/bit/day; **and**
      v. single event latch-up free and having a dose rate latch-up of 5×10^8 Rads (SI)/s or greater;

(All destinations other than United States)

   h. nuclear weapons design and test equipment, as follows:
      i. any article, material, equipment or device which is specially designed or modified for use in the design, development or fabrication of nuclear weapons or nuclear explosive devices;

      (All destinations)

      ii. any article, material, equipment or device which is specially designed or modified for use in the devising, carrying out or evaluating of nuclear weapons tests or other nuclear explosions;

      (All destinations)

      and
   i. any other articles not specifically set out in paragraphs a. to h. or in Group 2 or Group 6 that are United States origin goods or technology, which have been determined under Parts 120 to 130 of Title 22 of the International Traffic in Arms Regulations of the Code

of Federal Regulations (United States) as having substantial military applicability, and which have been specially designed or modified for military purposes.

(All destinations other than United States)

5505. Goods and Technology for Certain Uses (Catch-all)

1. Goods and technology whether or not included elsewhere on the List if their properties and any information made known to the exporter by any intermediary or final consignee or from any other source would lead a reasonable person to suspect that they will be used
    a. in the development, production, handling, operation, maintenance, storage, detection, identification or dissemination of
        i. chemical or biological weapons,
        ii. nuclear explosive or radiological dispersal devices, or
        iii. materials or equipment that could be used in such weapons or devices;
    b. in the development, production, handling, operation, maintenance or storage of
        i. missiles or other systems capable of delivering chemical or biological weapons or nuclear explosive or radiological dispersal devices, or
        ii. materials or equipment that could be used in such missiles or systems; or
    c. in any facility used for any of the activities described in paragraphs a. and b.
2. Goods and technology whether or not included elsewhere on the List if the Minister has determined, on the basis of their properties and any additional information relating to such matters as their intended end-use or the identity or conduct of their intermediary or final consignees, that they are likely to be used in the activities or facilities referred to in subitem (1).
3. Subitem (1) applies to goods and technology intended for export to all destinations unless
    a. they are intended for end-use in Argentina, Australia, Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Republic of Korea, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom or the United States;
    b. their intermediary consignees, if any, are located in those countries; and
    c. their final consignee is located in one of those countries.
4. Subitem (2) applies to goods and technology intended for export to all destinations.

GROUP 6 – MISSILE TECHNOLOGY CONTROL REGIME LIST

Note:

Terms in "double quotation marks" are defined terms. Refer to Definitions at the end of Group 6.

GENERAL TECHNOLOGY NOTE:

The transfer of "technology" directly associated with any goods controlled in Group 6 is controlled according to the provisions in each Item to the extent permitted by national legislation. The approval of any Group 6 item for export also authorizes the export to the same end-user of the minimum "technology" required for the installation, operation, maintenance, or repair of the item.

Note:

Controls do not apply to "technology" "in the public domain" or to "basic scientific research".

GENERAL SOFTWARE NOTE:

Group 6 does not control "software" which is either:

1. *Generally available to the public by being:*
   a. *Sold from stock at retail selling points without restriction, by means of:*
      1. *Over-the-counter transactions;*
      2. *Mail order transactions;* ***or***
      3. *Telephone call transactions;* ***and***
   b. *Designed for installation by the user without further substantial support by the supplier;* ***or***
2. *"In the public domain".*

Note:

The General Software Note only applies to general purpose, mass market "software".

CHEMICAL ABSTRACTS SERVICE (CAS) NUMBERS:

In some instances chemicals are listed by name and CAS number. Chemicals of the same structural formula (including hydrates) are controlled regardless of name or CAS number. CAS numbers are shown to assist in identifying whether a particular chemical or mixture is controlled, irrespective of nomenclature. CAS numbers cannot be used as unique identifiers because some forms of the listed chemical have different CAS numbers and mixtures containing a listed chemical may also have different CAS numbers.

CATEGORY I

6-1. COMPLETE DELIVERY SYSTEMS

(All destinations applies to all 6-1 Items)

6-1.A. Equipment, Assemblies and Components

1. Complete rocket systems (including ballistic missile systems, space launch vehicles, and sounding rockets) capable of delivering at least a 500 kg "payload" to a "range" of at least 300 km.
2. Complete unmanned aerial vehicle systems (including cruise missile systems, target drones and reconnaissance drones) capable of delivering at least a 500 kg "payload" to a "range" of at least 300 km.

6-1.B. Test and Production Equipment

1. "Production facilities" specially designed for the systems specified in 6-1.A.

6-1.C. Materials

None

6-1.D. Software

1. "Software" specially designed or modified for the "use" of "production facilities" specified in 6-1.B.

2. "Software" which coordinates the function of more than one subsystem, specially designed or modified for "use" in systems specified in 6-1.A.

6-1.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 6-1.A., 6-1.B., or 6-1.D.

6-2. COMPLETE SUBSYSTEMS USABLE FOR COMPLETE DELIVERY SYSTEMS

(All destinations applies to all 6-2 Items)

6-2.A. Equipment, Assemblies and Components

1. Complete subsystems usable in the systems specified in 6-1.A., as follows:
   a. Individual rocket stages usable in the systems specified in 6-1.A.;
   b. Re-entry vehicles, and equipment designed or modified therefor, usable in the systems specified in 6-1.A., as follows, except as provided in the Note below 6-2.A.1. for those designed for non-weapon payloads:
      1. Heat shields, and components therefor, fabricated of ceramic or ablative materials;
      2. Heat sinks and components therefor fabricated of light-weight, high heat capacity materials;
      3. Electronic equipment specially designed for re-entry vehicles;
   c. Solid propellant rocket motors, hybrid rocket motors or liquid propellant rocket engines, usable in the systems specified in 6-1.A., having a total impulse capacity equal to or greater than 1.1 x 10^6 Ns;

      Note:

      Liquid propellant apogee engines and station-keeping engines specified in 6-2.A.1.c., designed or modified for use on satellites, may be treated as Category II, if the subsystem is exported subject to end-use statements and quantity limits appropriate for the excepted end-use stated above, when having a vacuum thrust not greater than 1kN.
   d. 'Guidance sets', usable in the systems specified in 6-1.A., capable of achieving system accuracy of 3.33% or less of the "range" (e.g., a 'CEP' of 10 km or less at a "range" of 300 km), except as provided in the Note below 6-2.A.1. for those designed for missiles with a "range" under 300 km or manned aircraft;

      Technical Notes:

      1. *A 'guidance set' integrates the process of measuring and computing a vehicle's position and velocity (i.e. navigation) with that of computing and sending commands to the vehicle's flight control systems to correct the trajectory.*
      2. *'CEP' (circle of equal probability) is a measure of accuracy, defined as the radius of the circle centred at the target, at a specific range, in which 50% of the payloads impact.*
   e. Thrust vector control sub-systems, usable in the systems specified in 6-1.A., except as provided in the Note below 6-2.A.1. for those designed for rocket systems that do not exceed the "range"/"payload" capability of systems specified in 6-1.A.;

Technical Note:

6-2.A.1.e. includes the following methods of achieving thrust vector control:

a. Flexible nozzle;

b. Fluid or secondary gas injection;

c. Movable engine or nozzle;

d. Deflection of exhaust gas stream (jet vanes or probes);

e. Use of thrust tabs.

f. Weapon or warhead safing, arming, fuzing, and firing mechanisms, usable in the systems specified in 6-1.A., except as provided in the Note below 6-2.A.1. for those designed for systems other than those specified in 6-1.A.

Note:

The exceptions in 6-2.A.1.b., 6-2.A.1.d., 6-2.A.1.e. and 6-2.A.1.f. above may be treated as Category II if the subsystem is exported subject to end-use statements and quantity limits appropriate for the excepted end-use stated above.

6-2.B. Test and Production Equipment

1. “Production facilities” specially designed for the subsystems specified in 6-2.A.
2. “Production equipment” specially designed for the subsystems specified in 6-2.A.

6-2.C. Materials

None

6-2.D. Software

1. “Software” specially designed or modified for the “use” of “production facilities” specified in 6-2.B.1.
2. “Software” specially designed or modified for the “use” of rocket motors or engines specified in 6-2.A.1.c.
3. “Software”, specially designed or modified for the “use” of ‘guidance sets’ specified in 6-2.A.1.d.

   Note:

   6-2.D.3. includes “software”, specially designed or modified to enhance the performance of ′guidance sets′ to achieve or exceed the accuracy specified in 6-2.A.1.d.

4. “Software” specially designed or modified for the “use” of subsystems or equipment specified in 6-2.A.1.b.3.
5. “Software” specially designed or modified for the “use” of systems in 6-2.A.1.e.
6. “Software” specially designed or modified for the “use” of systems in 6-2.A.1.f.

   Note:

   Subject to end-use statements appropriate for the excepted end-use, “software” controlled by 6-2.D.2. to 6-2.D.6. may be treated as Category II as follows:

   1. Under 6-2.D.2. if specially designed or modified for liquid propellant apogee engines, designed or modified for satellite applications as specified in the Note to 6-2.A.1.c.;

2. *Under 6-2.D.3. if designed for missiles with a "range" of under 300 km or manned aircraft;*
3. *Under 6-2.D.4. if specially designed or modified for re-entry vehicles designed for non-weapon payloads;*
4. *Under 6-2.D.5. if designed for rocket systems that do not exceed the "range" "payload" capability of systems specified in 6-1.A.;*
5. *Under 6-2.D.6. if designed for systems other than those specified in 6-1.A.*

6-2.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 6-2.A., 6-2.B. or 6-2.D.

CATEGORY II

6-3. PROPULSION COMPONENTS AND EQUIPMENT

6-3.A. Equipment, Assemblies and Components

1. Turbojet and turbofan engines, as follows:
   a. Engines having both of the following characteristics:
      1. Maximum thrust value greater than 400 N (achieved un-installed) excluding civil certified engines with a maximum thrust value greater than 8.89 kN (achieved un-installed); **and**
      2. Specific fuel consumption of 0.15 kg N^{-1} h^{-1} or less (at maximum continuous power at sea level static and standard conditions);
   b. Engines designed or modified for systems specified in 6-1.A. or 6-19.A.2., regardless of thrust or specific fuel consumption.

   Note:

   Governments may permit the export of engines specified in 6-3.A.1. as part of a manned aircraft or in quantities appropriate for replacement parts for a manned aircraft.
2. Ramjet/scramjet/pulse jet/combined cycle engines, including devices to regulate combustion, and specially designed components therefor, usable in the systems specified in 6-1.A. or 6-19.A.2.

   Technical Note:

   In Item 6-3.A.2., 'combined cycle engines' are the engines that employ two or more cycles of the following types of engines: gas-turbine engine (turbojet, turboprop, turbofan and turboshaft), ramjet, scramjet, pulse jet, pulse detonation engine, rocket motor (liquid/solid-propellant and hybrid).
3. Rocket motor cases, 'insulation' components and nozzles therefor, usable in the systems specified in 6-1.A. or 6-19.A.1.

   Technical Note:

   In 6-3.A.3. 'insulation' intended to be applied to the components of a rocket motor, i.e. the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber components comprising sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps.

Note:

Refer to 6-3.C.2. for 'insulation' material in bulk or sheet form.

4. Staging mechanisms, separation mechanisms, and interstages therefor, usable in the systems specified in 6-1.A.
5. Liquid and slurry propellant (including oxidisers) control systems, and specially designed components therefor, usable in the systems specified in 6-1.A., designed or modified to operate in vibration environments greater than 10 g rms between 20 Hz and 2 kHz.

   Notes:

   1. *The only servo valves and pumps specified in 6-3.A.5. are the following:*
      a. *Servo valves designed for flow rates equal to or greater than 24 litres per minute, at an absolute pressure equal to or greater than 7 MPa, that have an actuator response time of less than 100 ms;*
      b. *Pumps, for liquid propellants, with shaft speeds equal to or greater than 8,000 rpm or with discharge pressures equal to or greater than 7 MPa.*
   2. *Governments may permit the export of systems and components specified in 6-3.A.5. as part of a satellite.*
6. Specially designed components for hybrid rocket motors specified in 6-2.A.1.c. and 6-20.A.1.b.
7. Radial ball bearings having all tolerances specified in accordance with ISO 492 Tolerance Class 2 (or ANSI/ABMA Std 20 Tolerance Class ABEC-9 or other national equivalents), or better and having all the following characteristics:
   a. An inner ring bore diameter between 12 and 50 mm;
   b. An outer ring outside diameter between 25 and 100 mm; **and**
   c. A width between 10 and 20 mm.
8. Liquid propellant tanks specially designed for the propellants controlled in Item 6-4.C. or other liquid propellants used in the systems specified in 6-1.A.1.
9. 'Turboprop engine systems' specially designed for the systems in 6-1.A.2. or 6-19.A.2., and specially designed components therefor, having a maximum power greater than 10 kW (achieved uninstalled at sea level standard conditions), excluding civil certified engines.

   Technical Note:

   For the purposes of Item 6-3.A.9., a 'turboprop engine system' incorporates all of the following:

   a. *Turboshaft engine; and*
   b. *Power transmission system to transfer the power to a propeller.*

6-3.B. Test and Production Equipment

1. "Production facilities" specially designed for equipment or materials specified in 6-3.A.1., 6-3.A.2., 6-3.A.3., 6-3.A.4., 6-3.A.5., 6-3.A.6., 6-3.A.8., 6-3.A.9. or 6-3.C.
2. "Production equipment" specially designed for equipment or materials specified in 6-3.A.1., 6-3.A.2., 6-3.A.3., 6-3.A.4., 6-3.A.5., 6-3.A.6. 6-3.A.8., 6-3.A.9. or 6-3.C.

3. Flow-forming machines, and specially designed components therefor, which:
   a. According to the manufacturers technical specification can be equipped with numerical control units or a computer control, even when not equipped with such units at delivery; **and**
   b. Have more than two axes which can be co-ordinated simultaneously for contouring control.

   Note:

   This item does not include machines that are not usable in the "production" of propulsion components and equipment (e.g. motor cases) for systems specified in 6-1.A.

   Technical Note:

   Machines combining the function of spin-forming and flow-forming are, for the purpose of this item, regarded as flow-forming machines.

6-3.C. Materials

1. 'Interior lining' usable for rocket motor cases in the systems specified in 6-1.A. or specially designed for systems specified in 6-19.A.1. or 6-19.A.2.

   Technical Note:

   In 6-3.C.1. 'interior lining' suited for the bond interface between the solid propellant and the case or insulating liner is usually a liquid polymer based dispersion of refractory or insulating materials e.g. carbon filled HTPB or other polymer with added curing agents to be sprayed or screeded over a case interior.

2. 'Insulation' material in bulk form usable for rocket motor cases in the systems specified in 6-1.A. or specially designed for systems specified in 6-19.A.1. or 6-19.A.2.

   Technical Note:

   In 6-3.C.2. 'insulation' intended to be applied to the components of a rocket motor, i.e. the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps specified in 6-3.A.3.

6-3.D. Software

1. "Software" specially designed or modified for the "use" of "production facilities" and flow forming machines specified in 6-3.B.1. or 6-3.B.3.
2. "Software" specially designed or modified for the "use" of equipment specified in 6-3.A.1., 6-3.A.2., 6-3.A.4., 6-3.A.5., 6-3.A.6. or 6-3.A.9.

   Notes:

   1. *Governments may permit the export of "software" specially designed or modified for the "use" of engines specified in 6-3.A.1. as part of a manned aircraft or as replacement "software" therefor.*
   2. *Governments may permit the export of "software" specially designed or modified for the "use" of propellant control systems specified in 6-3.A.5. as part of a satellite or as replacement "software" therefor.*

3. "Software" specially designed or modified for the "development" of equipment specified in 6-3.A.2., 6-3.A.3. or 6-3.A.4.

6-3.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment, materials or "software" specified in 6-3.A.1., 6-3.A.2., 6-3.A.3., 6-3.A.4., 6-3.A.5., 6-3.A.6., 6-3.A.9., 6-3.B., 6-3.C. or 6-3.D.

6-4. PROPELLANTS, CHEMICALS AND PROPELLANT PRODUCTION

6-4.A. Equipment, Assemblies and Components

None

6-4.B. Test and Production Equipment

1. "Production equipment", and specially designed components therefor, for the "production", handling or acceptance testing of liquid propellants or propellant constituents specified in 6-4.C.
2. "Production equipment", other than that described in 6-4.B.3., and specially designed components therefor, for the production, handling, mixing, curing, casting, pressing, machining, extruding or acceptance testing of solid propellants or propellant constituents specified in 6-4.C.
3. Equipment as follows and specially designed components therefor:
   a. Batch mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber and having all of the following:
      1. A total volumetric capacity of 110 litres or more; **and**
      2. At least one mixing/kneading shaft mounted off centre;
   b. Continuous mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with a temperature control capability of the mixing chamber having any of the following:
      1. Two or more mixing/kneading shafts; **or**
      2. A single rotating shaft which oscillates and having kneading teeth/pins on the shaft as well as inside the casing of the mixing chamber;
   c. Fluid energy mills usable for grinding or milling substances specified in 6-4.C.;
   d. Metal powder "production equipment" usable for the "production", in a controlled environment, of spherical or atomised materials specified in 6-4.C.2.c., 6-4.C.2.d. or 6-4.C.2.e.

      Note:

      6-4.B.3.d. includes:

      a. Plasma generators (high frequency arc-jet) usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;

      b. Electroburst equipment usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;

      c. Equipment usable for the "production" of spherical aluminium powders by powdering a melt in an inert medium (e.g. nitrogen).

Notes:

1. *The only batch mixers, continuous mixers, usable for solid propellants or propellants constituents specified in 6-4.C., and fluid energy mills specified in 6-4.B., are those specified in 6-4.B.3.*
2. *Forms of metal powder "production equipment" not specified in 6-4.B.3.d. are to be evaluated in accordance with 6-4.B.2.*

6-4.C. Materials

6-4.C.1. Composite and composite modified double base propellants.

6-4.C.2. Fuel substances as follows:

a. Hydrazine (CAS 302-01-2) with a concentration of more than 70%;

b. Hydrazine derivatives as follows:

1. Monomethylhydrazine (MMH) (CAS 60-34-4);
2. Unsymmetrical dimethylhydrazine (UDMH) (CAS 57-14-7);
3. Hydrazine mononitrate;
4. Trimethylhydrazine (CAS 1741-01-1);
5. Tetramethylhydrazine (CAS 6415-12-9);
6. N,N diallylhydrazine;
7. Allylhydrazine (CAS 7422-78-8);
8. Ethylene dihydrazine;
9. Monomethylhydrazine dinitrate;
10. Unsymmetrical dimethylhydrazine nitrate;
11. Hydrazinium azide (CAS 14546-44-2);
12. Dimethylhydrazinium azide;
13. Hydrazinium dinitrate;
14. Diimido oxalic acid dihydrazine (CAS 3457-37-2);
15. 2-hydroxyethylhydrazine nitrate (HEHN);
16. Hydrazinium perchlorate (CAS 27978-54-7);
17. Hydrazinium diperchlorate (CAS 13812-39-0);
18. Methylhydrazine nitrate (MHN);
19. Diethylhydrazine nitrate (DEHN);
20. 3,6-dihydrazino tetrazine nitrate (DHTN);

Technical Note:

3,6-dihydrazino tetrazine nitrate is also referred to as 1,4-dihydrazine nitrate.

c. Spherical aluminium powder (CAS 7429-90-5) with particles of uniform diameter of less than 200 x 10^{-6} m (200 µm) and an aluminium content of 97% by weight or more, if at least 10% of the total weight is made up of particles of less than 63 µm, according to ISO 2591:1988 or national equivalents such as JIS Z8820;

Technical Note:

A particle size of 63 µm (ISO R-565) corresponds to 250 mesh (Tyler) or 230 mesh (ASTM standard E-11).

d. Zirconium (CAS 7440-67-7), beryllium (CAS 7440-41-7), magnesium (CAS 7439-95-4) and alloys of these in particle size less than 60×10^{-6} m (60 µm), whether spherical, atomised, spheroidal, flaked or ground, consisting of 97% by weight or more of any of the above mentioned metals;

Technical Note:

The natural content of hafnium (CAS 7440-58-6) in the zirconium (typically 2% to 7%) is counted with the zirconium.

e. Boron (CAS 7440-42-8) and boron alloys in particle size less than 60×10^{-6} m (60 µm), whether spherical, atomised, spheroidal, flaked or ground with a purity of 85% by weight or more;

f. High energy density materials, usable in the systems specified in 6-1.A. or 6-19.A., as follows:

1. Mixed fuels that incorporate both solid and liquid fuels, such as boron slurry, having a mass-based energy density of 40×10^6 J/kg or greater;
2. Other high energy density fuels and fuel additives (e.g., cubane, ionic solutions, JP-10) having a volume-based energy density of 37.5×10^9 J/m^3 or greater, measured at 20° C and one atmosphere (101.325 kPa) pressure.

Note:

Item 6-4.C.2.f.2. does not control fossil refined fuels and biofuels produced from vegetables, including fuels for engines certified for use in civil aviation, unless specifically formulated for systems specified in 6-1.A. or 6-19.A.

6-4.C.3. Oxidisers/Fuels as follows:

Perchlorates, chlorates or chromates mixed with powdered metals or other high energy fuel components.

6-4.C.4. Oxidiser substances as follows:

a. Oxidiser substances usable in liquid propellant rocket engines as follows:

1. Dinitrogen trioxide (CAS 10544-73-7);
2. Nitrogen dioxide (CAS 10102-44-0)/dinitrogen tetroxide (CAS 10544-72-6);
3. Dinitrogen pentoxide (CAS 10102-03-1);
4. Mixed Oxides of Nitrogen (MON);
5. Inhibited Red Fuming Nitric Acid (IRFNA) (CAS 8007-58-7);
6. Compounds composed of fluorine and one or more of other halogens, oxygen or nitrogen;

Note:

Item 6-4.C.4.a.6. does not control Nitrogen Trifluoride (NF_3) (CAS 7783-54-2) in a gaseous state as it is not usable for missile applications.

Technical Note:

Mixed Oxides of Nitrogen (MON) are solutions of Nitric Oxide (NO) in Dinitrogen Tetroxide/Nitrogen Dioxide (N_2O_4/NO_2) that can be used in missile systems. There are a range of compositions that can be denoted as MONi or

MONij where i and j are integers representing the percentage of Nitric Oxide in the mixture (e.g. MON3 contains 3% Nitric Oxide, MON25 25% Nitric Oxide. An upper limit is MON40, 40% by weight).

b. Oxidiser substances usable in solid propellant rocket motors as follows:

1. Ammonium perchlorate (AP) (CAS 7790-98-9);
2. Ammonium dinitramide (ADN) (CAS 140456-78-6);
3. Nitro-amines (cyclotetramethylene - tetranitramine (HMX) (CAS 2691-41-0); cyclotrimethylene - trinitramine (RDX) (CAS 121-82-4));
4. Hydrazinium nitroformate (HNF) (CAS 20773-28-8).
5. 2,4,6,8,10,12-Hexanitrohexaazaisowurtzitane (CL-20) (CAS 135285-90-4).

6-4.C.5. Polymeric substances, as follows:

a. Carboxy - terminated polybutadiene (including carboxyl - terminated polybutadiene) (CTPB);

b. Hydroxy - terminated polybutadiene (including hydroxyl - terminated polybutadiene) (HTPB);

c. Glycidyl azide polymer (GAP);

d. Polybutadiene - Acrylic Acid (PBAA);

e. Polybutadiene - Acrylic Acid - Acrylonitrile (PBAN);

f. Polytetrahydrofuran polyethylene glycol (TPEG).

Technical Note:

Polytetrahydrofuran polyethylene glycol (TPEG) is a block co-polymer of poly 1,4-Butanediol and polyethylene glycol (PEG).

6-4.C.6. Other propellant additives and agents as follows:

a. Bonding agents as follows:

1. Tris (1-(2-methyl)aziridinyl) phosphine oxide (MAPO) (CAS 57-39-6);
2. 1,1’,1”-trimesoyl-tris(2-ethylaziridine) (HX-868, BITA) (CAS 7722-73-8);
3. Tepanol (HX-878), reaction product of tetraethlylene-pentamine, acrylonitrile and glycidol (CAS 68412-46-4);
4. Tepan (HX-879), reaction product of tetraethlylene-pentamine and acrylonitrile (CAS 68412-45-3);
5. Polyfunctional aziridine amides with isophthalic, trimesic, isocyanuric, or trimethyladipic backbone also having a 2-methyl or 2-ethyl aziridine group;

Note:

Item 6-4.C.6.a.5. includes:

1. *1,1’-Isophthaloyl-bis(2-methylaziridine) (HX-752) (CAS 7652-64-4);*
2. *2,4,6-tris(2-ethyl-1-aziridinyl)-1,3,5-triazine (HX-874) (CAS 18924-91-9);*
3. *1,1’-trimethyladipoylbis(2-ethylaziridine) (HX-877) (CAS 71463-62-2).*

b. Curing reaction catalysts as follows:

Triphenyl bismuth (TPB) (CAS 603-33-8);

c. Burning rate modifiers as follows:

1. Carboranes, decaboranes, pentaboranes and derivatives thereof;
2. Ferrocene derivatives, as follows:
   a. Catocene (CAS 37206-42-1);
   b. Ethyl ferrocene (CAS 1273-89-8);
   c. Propyl ferrocene;
   d. n-Butyl ferrocene (CAS 31904-29-7);
   e. Pentyl ferrocene (CAS 1274-00-6);
   f. Dicyclopentyl ferrocene;
   g. Dicyclohexyl ferrocene;
   h. Diethyl ferrocene (CAS 1273-97-8);
   i. Dipropyl ferrocene;
   j. Dibutyl ferrocene (CAS 1274-08-4);
   k. Dihexyl ferrocene (CAS 93894-59-8);
   l. Acetyl ferrocene (CAS 1271-55-2) / 1,1'-diacetyl ferrocene (CAS 1273-94-5);
   m. Ferrocene carboxylic acid (CAS 1271-42-7) / 1,1'-Ferrocenedicarboxylic acid (CAS 1293-87-4);
   n. Butacene (CAS 125856-62-4);
   o. Other ferrocene derivatives usable as rocket propellant burning rate modifiers;

   Note:

   Item 6-4.C.6.c.2.o does not control ferrocene derivatives that contain a six carbon aromatic functional group attached to the ferrocene molecule.

d. Esters and plasticisers as follows:

1. Triethylene glycol dinitrate (TEGDN) (CAS 111-22-8);
2. Trimethylolethane trinitrate (TMETN) (CAS 3032-55-1);
3. 1,2,4-butanetriol trinitrate (BTTN) (CAS 6659-60-5);
4. Diethylene glycol dinitrate (DEGDN) (CAS 693-21-0);
5. 4,5 diazidomethyl-2-methyl-1,2,3-triazole (iso- DAMTR);
6. Nitratoethylnitramine (NENA) based plasticisers, as follows:
   a. Methyl-NENA (CAS 17096-47-8);
   b. Ethyl-NENA (CAS 85068-73-1);
   c. Butyl-NENA (CAS 82486-82-6);
7. Dinitropropyl based plasticisers, as follows:
   a. Bis (2,2-dinitropropyl) acetal (BDNPA) (CAS 5108-69-0);
   b. Bis (2,2-dinitropropyl) formal (BDNPF) (CAS 5917-61-3);

e. Stabilisers as follows:

1. 2-Nitrodiphenylamine (CAS 119-75-5);

2. N-methyl-p-nitroaniline (CAS 100-15-2).

6-4.D. Software

1. "Software" specially designed or modified for the "use" of equipment specified in 6-4.B. for the "production" and handling of materials specified in 6-4.C.

6-4.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or materials specified in 6-4.B. and 6-4.C.

6-5. RESERVED FOR FUTURE USE

6-6. PRODUCTION OF STRUCTURAL COMPOSITES, PYROLYTIC DEPOSITION AND DENSIFICATION, AND STRUCTURAL MATERIALS

6-6.A. Equipment, Assemblies and Components

1. Composite structures, laminates, and manufactures thereof, specially designed for use in the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. and the subsystems specified in 6-2.A. or 6-20.A.
2. Resaturated pyrolised (i.e. carbon-carbon) components having all of the following:

   a. Designed for rocket systems; **and**

   b. Usable in the systems specified in 6-1.A. or 6-19.A.1.

6-6.B. Test and Production Equipment

1. Equipment for the "production" of structural composites, fibres, prepregs or preforms, usable in the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. as follows, and specially designed components, and accessories therefor:
   a. Filament winding machines or fibre placement machines, of which the motions for positioning, wrapping and winding fibres can be co-ordinated and programmed in three or more axes, designed to fabricate composite structures or laminates from fibrous or filamentary materials, and co-ordinating and programming controls;
   b. Tape-laying machines of which the motions for positioning and laying tape and sheets can be co-ordinated and programmed in two or more axes, designed for the manufacture of composite airframes and missile structures;
   c. Multi-directional, multi-dimensional weaving machines or interlacing machines, including adapters and modification kits for weaving, interlacing or braiding fibres to manufacture composite structures;

      Note:

      6-6.B.1.c. does not control textile machinery not modified for the end-uses stated.
   d. Equipment designed or modified for the production of fibrous or filamentary materials as follows:

1. Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon, or polycarbosilane) including special provision to strain the fibre during heating;
2. Equipment for the vapour deposition of elements or compounds on heated filament substrates;
3. Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);

e. Equipment designed or modified for special fibre surface treatment or for producing prepregs and preforms, including rollers, tension stretchers, coating equipment, cutting equipment and clicker dies.

Note:

Examples of components and accessories for the machines specified in 6-6.B.1. are moulds, mandrels, dies, fixtures and tooling for the preform pressing, curing, casting, sintering or bonding of composite structures, laminates and manufactures thereof.

2. Nozzles specially designed for the processes referred to in 6-6.E.3.
3. Isostatic presses having all of the following characteristics:
   a. Maximum working pressure equal to or greater than 69 MPa;
   b. Designed to achieve and maintain a controlled thermal environment of 600° C or greater; **and**
   c. Possessing a chamber cavity with an inside diameter of 254 mm or greater.
4. Chemical vapour deposition furnaces designed or modified for the densification of carbon-carbon composites.
5. Equipment and process controls, other than those specified in 6-6.B.3. or 6-6.B.4., designed or modified for densification and pyrolysis of structural composite rocket nozzles and re-entry vehicle nose tips.

6-6.C. Materials

1. Resin impregnated fibre prepregs and metal coated fibre preforms, for the goods specified in 6-6.A.1., made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a specific tensile strength greater than 7.62×10^4 m and a specific modulus greater than 3.18×10^6 m.

Note:

The only resin impregnated fibre prepregs specified in 6-6.C.1. are those using resins with a glass transition temperature (Tg), after cure, exceeding 145° C as determined by ASTM D4065 or national equivalents.

Technical Notes:

1. *In Item 6-6.C.1. 'specific tensile strength' is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3, measured at a temperature of (296 ± 2)K ((23 ± 2)° C) and a relative humidity of (50 ± 5)%.*
2. *In Item 6-6.C.1. 'specific modulus' is the Young's modulus in N/m^2 divided by the specific weight in N/m^3, measured at a temperature of (296 ± 2)K ((23 ± 2)° C) and a relative humidity of (50 ± 5)%.*

2. Resaturated pyrolised (i.e. carbon-carbon) materials having all of the following:

a. Designed for rocket systems; **and**

b. Usable in the systems specified in 6-1.A. or 6-19.A.1.

3. Fine grain graphites with a bulk density of at least 1.72 g/cc measured at 15º C and having a grain size of 100 x 10^{-6} m (100 µm) or less, usable for rocket nozzles and re-entry vehicle nose tips, which can be machined to any of the following products:
   a. Cylinders having a diameter of 120 mm or greater and a length of 50 mm or greater;
   b. Tubes having an inner diameter of 65 mm or greater and a wall thickness of 25 mm or greater and a length of 50 mm or greater; **or**
   c. Blocks having a size of 120 mm x 120 mm x 50 mm or greater.
4. Pyrolytic or fibrous reinforced graphites usable for rocket nozzles and re-entry vehicle nose tips usable in systems specified in 6-1.A. or 6-19.A.1.
5. Ceramic composite materials (dielectric constant less than 6 at any frequency from 100 MHz to 100 GHz) for use in missile radomes usable in systems specified in 6-1.A. or 6-19.A.1.
6. Silicon-carbide materials as follows:
   a. Bulk machinable silicon-carbide reinforced unfired ceramic usable for nose tips usable in systems specified in 6-1.A. or 6-19.A.1.;
   b. Reinforced silicon-carbide ceramic composites usable for nose tips, re-entry vehicles, nozzle flaps, usable in systems specified in 6-1.A. or 6-19.A.1.
7. Materials for the fabrication of missile components in the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2, as follows:
   a. Tungsten and alloys in particulate form with a tungsten content of 97% by weight or more and a particle size of 50 x10^{-6} m (50 µm) or less;
   b. Molybdenum and alloys in particulate form with a molybdenum content of 97% by weight or more and a particle size of 50 x10^{-6} m (50 µm) or less;
   c. Tungsten materials in the solid form having all of the following:
      1. Any of the following material compositions:
         a. Tungsten and alloys containing 97% by weight or more of tungsten;
         b. Copper infiltrated tungsten containing 80% by weight or more of tungsten; **or**
         c. Silver infiltrated tungsten containing 80% by weight or more of tungsten; **and**
      2. Able to be machined to any of the following products:
         a. Cylinders having a diameter of 120 mm or greater and a length of 50 mm or greater;
         b. Tubes having an inner diameter of 65 mm or greater and a wall thickness of 25 mm or greater and a length of 50 mm or greater; **or**
         c. Blocks having a size of 120 mm x 120 mm x 50 mm or greater.
8. Maraging steels having an ultimate tensile strength equal to or greater than 1.5 GPa, measured at 20° C, in the form of sheet, plate or tubing with a wall

or plate thickness equal to or less than 5.0 mm usable in systems specified in 6-1.A. or 6-19.A.1.

Technical Note:

Maraging steels are iron alloys generally characterised by high nickel, very low carbon content and use substitutional elements or precipitates to produce strengthening and age-hardening of the alloy.

9. Titanium-stabilized duplex stainless steel (Ti-DSS) usable in the systems specified in 6-1.A. or 6-19.A.1. and having all of the following:
   a. Having all of the following characteristics:
      1. Containing 17.0 - 23.0 weight percent chromium and 4.5 - 7.0 weight percent nickel;
      2. Having a titanium content of greater than 0.10 weight percent; **and**
      3. A ferritic-austenitic microstructure (also referred to as a two-phase microstructure) of which at least 10% is austenite by volume (according to ASTM E-1181-87 or national equivalents); **and**
   b. Any of the following forms:
      1. Ingots or bars having a size of 100 mm or more in each dimension;
      2. Sheets having a width of 600 mm or more and a thickness of 3 mm or less; **or**
      3. Tubes having an outer diameter of 600 mm or more and a wall thickness of 3 mm or less.

6-6.D. Software

1. "Software" specially designed or modified for the "use" of equipment specified in 6-6.B.1.
2. "Software" specially designed or modified for the equipment specified in 6-6.B.3., 6-6.B.4. or 6-6.B.5.

6-6.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment, materials or "software" specified in 6-6.A., 6-6.B., 6-6.C. or 6-6.D.
2. "Technical data" (including processing conditions) and procedures for the regulation of temperature, pressures or atmosphere in autoclaves or hydroclaves when used for the production of composites or partially processed composites, usable for equipment or materials specified in 6-6.A. or 6-6.C.
3. "Technology" for producing pyrolytically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1,300° C to 2,900° C temperature range at pressures of 130 Pa (1 mm Hg) to 20 kPa (150 mm Hg) including "technology" for the composition of precursor gases, flow-rates, and process control schedules and parameters.

<u>6-7. RESERVED FOR FUTURE USE</u>

<u>6-8. RESERVED FOR FUTURE USE</u>

6-9. INSTRUMENTATION, NAVIGATION AND DIRECTION FINDING

6-9.A. Equipment, Assemblies and Components

1. Integrated flight instrument systems which include gyrostabilisers or automatic pilots, designed or modified for use in the systems specified in 6-1.A., or 6-19.A.1. or 6-19.A.2. and specially designed components therefor.
2. Gyro-astro compasses and other devices which derive position or orientation by means of automatically tracking celestial bodies or satellites, and specially designed components therefor.
3. Linear accelerometers, designed for use in inertial navigation systems or in guidance systems of all types, usable in the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2., having all of the following characteristics, and specially designed components therefor:
   a. ‘Scale factor’ ‘repeatability’ less (better) than 1250 ppm; **and**
   b. ‘Bias’ ‘repeatability’ less (better) than 1250 micro g.

   Note:

   Item 6-9.A.3. does not control accelerometers specially designed and developed as Measurement While Drilling (MWD) sensors for use in downhole well service operations.

   Technical Notes:

   1. ‘Bias’ is defined as the accelerometer output when no acceleration is applied.

   2. ‘Scale factor’ is defined as the ratio of change in output to a change in the input.

   3. The measurement of ‘bias’ and ‘scale factor’ refers to one sigma standard deviation with respect to a fixed calibration over a period of one year.

   4. ‘Repeatability’ is defined according to IEEE Standard 528-2001 as follows:

   ‘‘The closeness of agreement among repeated measurements of the same variable under the same operating conditions when changes in conditions or non-operating periods occur between measurements.”
4. All types of gyros usable in the systems specified in 6-1.A., 6-19.A.1 or 6-19.A.2., with a rated ‘drift rate’ ‘stability’ of less than 0.5 degrees (1 sigma or rms) per hour in a 1 g environment, and specially designed components therefor.

   Technical Notes:

   1. ‘Drift rate’ is defined as the component of gyro output that is functionally independent of input rotation and is expressed as an angular rate. (IEEE STD 528-2001 paragraph 2.56)

   2. ‘Stability’ is defined as a measure of the ability of a specific mechanism or performance coefficient to remain invariant when continuously exposed to a fixed operating condition. (This definition does not refer to dynamic or servo stability.) (IEEE STD 528-2001 paragraph 2.247)
5. Accelerometers or gyros of any type, designed for use in inertial navigation systems or in guidance systems of all types, specified to function at acceleration levels greater than 100 g, and specially designed components therefor.

Note:

6-9.A.5. does not include accelerometers that are designed to measure vibration or shock.

6. Inertial or other equipment using accelerometers specified in 6-9.A.3. or 6-9.A.5. or gyros specified in 6-9.A.4. or 6-9.A.5., and systems incorporating such equipment, and specially designed components therefor.
7. 'Integrated navigation systems', designed or modified for the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. and capable of providing a navigational accuracy of 200 m CEP or less.

Technical Note:

An 'integrated navigation system' typically incorporates all of the following components:

a. An inertial measurement device (e.g. an attitude and heading reference system, inertial reference unit, or inertial navigation system);

b. One or more external sensors used to update the position and/or velocity, either periodically or continuously throughout the flight (e.g. satellite navigation receiver, radar altimeter, and/or Doppler radar); ***and***

c. Integration hardware and software.

N.B. :

For integration "software", see Item 6-9.D.4.

8. Three axis magnetic heading sensors having all of the following characteristics, and specially designed components therefor:
   a. Internal tilt compensation in pitch (+/-90 degrees) and roll (+/-180 degrees) axes;
   b. Capable of providing azimuthal accuracy better (less) than 0.5 degrees rms at latitudes of +/-80 degrees, referenced to local magnetic field; **and**
   c. Designed or modified to be integrated with flight control and navigation systems.

Note:

Flight control and navigation systems in Item 6-9.A.8. include gyrostabilisers, automatic pilots and inertial navigation systems.

6-9.B. Test and Production Equipment

1. "Production equipment", and other test, calibration and alignment equipment, other than that described in 6-9.B.2., designed or modified to be used with equipment specified in 6-9.A.

Note:

Equipment specified in 6-9.B.1. includes the following:

a. For laser gyro equipment, the following equipment used to characterise mirrors, having the threshold accuracy shown or better:

1. Scatterometer (10 ppm);

2. Reflectometer (50 ppm);

3. Profilometer (5 Angstroms);

b. For other inertial equipment:

1. Inertial Measurement Unit (IMU) Module Tester;

2. *IMU Platform Tester;*
3. *IMU Stable Element Handling Fixture;*
4. *IMU Platform Balance Fixture;*
5. *Gyro Tuning Test Station;*
6. *Gyro Dynamic Balance Station;*
7. *Gyro Run-In/Motor Test Station;*
8. *Gyro Evacuation and Filling Station;*
9. *Centrifuge Fixture for Gyro Bearings;*
10. *Accelerometer Axis Align Station;*
11. *Accelerometer Test Station.*

2. Equipment as follows:
   a. Balancing machines having all the following characteristics:
      1. Not capable of balancing rotors/assemblies having a mass greater than 3 kg;
      2. Capable of balancing rotors/assemblies at speeds greater than 12,500 rpm;
      3. Capable of correcting unbalance in two planes or more; **and**
      4. Capable of balancing to a residual specific unbalance of 0.2 g mm per kg of rotor mass;
   b. Indicator heads (sometimes known as balancing instrumentation) designed or modified for use with machines specified in 6-9.B.2.a.;
   c. Motion simulators/rate tables (equipment capable of simulating motion) having all of the following characteristics:
      1. Two axes or more;
      2. Designed or modified to incorporate sliprings or integrated non-contact devices capable of transferring electrical power, signal information, or both; **and**
      3. Having any of the following characteristics:
         a. For any single axis having all of the following:
            1. Capable of rates of 400 degrees/s or more, or 30 degrees/s or less; **and**
            2. A rate resolution equal to or less than 6 degrees/s and an accuracy equal to or less than 0.6 degrees/s;
         b. Having a worst-case rate stability equal to or better (less) than plus or minus 0.05% averaged over 10 degrees or more; **or**
         c. A positioning “accuracy” equal to or less (better) than 5 arc second;
   d. Positioning tables (equipment capable of precise rotary positioning in any axes) having the following characteristics:
      1. Two axes or more; **and**
      2. A positioning “accuracy” equal to or less (better) than 5 arc second;
   e. Centrifuges capable of imparting accelerations above 100 g and designed or modified to incorporate sliprings or integrated non-contact

devices capable of transferring electrical power, signal information, or both.

Notes:

1. *The only balancing machines, indicator heads, motion simulators, rate tables, positioning tables and centrifuges specified in Item 6-9. are those specified in 6-9.B.2.*
2. *6-9.B.2.a. does not control balancing machines designed or modified for dental or other medical equipment.*
3. *6-9.B.2.c. and 6-9.B.2.d. do not control rotary tables designed or modified for machine tools or for medical equipment.*
4. *Rate tables not controlled by 6-9.B.2.c. and providing the characteristics of a positioning table are to be evaluated according to 6-9.B.2.d.*
5. *Equipment that has the characteristics specified in 6-9.B.2.d. which also meets the characteristics of 6-9.B.2.c. will be treated as equipment specified in 6-9.B.2.c.*
6. *Item 6-9.B.2.c. applies whether or not sliprings or integrated non-contact devices are fitted at the time of export.*
7. *Item 6-9.B.2.e. applies whether or not sliprings or integrated non-contact devices are fitted at the time of export.*

6-9.C. Materials

None

6-9.D. Software

1. “Software” specially designed or modified for the “use” of equipment specified in 6-9.A. or 6-9.B.
2. Integration “software” for the equipment specified in 6-9.A.1.
3. Integration “software” specially designed for the equipment specified in 6-9.A.6.
4. Integration “software”, designed or modified for the ‘integrated navigation systems’ specified in 6-9.A.7.

Note:

A common form of integration “software” employs Kalman filtering.

6-9.E. Technology

1. “Technology”, in accordance with the General Technology Note, for the “development”, “production” or “use” of equipment or “software” specified in 6-9.A., 6-9.B. or 6-9.D.

Note:

Governments may permit the export of equipment or “software” specified in 6-9.A. or 6-9.D. as part of a manned aircraft, satellite, land vehicle, marine/submarine vessel or geophysical survey equipment or in quantities appropriate for replacement parts for such applications.

6-10. FLIGHT CONTROL

6-10.A. Equipment, Assemblies and Components

1. Hydraulic, mechanical, electro-optical, or electromechanical flight control systems (including fly-by-wire systems) designed or modified for the systems specified in 6-1.A.
2. Attitude control equipment designed or modified for the systems specified in 6-1.A.
3. Flight control servo valves designed or modified for the systems in 6-10.A.1. or 6-10.A.2., and designed or modified to operate in a vibration environment greater than 10 g rms between 20 Hz and 2 kHz.

Note:

Governments may permit the export of systems, equipment or valves specified in 6-10.A. as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.

6-10.B. Test and Production Equipment

1. Test, calibration, and alignment equipment specially designed for equipment specified in 6-10.A.

6-10.C. Materials

None

6-10.D. Software

1. "Software" specially designed or modified for the "use" of equipment specified in 6-10.A. or 6-10.B.

Note:

Governments may permit the export of "software" specified in 6-10.D.1. as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.

6-10.E. Technology

1. Design "technology" for integration of air vehicle fuselage, propulsion system and lifting control surfaces, designed or modified for the systems specified in 6-1.A. or 6-19.A.2., to optimise aerodynamic performance throughout the flight regime of an unmanned aerial vehicle.
2. Design "technology" for integration of the flight control, guidance, and propulsion data into a flight management system, designed or modified for the systems specified in 6-1.A. or 6-19.A.1., for optimisation of rocket system trajectory.
3. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 6-10.A., 6-10.B. or 6-10.D.

6-11. AVIONICS

6-11.A. Equipment, Assemblies and Components

1. Radar and laser radar systems, including altimeters, designed or modified for use in the systems specified in 6-1.A.

Technical Note:

Laser radar systems embody specialised transmission, scanning, receiving and signal processing techniques for utilisation of lasers for echo ranging, direction *finding and discrimination of targets by location, radial speed and body reflection characteristics.*

2. Passive sensors for determining bearings to specific electromagnetic sources (direction finding equipment) or terrain characteristics, designed or modified for use in the systems specified in 6-1.A.
3. Receiving equipment for Global Navigation Satellite Systems (GNSS; e.g., GPS, GLONASS or Galileo), having any of the following characteristics, and specially designed components therefor:
    a. Designed or modified for use in systems specified in 6-1.A.; **or**
    b. Designed or modified for airborne applications and having any of the following:
        1. Capable of providing navigation information at speeds in excess of 600 m/s;
        2. Employing decryption, designed or modified for military or governmental services, to gain access to GNSS secure signal/data; **or**
        3. Being specially designed to employ anti-jam features (e.g. null steering antenna or electronically steerable antenna) to function in an environment of active or passive countermeasures.

        Note:

        6-11.A.3.b.2. and 6-11.A.3.b.3. do not control equipment designed for commercial, civil or 'Safety of Life' (e.g. data integrity, flight safety) GNSS services.
4. Electronic assemblies and components, designed or modified for use in the systems specified in 6-1.A. or 6-19.A. and specially designed for military use and operation at temperatures in excess of 125° C.

Notes:

1. *Equipment specified in 6-11.A. includes the following:*
    a. *Terrain contour mapping equipment;*
    b. *Scene mapping and correlation (both digital and analogue) equipment;*
    c. *Doppler navigation radar equipment;*
    d. *Passive interferometer equipment;*
    e. *Imaging sensor equipment (both active and passive).*
2. *Governments may permit the export of equipment specified in 6-11.A. as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.*

6-11.B. Test and Production Equipment

None

6-11.C. Materials

None

6-11.D. Software

1. "Software" specially designed or modified for the "use" of equipment specified in 6-11.A.1., 6-11.A.2. or 6-11.A.4.
2. "Software" specially designed for the "use" of equipment specified in 6-11.A.3.

6-11.E. Technology

1. Design “technology” for protection of avionics and electrical subsystems against Electromagnetic Pulse (EMP) and Electromagnetic Interference (EMI) hazards from external sources, as follows:
   a. Design “technology” for shielding systems;
   b. Design “technology” for the configuration of hardened electrical circuits and subsystems;
   c. Design “technology” for determination of hardening criteria for the above.
2. “Technology”, in accordance with the General Technology Note, for the “development”, “production” or “use” of equipment or “software” specified in 6-11.A. or 6-11.D.

6-12. LAUNCH SUPPORT

6-12.A. Equipment, Assemblies and Components

1. Apparatus and devices designed or modified for the handling, control, activation and launching of the systems specified in 6-1.A., 6-19.A.1., or 6-19.A.2.
2. Vehicles designed or modified for the transport, handling, control, activation and launching of the systems specified in 6-1.A.
3. Gravity meters (gravimeters), gravity gradiometers, and specially designed components therefor, designed or modified for airborne or marine use, and having a static or operational accuracy of 7 x 10^{-6} m/s^2 (0.7 milligal) or better, with a time to steady-state registration of two minutes or less, usable for systems specified in 6-1.A.
4. Telemetry and telecontrol equipment, including ground equipment, designed or modified for systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2.

   Notes:

   1. 6-12.A.4. does not control equipment designed or modified for manned aircraft or satellites.

   2. 6-12.A.4. does not control ground based equipment designed or modified for terrestrial or marine applications.

   3. 6-12.A.4. does not control equipment designed for commercial, civil or ‘Safety of Life’ (e.g., data integrity, flight safety) GNSS services.
5. Precision tracking systems, usable for systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. as follows:
   a. Tracking systems which use a code translator installed on the rocket or unmanned aerial vehicle in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of inflight position and velocity;
   b. Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:
      1. Angular resolution better than 1.5 mrad;
      2. Range of 30 km or greater with a range resolution better than 10 m rms; **and**
      3. Velocity resolution better than 3 m/s.

6. Thermal batteries designed or modified for the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2.

Note:

Item 6-12.A.6. does not control thermal batteries specially designed for rocket systems or unmanned aerial vehicles that are not capable of a "range" equal to or greater than 300 km.

Technical Note:

Thermal batteries are single use batteries that contain a solid non-conducting inorganic salt as the electrolyte. These batteries incorporate a pyrolytic material that, when ignited, melts the electrolyte and activates the battery.

6-12.B. Test and Production Equipment

None

6-12.C. Materials

None

6-12.D. Software

1. "Software" specially designed or modified for the "use" of equipment specified in 6-12.A.1.
2. "Software" which processes post-flight, recorded data, enabling determination of vehicle position throughout its flight path, specially designed or modified for systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2.
3. "Software" specially designed or modified for the "use" of equipment specified in 6-12.A.4. or 6-12.A.5., usable for systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2.

6-12.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 6-12.A. or 6-12.D.

6-13. COMPUTERS

6-13.A. Equipment, Assemblies and Components

1. Analogue computers, digital computers or digital differential analysers, designed or modified for use in the systems specified in 6-1.A., having any of the following characteristics:
   a. Rated for continuous operation at temperatures from below –45° C to above +55° C; **or**
   b. Designed as ruggedised or "radiation hardened".

6-13.B. Test and Production Equipment

None

6-13.C. Materials

None

6-13.D. Software

None

6-13.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 6-13.A.

Note:

Item 6-13. equipment may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.

6-14. ANALOGUE TO DIGITAL CONVERTERS

6-14.A. Equipment, Assemblies and Components

1. Analogue-to-digital converters, usable in the systems specified in 6-1.A., having any of the following characteristics:
   a. Designed to meet military specifications for ruggedised equipment; **or**
   b. Designed or modified for military use and being any of the following types:
      1. Analogue-to-digital converter "microcircuits", which are "radiation-hardened" or have all of the following characteristics:
         a. Having a quantisation corresponding to 8 bits or more when coded in the binary system;
         b. Rated for operation in the temperature range from below -54° C to above +125° C; **and**
         c. Hermetically sealed; **or**
      2. Electrical input type analogue-to-digital converter printed circuit boards or modules, having all of the following characteristics:
         a. Having a quantisation corresponding to 8 bits or more when coded in the binary system;
         b. Rated for operation in the temperature range from below -45° C to above +55° C; **and**
         c. Incorporating "microcircuits" specified in 6-14.A.1.b.1.

6-14.B. Test and Production Equipment

None

6-14.C. Materials

None

6-14.D. Software

None

6-14.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 6-14.A.

6-15. TEST FACILITIES AND EQUIPMENT

6-15.A. Equipment, Assemblies and Components

None

6-15.B. Test and Production Equipment

1. Vibration test equipment, usable for the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. or the subsystems specified in 6-2.A. or 6-20.A., and components therefor, as follows:

   a. Vibration test systems employing feedback or closed loop techniques and incorporating a digital controller, capable of vibrating a system at an acceleration equal to or greater than 10 g rms between 20 Hz and 2 kHz while imparting forces equal to or greater than 50 kN, measured ‘bare table’;

   b. Digital controllers, combined with specially designed vibration test “software”, with a ‘real-time control bandwidth’ greater than 5 kHz and designed for use with vibration test systems specified in 6-15.B.1.a.;

      Technical Note:

      ‘Real-time control bandwidth’ is defined as the maximum rate at which a controller can execute complete cycles of sampling, processing data and transmitting control signals.

   c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force equal to or greater than 50 kN, measured ‘bare table’, and usable in vibration test systems specified in 6-15.B.1.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 equal to or greater than 50 kN, measured ‘bare table’, and usable in vibration test systems specified in 6-15.B.1.a.

   Technical Note:

   Vibration test systems incorporating a digital controller are those systems, the functions of which are, partly or entirely, automatically controlled by stored and digitally coded electrical signals.

2. Wind-tunnels for speeds of Mach 0.9 or more, usable for the systems specified in 6-1.A. or 6-19.A. or the subsystems specified in 6-2.A. or 6-20.A.

3. Test benches/stands, usable for the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. or the subsystems specified in 6-2.A. or 6-20.A., which have the capacity to handle solid or liquid propellant rockets, motors or engines having a thrust greater than 68 kN, or which are capable of simultaneously measuring the three axial thrust components.

4. Environmental chambers as follows, usable for the systems specified in 6-1.A. or 6-19.A. or the subsystems specified in 6-2.A. or 6-20.A.:

   a. Environmental chambers capable of simulating all of the following flight conditions:

      1. Having any of the following:

         a. Altitude equal to or greater than 15 km; **or**

         b. Temperature range from below –50º C to above +125º C; **and**

      2. Incorporating, or designed or modified to incorporate, a shaker unit or other vibration test equipment to produce vibration

environments equal to or greater than 10 g rms, measured ‘bare table’, between 20 Hz and 2 kHz imparting forces equal to or greater than 5 kN;

Technical Notes:

1. *Item 6-15.B.4.a.2. describes systems that are capable of generating a vibration environment with a single wave (e.g. a sine wave) and systems capable of generating a broad band random vibration (i.e. power spectrum).*
2. *In Item 6-15.B.4.a.2., designed or modified means the environmental chamber provides appropriate interfaces (e.g. sealing devices) to incorporate a shaker unit or other vibration test equipment as specified in this Item.*

b. Environmental chambers capable of simulating all of the following flight conditions:

1. Acoustic environments at an overall sound pressure level of 140 dB or greater (referenced to 2 x 10^{-5} N/m^2) or with a total rated acoustic power output of 4 kW or greater; **and**
2. Any of the following:

a. Altitude equal to or greater than 15 km; **or**

b. Temperature range from below -50° C to above +125° C.

5. Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and equipment containing those accelerators, usable for the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. or the subsystems specified in 6-2.A. or 6-20.A.

Note:

6-15.B.5. does not control equipment specially designed for medical purposes.

Technical Note:

In Item 6-15.B. ‘bare table’ means a flat table, or surface, with no fixture or fittings.

6-15.C. Materials

None

6-15.D. Software

1. “Software” specially designed or modified for the “use” of equipment specified in 6-15.B. usable for testing systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. or subsystems specified in 6-2.A. or 6-20.A.

6-15.E. Technology

1. “Technology”, in accordance with the General Technology Note, for the “development”, “production” or “use” of equipment or “software” specified in 6-15.B. or 6-15.D.

6-16. MODELLING-SIMULATION AND DESIGN INTEGRATION

6-16.A. Equipment, Assemblies and Components

1. Specially designed hybrid (combined analogue/digital) computers for modelling, simulation or design integration of systems specified in 6-1.A. or the subsystems specified in 6-2.A.

   Note:

   This control only applies when the equipment is supplied with "software" specified in 6-16.D.1.

6-16.B. Test and Production Equipment

None

6-16.C. Materials

None

6-16.D. Software

1. "Software" specially designed for modelling, simulation, or design integration of the systems specified in 6-1.A. or the subsystems specified in 6-2.A. or 6-20.A.

   Technical Note:

   The modelling includes in particular the aerodynamic and thermodynamic analysis of the systems.

6-16.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 6-16.A. or 6-16.D.

<u>6-17. STEALTH</u>

6-17.A. Equipment, Assemblies and Components

1. Devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 6-1.A. or 6-19.A. or the subsystems specified in 6-2.A. or 6-20.A.

6-17.B. Test and Production Equipment

1. Systems, specially designed for radar cross section measurement, usable for the systems specified in 6-1.A., 6-19.A.1. or 6-19.A.2. or the subsystems specified in 6-2.A.

6-17.C. Materials

1. Materials for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 6-1.A. or 6-19.A. or the subsystems specified in 6-2.A.

   Notes:

   1. *6-17.C.1. includes structural materials and coatings (including paints), specially designed for reduced or tailored reflectivity or emissivity in the microwave, infrared or ultraviolet spectra.*
   2. *6-17.C.1. does not control coatings (including paints) when specially used for thermal control of satellites.*

6-17.D. Software

1. "Software" specially designed for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 6-1.A. or 6-19.A. or the subsystems specified in 6-2.A.

Note:

6-17.D.1. includes "software" specially designed for analysis of signature reduction.

6-17.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment, materials or "software" specified in 6-17.A., 6-17.B., 6-17.C. or 6-17.D.

Note:

6-17.E.1. includes databases specially designed for analysis of signature reduction.

6-18. NUCLEAR EFFECTS PROTECTION

6-18.A. Equipment, Assemblies and Components

1. "Radiation Hardened" "microcircuits" usable in protecting rocket systems and unmanned aerial vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 6-1.A.
2. 'Detectors' specially designed or modified to protect rocket systems and unmanned aerial vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 6-1.A.

   Technical Note:

   A 'detector' is defined as a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material. This includes devices that sense by one time operation or failure.
3. Radomes designed to withstand a combined thermal shock greater than 4.184×10^6 J/m^2 accompanied by a peak over pressure of greater than 50 kPa, usable in protecting rocket systems and unmanned aerial vehicles against nuclear effects (e.g., Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 6-1.A.

6-18.B. Test and Production Equipment

None

6-18.C. Materials

None

6-18.D. Software

None

6-18.E. Technology

1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 6-18.A.

6-19. OTHER COMPLETE DELIVERY SYSTEMS

6-19.A. Equipment, Assemblies and Components

1. Complete rocket systems (including ballistic missile systems, space launch vehicles, and sounding rockets), not specified in 6-1.A.1., capable of a "range" equal to or greater than 300 km.
2. Complete unmanned aerial vehicle systems (including cruise missile systems, target drones and reconnaissance drones), not specified in 6-1.A.2., capable of a "range" equal to or greater than 300 km.
3. Complete unmanned aerial vehicle systems, not specified in 6-1.A.2. or 6-19.A.2., having all of the following:
   a. Having any of the following:
      1. An autonomous flight control and navigation capability; **or**
      2. Capability of controlled flight out of the direct vision range involving a human operator; **and**
   b. Having any of the following:
      1. Incorporating an aerosol dispensing system/mechanism with a capacity greater than 20 litres; **or**
      2. Designed or modified to incorporate an aerosol dispensing system/mechanism with a capacity greater than 20 litres.

   Note:

   Item 6-19.A.3. does not control model aircraft, specially designed for recreational or competition purposes.

   Technical Notes:

   1. *An aerosol consists of particulate or liquids other than fuel components, by-products or additives, as part of the "payload" to be dispersed in the atmosphere. Examples of aerosols include pesticides for crop dusting and dry chemicals for cloud seeding.*
   2. *An aerosol dispensing system/mechanism contains all those devices (mechanical, electrical, hydraulic, etc.), which are necessary for storage and dispersion of an aerosol into the atmosphere. This includes the possibility of aerosol injection into the combustion exhaust vapour and into the propeller slip stream.*

6-19.B. Test and Production Equipment

1. "Production facilities" specially designed for the systems specified in 6-19.A.1 or 6-19.A.2.

6-19.C. Materials

None

6-19.D. Software

1. “Software” which coordinates the function of more than one subsystem, specially designed or modified for “use” in the systems specified in 6-19.A.1. or 6-19.A.2.

6-19.E. Technology

1. “Technology”, in accordance with the General Technology Note, for the “development”, “production” or “use” of equipment specified in 6-19.A.1. or 6-19.A.2.

6-20. OTHER COMPLETE SUBSYSTEMS

6-20.A. Equipment, Assemblies and Components

1. Complete subsystems as follows:
   a. Individual rocket stages, not specified in 6-2.A.1., usable in systems specified in 6-19.A.;
   b. Solid propellant rocket motors, hybrid rocket motors or liquid propellant rocket engines, not specified in 6-2.A.1., usable in systems specified in 6-19.A., having a total impulse capacity equal to or greater than 8.41×10^5 Ns, but less than 1.1×10^6 Ns.

6-20.B. Test and Production Equipment

1. “Production facilities” specially designed for the subsystems specified in 6-20.A.
2. “Production equipment” specially designed for the subsystems specified in 6-20.A.

6-20.C. Materials

None

6-20.D. Software

1. “Software” specially designed or modified for the systems specified in 6-20.B.1.
2. “Software”, not specified in 6-2.D.2., specially designed or modified for the “use” of rocket motors or engines specified in 6-20.A.1.b.

6-20.E. Technology

1. “Technology”, in accordance with the General Technology Note, for the “development”, “production” or “use” of equipment or “software” specified in 6-20.A., 6-20.B. or 6-20.D.

GROUP 6 – DEFINITIONS

For the purpose of Group 6, the following definitions apply:

"Accuracy"

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

"Basic scientific research"

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

"Development"

Is related to all phases prior to "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

"In the public domain"

This means "software" or "technology" which has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove "software" or "technology" from being "in the public domain".)

"Microcircuit"

A device in which a number of passive and/or active elements are considered as indivisibly associated on or within a continuous structure to perform the function of a circuit.

"Microprogrammes"

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

"Payload"

The total mass that can be carried or delivered by the specified rocket system or unmanned aerial vehicle (UAV) system that is not used to maintain flight.

Note: *The particular equipment, subsystems, or components to be included in the "payload" depends on the type and configuration of the vehicle under consideration.*

<u>*Technical Notes:*</u>

1. Ballistic Missiles

a. "Payload" for systems with separating re-entry vehicles (RVs) includes:

1. The RVs, including:

a. Dedicated guidance, navigation, and control equipment;

b. Dedicated countermeasures equipment;

2. Munitions of any type (e.g. explosive or non-explosive);

3. Supporting structures and deployment mechanisms for the munitions (e.g. hardware used to attach to, or separate the RV from, the bus/post-boost vehicle) that can be removed without violating the structural integrity of the vehicle;

4. Mechanisms and devices for safing, arming, fuzing or firing;

5. Any other countermeasures equipment (e.g. decoys, jammers or chaff dispensers) that separate from the RV bus/post-boost vehicle;

6. The bus/post-boost vehicle or attitude control/velocity trim module not including systems/subsystems essential to the operation of the other stages.

b. "Payload" for systems with non-separating re-entry vehicles includes:

1. Munitions of any type (e.g. explosive or non-explosive);

2. Supporting structures and deployment mechanisms for the munitions that can be removed without violating the structural integrity of the vehicle;

3. Mechanisms and devices for safing, arming, fuzing or firing;

4. Any countermeasures equipment (e.g. decoys, jammers or chaff dispensers) that can be removed without violating the structural integrity of the vehicle.

2. Space Launch Vehicles

"Payload" includes:

a. Satellites (single or multiple);

b. Satellite-to-launch vehicle adapters including, if applicable, apogee/perigee kick motors or similar manoeuvering systems.

3. Sounding Rockets

"Payload" includes:

a. Equipment required for a mission, such as data gathering, recording or transmitting devices for mission-specific data;

b. Recovery equipment (e.g. parachutes) that can be removed without violating the structural integrity of the vehicle.

4. Cruise Missiles

"Payload" includes:

a. Munitions of any type (e.g. explosive or non-explosive);

b. Supporting structures and deployment mechanisms for the munitions that can be removed without violating the structural integrity of the vehicle;

c. Mechanisms and devices for safing, arming, fuzing or firing;

d. Countermeasures equipment (e.g. decoys, jammers or chaff dispensers) that can be removed without violating the structural integrity of the vehicle;

e. Signature alteration equipment that can be removed without violating the structural integrity of the vehicle.

5. Other UAVs

"Payload" includes:

a. Munitions of any type (e.g. explosive or non-explosive);

b. Mechanisms and devices for safing, arming, fuzing or firing;

c. Countermeasures equipment (e.g. decoys, jammers or chaff dispensers) that can be removed without violating the structural integrity of the vehicle;

d. Signature alteration equipment that can be removed without violating the structural integrity of the vehicle;

e. Equipment required for a mission such as data gathering, recording or transmitting devices for mission-specific data and supporting structures that can be removed without violating the structural integrity of the vehicle;

f. Recovery equipment (e.g. parachutes) that can be removed without violating the structural integrity of the vehicle.

g. Munitions supporting structures and deployment mechanisms that can be removed without violating the structural integrity of the vehicle.

"Production"

Means all production phases such as:

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

"Production equipment"

Means tooling, templates, jigs, mandrels, moulds, dies, fixtures, alignment mechanisms, test equipment, other machinery and components therefor, limited to those specially designed or modified for "development" or for one or more phases of "production".

"Production facilities"

Means "production equipment" and specially designed "software" therefor integrated into installations for "development" or for one or more phases of "production".

"Programmes"

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

"Radiation hardened"

Means that the component or equipment is designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of 5×10^5 rads (Si).

"Range"

The maximum distance that the specified rocket system or unmanned aerial vehicle (UAV) system is capable of travelling in the mode of stable flight as measured by the projection of its trajectory over the surface of the Earth.

Technical Notes:

1. *The maximum capability based on the design characteristics of the system, when fully loaded with fuel or propellant, will be taken into consideration in determining "range".*
2. *The "range" for both rocket systems and UAV systems will be determined independently of any external factors such as operational restrictions, limitations imposed by telemetry, data links or other external constraints.*
3. *For rocket systems, the "range" will be determined using the trajectory that maximises "range", assuming ICAO standard atmosphere with zero wind.*
4. *For UAV systems, the "range" will be determined for a one-way distance using the most fuel-efficient flight profile (e.g. cruise speed and altitude), assuming ICAO standard atmosphere with zero wind.*

"Software"

A collection of one or more "programmes", or "micro-programmes", fixed in any tangible medium of expression.

"Technology"

Means specific information which is required for the "development", "production" or "use" of a product. The information may take the form of "technical data" or "technical assistance".

"Technical assistance"

May take forms such as:

- instruction
- skills
- training
- working knowledge
- consulting services

"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

"Use"

Means:

- operation
- installation (including on-site installation)
- maintenance
- repair
- overhaul
- refurbishing

GROUP 6 – TERMINOLOGY

Where the following terms appear in Group 6, they are to be understood according to the explanations below:

a. “Specially designed” describes equipment, parts, components or “software” which, as a result of “development”, have unique properties that distinguish them for certain predetermined purposes. For example, a piece of equipment that is “specially designed” for use in a missile will only be considered so if it has no other function or use. Similarly, a piece of manufacturing equipment that is “specially designed” to produce a certain type of component will only be considered such if it is not capable of producing other types of components.

b. “Designed or modified” describes equipment, parts or components which, as a result of “development,” or modification, have specified properties that make them fit for a particular application. “Designed or modified” equipment, parts, components or “software” can be used for other applications. For example, a titanium coated pump designed for a missile may be used with corrosive fluids other than propellants.

c. “Usable in”, “usable for”, “usable as” or “capable of” describes equipment, parts, components, materials or “software” which are suitable for a particular purpose. There is no need for the equipment, parts, components or “software” to have been configured, modified or specified for the particular purpose. For example, any military specification memory circuit would be “capable of” operation in a guidance system.

d. “Modified” in the context of “software” describes “software” which has been intentionally changed such that it has properties that make it fit for specified purposes or applications. Its properties may also make it suitable for purposes or applications other than those for which it was “modified”.

UNITS, CONSTANTS, ACRONYMS AND ABBREVIATIONS USED IN GROUP 6

ABEC	Annular Bearing Engineers Committee
ABMA	American Bearing Manufactures Association
ANSI	American National Standards Institute
Angstrom	1 x 10^{-10} metre
ASTM	American Society for Testing and Materials
bar	unit of pressure
°C	degree Celsius
cc	cubic centimetre
CAS	Chemical Abstracts Service
CEP	Circle of Equal Probability
dB	decibel
G	gram; also, acceleration due to gravity
GHz	gigahertz
GNSS	Global Navigation Satellite System
	e.g. ‘Galileo’
	‘GLONASS’ – Global’naya Navigatsionnaya Sputnikovaya Sistema
	‘GPS’ – Global Positioning System
h	hour
Hz	hertz
HTPB	Hydroxy-Terminated Polybutadiene
ICAO	International Civil Aviation Organisation
IEEE	Institute of Electrical and Electronic Engineers
IR	Infrared
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industrial Standard
K	Kelvin
kg	kilogram
kHz	kilohertz
km	kilometre
kN	kilonewton
kPa	kilopascal
kW	kilowatt
m	metre
MeV	million electron volt or mega electron volt

MHz	megahertz
milligal	10^{-5} m/s^2 (also called mGal, mgal or milligalileo)
mm	millimetre
mm Hg	mm of mercury
MPa	megapascal
mrad	milliradian
ms	millisecond
µm	micrometre
N	newton
Pa	pascal
ppm	parts per million
rads (Si)	radiation absorbed dose
RF	radio frequency
rms	root mean square
rpm	revolutions per minute
RV	Re-entry Vehicles
s	second
Tg	glass transition temperature
Tyler	Tyler mesh size, or Tyler standard sieve series
UAV	Unmanned Aerial Vehicle
UV	Ultra violet

TABLE OF CONVERSIONS USED IN GROUP 6

Unit (from)	Unit (to)	Conversion
bar	pascal (Pa)	1 bar = 100 kPa
g (gravity)	m/s^2	1 g = 9.80665 m/s^2
mrad (millirad)	degrees (angle)	1 mrad ≈ 0.0573°
rads	ergs/gram of Si	1 rad (Si) = 100 ergs/gram of silicon (= 0.01 gray [Gy])
Tyler 250 mesh	mm	For a Tyler 250 mesh, mesh opening 0.063 mm

GROUP 7 – CHEMICAL AND BIOLOGICAL WEAPONS NON-PROLIFERATION LIST

Notes:

1. *Terms in "double quotation marks" are defined terms. Refer to "Group 7 - Definitions".*
2. *In items 7-3. and 7-4. the numbers in brackets following the chemical name in each item is the Chemical Abstracts Service Registry number for that chemical as listed in the Chemical Abstracts Service Registry Handbook published by the American Chemical Society, Washington, D.C.*
3. *Mixtures containing any quantity of CWC Schedule 1A and 1B chemicals/precursors (Items 7-3.1. and 7-3.2.) are also controlled.*
4. *Mixtures containing any quantity of chemicals/precursors listed in the CWC Schedules 2A, 2B, 3A and 3B (items 7-3.3. through 7-3.6.) and Australia Group (item 7-4.) are controlled unless the listed chemical is an ingredient in a product identified as a consumer good packaged for retail sale or packaged for personal use.*
5. *Item 7-3. is based on the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction. (known as the Chemical Weapons Convention or CWC.) The other items in the Group are based on the Australia Group (AG).*

CHEMICAL ABSTRACTS SERVICE (CAS) NUMBERS:

Chemicals are listed by name, Chemical Abstract Service (CAS) number and CWC Schedule (where applicable). Chemicals of the same structural formula (e.g., hydrates) are controlled regardless of name or CAS number. CAS numbers are shown to assist in identifying whether a particular chemical or mixture is controlled, irrespective of nomenclature. However, CAS numbers cannot be used as unique identifiers in all situations because some forms of the listed chemical have different CAS numbers, and mixtures containing a listed chemical may also have different CAS numbers.

DUAL-USE CHEMICAL MANUFACTURING FACILITIES AND EQUIPMENT, CHEMICAL WEAPONS AND RELATED SOFTWARE AND TECHNOLOGY

7-1. Equipment, Assemblies and Components

None

7-2. Manufacturing Facilities and Equipment

Note:

1. *The objective of these controls should not be defeated by the transfer of any non-controlled item containing one or more controlled components where the controlled component or components are the principal element of the item and can feasibly be removed or used for other purposes.*

   NB:

   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.
2. *The objective of these controls should not be defeated by the transfer of a whole plant, on any scale, which has been designed to produce any CW agent or AG-controlled precursor chemical.*

7-2.1. Reaction Vessels, Reactors or Agitators, Storage Tanks, Containers or Receivers, Heat Exchangers or Condensers, Distillation or Absorption Columns, Valves, Multi-walled Piping, Pumps, Filling Equipment, and Incinerators, as follows:

a. Reaction vessels or reactors, with or without agitators, with total internal (geometric) volume greater than 0.1 m^3 (100 l) and less than 20 m^3 (20,000 l), where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from the following materials:
   1. Nickel or alloys with more than 40% nickel by weight;
   2. Alloys with more than 25% nickel and 20% chromium by weight;
   3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
   4. Glass or glass-lined (including vitrified or enamelled coating);
   5. Tantalum or tantalum alloys;
   6. Titanium or titanium alloys;
   7. Zirconium or zirconium alloys; or
   8. Niobium (columbium) or niobium alloys.

b. Agitators for use in the above-mentioned reaction vessels or reactors; and impellers, blades or shafts designed for such agitators, where all surfaces of the agitator or component that come in direct contact with the chemical(s) being processed or contained are made from the following materials:
   1. Nickel or alloys with more than 40% nickel by weight;
   2. Alloys with more than 25% nickel and 20% chromium by weight;
   3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
   4. Glass or glass-lined (including vitrified or enamelled coating);
   5. Tantalum or tantalum alloys;
   6. Titanium or titanium alloys;
   7. Zirconium or zirconium alloys; or
   8. Niobium (columbium) or niobium alloys.

c. Storage tanks, containers or receivers with a total internal (geometric) volume greater than 0.1 m^3 (100 l) where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from the following materials:
   1. Nickel or alloys with more than 40% nickel by weight;
   2. Alloys with more than 25% nickel and 20% chromium by weight;
   3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
   4. Glass or glass-lined (including vitrified or enamelled coating);
   5. Tantalum or tantalum alloys;
   6. Titanium or titanium alloys;
   7. Zirconium or zirconium alloys; or
   8. Niobium (columbium) or niobium alloys.

d. Heat exchangers or condensers with a heat transfer surface area of greater than 0.15 m^2, and less than 20 m^2; and tubes, plates, coils, or blocks (cores) designed for such heat exchangers or condensers, where all surfaces that come in direct contact with the chemical(s) being processed are made from the following materials:
   1. Nickel or alloys with more than 40% nickel by weight;
   2. Alloys with more than 25% nickel and 20% chromium by weight;
   3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
   4. Glass or glass-lined (including vitrified or enamelled coating);
   5. Graphite or carbon-graphite;
   6. Tantalum or tantalum alloys;
   7. Titanium or titanium alloys;
   8. Zirconium or zirconium alloys;
   9. Silicon carbide;
   10. Titanium carbide; or
   11. Niobium (columbium) or niobium alloys.

   Technical Note:

   Carbon-graphite is a composition consisting of amorphous carbon and graphite, in which the graphite content is eight percent or more by weight.

e. Distillation or absorption columns of internal diameter greater than 0.1 m; and liquid distributors, vapour distributors or liquid collectors designed for such distillation or absorption columns, where all surfaces that come in direct contact with the chemical(s) being processed are made from the following materials:
   1. Nickel or alloys with more than 40% nickel by weight;
   2. Alloys with more than 25% nickel and 20% chromium by weight;
   3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
   4. Glass or glass-lined (including vitrified or enamelled coating);
   5. Graphite or carbon-graphite;
   6. Tantalum or tantalum alloys;
   7. Titanium or titanium alloys;
   8. Zirconium or zirconium alloys; or
   9. Niobium (columbium) or niobium alloys.

   Technical Note:

   Carbon-graphite is a composition consisting of amorphous carbon and graphite, in which the graphite content is eight percent or more by weight.

f. Valves with nominal sizes greater than 1.0 cm (3/8”) and casings (valve bodies) or preformed casing liners designed for such valves, in which all surfaces that come in direct contact with the chemical(s) being produced, processed, or contained are made from the following materials:

1. Nickel or alloys with more than 40% nickel by weight;
2. Alloys with more than 25% nickel and 20% chromium by weight;
3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
4. Glass or glass-lined (including vitrified or enamelled coating);
5. Tantalum or tantalum alloys;
6. Titanium or titanium alloys;
7. Zirconium or zirconium alloys;
8. Niobium (columbium) or niobium alloys; or
9. Ceramics materials as follows:
    a. Silicon carbide with a purity of 80% or more by weight;
    b. Aluminum oxide (alumina) with a purity of 99.9% or more by weight;
    c. Zirconium oxide (zirconia);

Technical Note:

The 'nominal size' is defined as the smaller of the inlet and outlet port diameters.

g. Multi-walled piping incorporating a leak detection port, in which all surfaces that come in direct contact with the chemical(s) being processed or contained are made from the following materials:
1. Nickel or alloys with more than 40% nickel by weight;
2. Alloys with more than 25% nickel and 20% chromium by weight;
3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
4. Glass or glass-lined (including vitrified or enamelled coating);
5. Graphite or carbon-graphite;
6. Tantalum or tantalum alloys;
7. Titanium or titanium alloys;
8. Zirconium or zirconium alloys; or
9. Niobium (columbium) or niobium alloys.

Technical Note:

Carbon-graphite is a composition consisting of amorphous carbon and graphite, in which the graphite content is eight percent or more by weight.

h. Multiple-seal and seal-less pumps with manufacturer's specified maximum flow-rate greater than 0.6 m^3/h, or vacuum pumps with manufacturer's specified maximum flow-rate greater than 5 m^3/h (under standard temperature (273 K (0° C)) and pressure (101.3 kPa) conditions), and casings (pump bodies), preformed casing liners, impellers, rotors or jet pump nozzles designed for such pumps, in which all surfaces that come into direct contact with the chemical(s) being processed are made from the following materials:
1. Nickel or alloys with more than 40% nickel by weight;
2. Alloys with more than 25% nickel and 20% chromium by weight;

3. Fluoropolymers (polymeric or elastomeric materials with more than 35% fluorine by weight);
4. Glass or glass-lined (including vitrified or enamelled coating);
5. Graphite or carbon-graphite;
6. Tantalum or tantalum alloys;
7. Titanium or titanium alloys;
8. Zirconium or zirconium alloys;
9. Ceramics;
10. Ferrosilicon (high silicon iron alloys); or
11. Niobium (columbium) or niobium alloys.

Technical Note:

Carbon-graphite is a composition consisting of amorphous carbon and graphite, in which the graphite content is eight percent or more by weight.

i. Remotely operated filling equipment in which all surfaces that come in contact with the chemical(s) being processed are made from the following materials:
   a. Nickel or alloys with more than 40% nickel by weight; **or**
   b. Alloys with more than 25% nickel and 20% chromium by weight.
j. Incinerators designed to destroy CW agents, AG-controlled precursors or chemical munitions, having specially designed waste supply systems, special handling facilities, and an average combustion chamber temperature greater than 1000° C, in which all surfaces in the waste supply system that come into direct contact with the waste products are made from or lined with the following materials:
   a. Nickel or alloys with more than 40% nickel by weight; **or**
   b. Alloys with more than 25% nickel and 20% chromium by weight; or
   c. Ceramics.

Technical Note:

For the listed materials in the above entries 7-2.1.a to 7-2.1.j, the term 'alloy' when not accompanied by a specific elemental concentration is understood as identifying those alloys where the identified metal is present in a higher percentage by weight than any other element.

Statement of Understanding

These controls do not apply to equipment which is specially designed for use in civil applications (for example, food processing, pulp and paper processing or water purification, etc.) and is, by the nature of its design, inappropriate for use in storing, processing, producing or conducting and controlling the flow of chemical warfare agents or any of the AG-controlled precursors chemicals.

7-2.2. Deleted.

N.B.

For remotely operated filling equipment, see 7-2.1.i .

7-2.3. Deleted.

N.B.

For incinerators, see 7-2.1.j .

7-2.4 Toxic gas monitoring systems and their dedicated detecting components as follows: detectors; sensor devices; replaceable sensor cartridges; and dedicated software therefore

a. Designed for continuous operation and usable for the detection of chemical warfare agents, or AG-controlled precursors at concentrations of less than 0.3 mg/m^3; **or**

b. Designed for the detection of cholinesterase-inhibiting activity.

(Item 7-2. applies to all destinations except Argentina, Australia, Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Cyprus, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States.)

7-3. CWC Materials

(All destinations applies to all 7-3 Items)

1. CWC Schedule 1 A Toxic Chemicals:

a. **O-Alkyl** (equal to or less than C10, including cycloalkyl) alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) - phosphonofluoridate;

e.g. Sarin (GB):O-Isopropyl methylphosphono-fluoridate, (CAS 107-44-8);

Soman (GD):O-Pinacolyl methyl-phosphono-fluoridate, (CAS 96-64-0);

b. **O-Alkyl** (equal to or less than C10, including cycloalkyl) N,N-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphoramidocyanidates;

e.g. Tabun: O-Ethyl N,N-dimethylphosphoramidocyanidate, (CAS 77-81-6);

c. **O-Alkyl** (H or equal to or less than C10, including cycloalkyl) S-2-dialkyl (Methyl, Ethyl, n-Propyl or Isopropyl)-aminoethyl alkyl (Methyl, Ethyl, n-Propyl or Isopropyl) phosphonothiolates and corresponding alkylated or protonated salts;

e.g. VX: O-Ethyl S-2-diisopropylaminoethyl methylphosphonothiolate, (CAS 50782-69-9);

d. **Sulphur mustards:**

2-Chloroethylchloromethylsulphide, (CAS 2625-76-5);

Mustard gas: Bis(2-chloroethyl) sulphide, (CAS 505-60-2);

Bis(2-chloroethylthio) methane, (CAS 63869-13-6);

Sesquimustard: 1,2-Bis(2-chloroethylthio)ethane, (CAS 3563-36-8);

1,3-Bis(2-chloroethylthio)-n-propane, (CAS 63905-10-2);

1,4-Bis(2-chloroethylthio)-n-butane, (CAS 142868-93-7);

1,5-Bis(2-chloroethylthio)-n-pentane, (CAS 142868-94-8);

Bis (2-chloroethylthiomethyl) ether; (CAS 63918-90-1);

O-Mustard: Bis(2-chloroethylthioethyl)ether, (CAS 63918-89-8);

e. **Lewisites:**

Lewisite 1: 2-Chlorovinyldichloroarsine, (CAS 541-25-3);

Lewisite 2: Bis(2-chlorovinyl)chloroarsine, (CAS 40334-69-8);

Lewisite 3: Tris (2-chlorovinyl) arsine, (CAS 40334-70-1);

f. **Nitrogen mustards:**

HN1: Bis (2-chloroethyl)ethylamine, (CAS 538-07-8);

HN2: Bis (2-chloroethyl)methylamine, (CAS 51-75-2);

HN3: Tris (2-chloroethyl)amine, (CAS 555-77-1);

g. Saxitoxin, (CAS 35523-89-8);

h. Ricin, (CAS 9009-86-3).

2. CWC Schedule 1 B Precursors:

a. Alkyl(Me, Et, n-Pr or i-Pr) phosphonyldifluorides;

e.g. DF: Methylphosphonyldifluoride, (CAS 676-99-3);

b. O-Alkyl (H equal to or less than C10, including cycloalkyl) O-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonites and corresponding alkylated or protonated salts;

e.g. QL: O-Ethyl O-2-diisopropylamino- ethyl methylphosphonite, (CAS 57856-11-8);

c. Chlorosarin: O-Isopropyl methylphosphonochloridate, (CAS 1445-76-7);

d. Chlorosoman: O-Pinacolyl methylphosphonochloridate, (CAS 7040-57-5).

3. CWC Schedule 2 A Toxic Chemicals:

a. Amiton: O,O-Diethyl S-[2-(diethylamino)ethyl] phosphor-othiolate, (CAS 78-53-5) and corresponding alkylated or protonated salts;

b. PFIB: 1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene, (CAS 382-21-8);

c. BZ: 3-Quinuclidinyl benzilate, (CAS 6581-06-2).

4. CWC Schedule 2 B Precursors:

a. Chemicals, except for those listed in Item 7-3.1. or 7-3.2., containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms, such as:

1. Dimethyl methylphosphonate, (CAS 756-79-6);
2. Methylphosphonyl dichloride, (CAS 676-97-1);

Note:

This Item does not control Fonofos: O-Ethyl S-phenyl ethylphosphonothiolothionate, (CAS 944-22-9).

b. N,N-Dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidic dihalides;

c. Dialkyl (Me, Et, n-Pr or i-Pr) N,N-Dialkyl (Me, Et, n-Pr or i-Pr)-phosphoramidates;

d. Arsenic trichloride, (CAS 7784-34-1);

e. 2,2-diphenyl-2-hydroxyacetic acid, (CAS 76-93-7);

f. Quinuclidin-3-ol, (CAS 1619-34-7);

g. N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethyl-2-chlorides and corresponding protonated salts;

h. N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-ols and corresponding protonated salts;

Note:

This Item does not control:

a. N,N-Dimethylaminoethanol, (CAS 108-01-0) and corresponding protonated salts;

b. N,N-Diethylaminoethanol, (CAS 100-37-8) and corresponding protonated salts.

i. N,N-Dialkyl (Me, Et, n-Pr or i-Pr)aminoethane-2-thiols and corresponding protonated salts;

j. Thiodiglycol: Bis(2-hydroxyethyl)sulfide, (CAS 111-48-8);

k. Pinacolyl alcohol: 3,3-Dimethylbutan-2-ol, (CAS 464-07-3).

5. CWC Schedule 3 A Toxic Chemicals:

a. Phosgene: Carbonyl dichloride, (CAS 75-44-5);

b. Cyanogen chloride, (CAS 506-77-4);

c. Hydrogen cyanide, (CAS 74-90-8);

d. Chloropicrin: Trichloronitromethane, (CAS 76-06-2).

6. CWC Schedule 3 B Precursors:

a. Phosphorus oxychloride, (CAS 10025-87-3);

b. Phosphorus trichloride, (CAS 7719-12-2);

c. Phosphorus pentachloride, (CAS 10026-13-8);

d. Trimethyl phosphite, (CAS 121-45-9);

e. Triethyl phosphite, (CAS 122-52-1);

f. Dimethyl phosphite, (CAS 868-85-9);

g. Diethyl phosphite, (CAS 762-04-9);

h. Sulphur monochloride, (CAS 10025-67-9);

i. Sulphur dichloride, (CAS 10545-99-0);

j. Thionyl chloride, (CAS 7719-09-7);

k. Ethyldiethanolamine, (CAS 139-87-7);

l. Methyldiethanolamine, (CAS 105-59-9);

m. Triethanolamine, (CAS 102-71-6).

7-4. AG Materials

1. Chemical Weapons Precursor Chemicals, as follows:

a. 3-hydroxy-1-methylpiperidine, (CAS 3554-74-3);

b. Potassium fluoride, (CAS 7789-23-3);

c. 2-chloroethanol, (CAS 107-07-3);

d. Dimethylamine, (CAS 124-40-3);

e. Dimethylamine hydrochloride, (CAS 506-59-2);

f. Hydrogen fluoride, (CAS 7664-39-3);

g. Methyl benzilate, (CAS 76-89-1);

h. 3-quinuclidone, (CAS 3731-38-2);

- i. Pinacolone, (CAS 75-97-8);
- j. Potassium cyanide, (CAS 151-50-8);
- k. Potassium bifluoride, (CAS 7789-29-9);
- l. Ammonium bifluoride, (CAS 1341-49-7);
- m. Sodium bifluoride, (CAS 1333-83-1);
- n. Sodium fluoride, (CAS 7681-49-4);
- o. Sodium cyanide, (CAS 143-33-9);
- p. Phosphorus pentasulphide, (CAS 1314-80-3);
- q. Diisopropylamine, (CAS 108-18-9);
- r. Diethylaminoethanol, (CAS 100-37-18);
- s. Sodium sulphide, (CAS 1313-82-2);
- t. Triethanolamine hydrochloride, (CAS 637-39-8);
- u. Triisopropyl phosphite, (CAS 116-17-6);
- v. O,O-Diethyl phosphorothioate, (CAS 2465-65-8);
- w. O,O-Diethyl phosphorodithioate, (CAS 298-06-6);
- x. Sodium hexafluorosilicate, (CAS 16893-85-9).

7-5. Software

Controls on ‘software’ transfer only apply where specifically indicated in section 7-2 above, and do not apply to ‘software’ which is either:

1. Generally available to the public by being:
    - a. Sold from the stock at retail selling points without restriction, by means of:
        1. Over-the-counter transactions;
        2. Mail order transactions;
        3. Electronic transactions; **or**
        4. Telephone call transactions; **and**
    - b. Designed for installation by the user without further substantial support by the supplier; **or**
2. ‘In the public domain’.

7-6. Technology

‘Technology’ including licences, directly associated with

- CW agents specified by 7-3,
- AG-controlled precursors specified by 7-4, **or**
- AG-controlled dual-use equipment items specified by 7-2.

This includes:

- a. transfer of technology (technical data) by any means, including electronic media, fax or telephone;
- b. transfer of technology in the form of technical assistance.

Notes:

1. *Controls on "technology" do not apply to information "in the public domain" or to "basic scientific research", or the minimum necessary information for patent application.*
2. *The approval for export of any AG-controlled item of dual-use equipment also authorises the export to the same end-user of the minimum "technology" required for the installation, operation, maintenance, or repair of that item.*

DUAL-USE BIOLOGICAL EQUIPMENT, BIOLOGICAL WEAPONS AND RELATED SOFTWARE AND TECHNOLOGY

7-11. Equipment, Assemblies and Components

None

7-12. Biological Test, Inspection and Production Equipment, as follows:

1. Complete containment facilities at P3 or P4 containment level

   Complete containment facilities that meet the criteria for P3 or P4 (BL3, BL4, L3, L4,) containment as specified in the WHO Laboratory Biosafety Manual (3rd edition, Geneva, 2004).
2. Fermenters

   Fermenters capable of cultivation of pathogenic micro-organisms, viruses or for toxin production, without the propagation of aerosols, having a capacity of 20 litres or greater. Fermenters include bioreactors, chemostats and continuous-flow systems.
3. Centrifugal Separators

   Centrifugal separators capable of the continuous separation of pathogenic microorganisms, without the propagation of aerosols, and having all the following characteristics:

   a. one or more sealing joints within the steam containment area;
   b. a flow rate greater than 100 litres per hour;
   c. components of polished stainless steel or titanium; **and**
   d. capable of in-situ steam sterilisation in a closed state.

   Technical Note:

   Centrifugal separators include decanters.
4. Cross (tangential) flow filtration equipment

   a. Cross (tangential) flow filtration equipment capable of separation of pathogenic microorganisms, viruses, toxins or cell cultures, without the propagation of aerosols, having all the following characteristics:
      1. a total filtration area equal to or greater than 1 square metre; **and**
      2. having any of the following characteristics:
         a. capable of being sterilized or disinfected in-situ; **or**
         b. using disposable or single-use filtration components.

   N.B.:

   This control excludes reverse osmosis equipment, as specified by the manufacturer.

b. Cross (tangential) flow filtration components (e.g. modules, elements, cassettes, cartridges, units or plates) with filtration area equal to or greater than 0.2 square metres for each component and designed for use in cross (tangential) flow filtration equipment as specified by 7-12.4.a.

Technical Note:

In this control, 'sterilized' denotes the elimination of all viable microbes from the equipment through the use of either physical (e.g. steam) or chemical agents. 'Disinfected' denotes the destruction of potential microbial infectivity in the equipment through the use of chemical agents with a germicidal effect. 'Disinfection' and 'sterilization' are distinct from 'sanitization', the latter referring to cleaning procedures designed to lower the microbial content of equipment without necessarily achieving elimination of all microbial infectivity or viability.

5. Freeze-drying Equipment

   Steam sterilisable freeze-drying equipment with a condenser capacity of 10 kg of ice or greater in 24 hours and less than 1000 kg of ice in 24 hours.

6. Protective and containment equipment as follows:

   a. Protective full or half suits, or hoods dependent upon a tethered external air supply and operating under positive pressure;

      Technical Note:

      This does not control suits designed to be worn with self-contained breathing apparatus.

   b. Class III biological safety cabinets or isolators with similar performance standards. [e.g., flexible isolators, dry boxes, anaerobic chambers, glove boxes, or laminar flow hoods (closed with vertical flow)].

7. Aerosol inhalation chambers

   Chambers designed for aerosol challenge testing with microorganisms, viruses or toxins and having a capacity of 1 m^3 or greater.

8. Spraying or fogging systems and components therefore, as follows:

   a. Complete spraying or fogging systems, specially designed or modified for fitting to aircraft, lighter than air vehicles or UAVs, capable of delivering, from a liquid suspension, an initial droplet "VMD" of less than 50 microns at a flow rate of greater than two litres per minute.

   b. Spray booms or arrays of aerosol generating units, specially designed or modified for fitting to aircraft, lighter than air vehicles or UAVs, capable of delivering, from a liquid suspension, an initial droplet "VMD" of less than 50 microns at a flow rate of greater than two litres per minute.

   c. Aerosol generating units specially designed for fitting to systems that fulfil all the criteria specified in paragraphs 7-12.8.a. and 7-12.8.b.

      Technical Notes:

      Aerosol generating units are devices specially designed or modified for fitting to aircraft such as nozzles, rotary drum atomisers and similar devices.

      This entry does not control spraying or fogging systems and components as specified in paragraph 7-12.8 above that are demonstrated not to be capable of delivering biological agents in the form of infectious aerosols.

      Pending definition of international standards, the following guidelines should be followed:

Droplet size for spray equipment or nozzles specially designed for use on aircraft or UAVs should be measured using either of the following methods:

a. Doppler laser method;

b. Forward laser diffraction method.

(Item 7-12. applies to all destinations except Argentina, Australia, Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Cyprus, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States.)

7-13. Materials

(All destinations applies to all 7-13 Items)

Biological Weapon Agents

7-13.1. Human Pathogens, as follows:

a. Viruses:

1 Andes virus
2 Chapare virus
3 Chikungunya virus;
4 Choclo virus
5 Congo-Crimean haemorrhagic fever virus;
6 Dengue fever virus;
7 Dobrava-Belgrade virus
8 Eastern equine encephalitis virus;
9 Ebola virus;
10 Guanarito virus
11 Hantaan virus;
12 Hendra virus (Equine morbillivirus);
13 Japanese encephalitis virus;
14 Junin virus;
15 Kyasanur Forest virus;
16 Laguna Negra virus
17 Lassa fever virus;
18 Louping ill virus;
19 Lujo virus
20 Lymphocytic choriomeningitis virus;
21 Machupo virus;
22 Marburg virus;
23 Monkey pox virus;
24 Murray Valley encephalitis virus;
25 Nipah virus;

26 Omsk haemorrhagic fever virus;

27 Oropouche virus;

28 Powassan virus;

29 Rift Valley fever virus;

30 Rocio virus;

31 Sabia virus

32 Seoul virus

33 Sin nombre virus

34 St. Louis encephalitis virus;

35 Tick-borne encephalitis virus (Russian Spring-Summer encephalitis virus);

36 Variola virus;

37 Venezuelan equine encephalitis virus;

38 Western equine encephalitis virus;

39 Yellow fever virus;

b. Rickettsiae:

1. Coxiella burnetii;
2. Bartonella Quintana (Rickettsiae quintana, Rochalimea quintana);
3. Rickettsia prowazeki;
4. Rickettsia rickettsii;

c. Bacteria:

1. Bacillus anthracis;
2. Brucella abortus;
3. Brucella melitensis;
4. Brucella suis;
5. Chlamydia psittaci;
6. Clostridium botulinum;
7. Francisella tularensis;
8. Burkholderia mallei (Pseudomonas mallei);
9. Burkholderia pseudomallei (Pseudomonas pseudomallei);
10. Salmonella typhi;
11. Shigella dysenteriae;
12. Vibrio cholerae;
13. Yersinia pestis;
14. Clostridium perfringens, epsilon toxin producing types;

Note

It is understood that limiting this control to epsilon toxin producing strains of Clostridium perfringens therefore exempts from control the transfer of other Clostridium perfringens strains to be used as positive control cultures for food testing and quality control.

15. Enterohaemorrhagic Escherichia coli, serotype O157 and other verotoxin producing serotypes;

d. Toxins as follow and subunits thereof:

Note

Excluding immunotoxins.

1. Botulinum toxins;

   Note

   Excluding botulinum toxins in product form meeting all of the following criteria:

   a. pharmaceutical formulations designed for testing and human administration in the treatment of medical conditions;

   b. pre-packaged for distribution as clinical or medical products; and

   c. authorized by a state authority to be marketed as clinical or medical products.

2. Clostridium perfringens toxins;
3. Conotoxin;

   Note

   Excluding conotoxins in product form meeting all of the following criteria:

   a. pharmaceutical formulations designed for testing and human administration in the treatment of medical conditions;

   b. pre-packaged for distribution as clinical or medical products; and

   c. authorized by a state authority to be marketed as clinical or medical products.

4. Ricin;
5. Saxitoxin;
6. Shiga toxin;
7. Staphylococcus aureus toxins;
8. Tetrodotoxin;
9. Verotoxin and shiga-like ribosome inactivating proteins;
10. Microcystin (Cyanginosin);
11. Aflatoxins;
12. Abrin;
13. Cholera toxin;
14. Diacetoxyscirpenol toxin;
15. T-2 toxin;
16. HT-2 toxin;
17. Modeccin toxin;
18. Volkensin toxin;
19. Viscum Album Lectin 1 (Viscumin);

e. Fungi:

1. Coccidioides immitis;
2. Coccidioides posadasii;

Note:

Biological agents are controlled when they are an isolated live culture of a pathogen agent, or a preparation of a toxin agent which has been isolated or extracted from any source, or material including living material which has been deliberately inoculated or contaminated with the agent. Isolated live cultures of a pathogen agent include live cultures in dormant form or in dried preparations, whether the agent is natural, enhanced or modified.

An agent is covered by item 7-13.1.a. to 7-13.1.e. except when it is in the form of a vaccine. A vaccine is a medicinal product in a pharmaceutical formulation licensed by, or having marketing or clinical trial authorization from, the regulatory authorities of either the country of manufacture or of use, which is intended to stimulate a protective immunological response in humans or animals in order to prevent disease in those to whom or to which it is administered.

f. Genetic Elements and Genetically-modified Organisms:

1. Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in items 7-13.1.a. through 7-13.1.e.;
2. Genetic elements that contain nucleic acid sequences coding for any of the toxins in item 7-13.1.d. or for their sub-units;
3. Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in items 7-13.1.a. through 7-13.1.e.;
4. Genetically modified organisms that contain nucleic acid sequences coding for any of the toxins in item 7-13.1.d. or for their sub-units.

Technical Note:

Genetic elements include inter alia chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.

Nucleic acid sequences associated with the pathogenicity of any of the micro-organisms in item 7-13.1 means any sequence specific to the relevant listed micro-organism:

- that in itself or through its transcribed or translated products represents a significant hazard to human, animal or plant health; ***or***

- that is known to enhance the ability of a listed micro-organism, or any other organism into which it may be inserted or otherwise integrated, to cause serious harm to human, animal or plant health.

These controls do not apply to nucleic acid sequences associated with the pathogenicity of enterohaemorrhagic Escherichia coli, serotype O157 and other verotoxin producing strains, other than those coding for the verotoxin, or for its sub-units.

7-13.2. Animal Pathogens, as follows:

Note:

Except where the agent is in the form of a vaccine.

a. Viruses:

1. African swine fever virus;
2. Avian influenza virus;

Note:

This includes only those Avian influenza viruses of high pathogenicity as defined by competent international authorities or regulatory bodies such *as the World Health Organization for Animal Health (OIE) or the European Union (EU).*

3. Bluetongue virus;
4. Foot and mouth disease virus;
5. Goat pox virus;
6. Herpes virus (Aujeszky's disease);
7. Hog cholera virus (synonym swine fever virus);
8. Lyssa virus;
9. Newcastle disease virus;
10. Peste des petits ruminants virus;
11. Porcine enterovirus type 9 (synonym swine vesicular disease virus);
12. Rinderpest virus;
13. Sheep pox virus;
14. Teschen disease virus;
15. Vesicular stomatitis virus;
16. Lumpy skin disease virus;
17. African horse sickness virus;

b. Rickettsiae

None

c. Bacteria:

1. Mycoplasma mycoides subspecies mycoides SC (small colony);
2. Mycoplasma capricolum subspecies capripneumoniae ("strain F38");

d. Genetic Elements and Genetically-modified Organisms:

1. Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in items 7-13.2.a. through 7-13.2.c.;
2. Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in items 7-13.2.a. through 7-13.2.c.;

Technical Note

Genetic elements include inter alia chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.

Nucleic acid sequences associated with the pathogenicity of any of the micro-organisms in item 7-13.2 means any sequence specific to the relevant listed micro-organism:

- that in itself or through its transcribed or translated products represents a significant hazard to human, animal or plant health; ***or***

- that is known to enhance the ability of a listed micro-organism, or any other organism into which it may be inserted or otherwise integrated, to cause serious harm to human, animal or plant health.

7-13.3. Plant Pathogens, as follows:

a. Viruses;
   1. Potato Andean latent tymovirus;
   2. Potato spindle tuber viroid;
b. Rickettsiae

   None
c. Bacteria:
   1. Xanthomonas albilineans;
   2. Xanthomonas campestris pv.citri;
   3. Xanthomonas oryzae pv.oryzae (Pseudomonas campestris pv. oryzae);
   4. Clavibacter michiganensis subsp. sepedonicus (Coryne-bacterium michiganensis subsp. sepedonicum or Corynebacterium sepedonicum);
   5. Ralstonia solanacearum races 2 and 3 (Pseudomonas solanacearum races 2 and 3 or Burkholderia solanacearum races 2 and 3);
d. Toxins

   None
e. Fungi:
   1. Colletotrichum coffeanum var. virulans (Colletotrichum kahawae);
   2. Cochliobolus miyabeanus (Helminthospo-rium oryzae);
   3. Microcyclus ulei (syn. Dothidella ulei);
   4. Puccinia graminis (syn. Puccinia graminis f.sp. tritici);
   5. Puccinia striiformis (syn. Puccinia glumarum);
   6. Pyricularia grisea/Pyricularia oryzae;
f. Genetic Elements and Genetically-modified Organisms:
   1. Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in items 7-13.3.a. through 7-13.3.e.;
   2. Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in items 7-13.3.a. through 7-13.3.e.

Technical Note:

Genetic elements include inter alia chromosomes, genomes, plasmids, transposons, and vectors whether genetically modified or unmodified.

Nucleic acid sequences associated with the pathogenicity of any of the micro-organisms in item 7-13.3 means any sequence specific to the relevant listed micro-organism:

- that in itself or through its transcribed or translated products represents a significant hazard to human, animal or plant health; ***or***

- that is known to enhance the ability of a listed micro-organism, or any other organism into which it may be inserted or otherwise integrated, to cause serious harm to human, animal or plant health.

7-14. Software

Controls on 'software' transfer only apply where specifically indicated in sections 7-12 and 7-15 above, and do not apply to 'software' which is either:

1. Generally available to the public by being:
   a. Sold from the stock at retail selling points without restriction, by means of:
      1. Over-the-counter transactions;
      2. Mail order transactions;
      3. Electronic transactions; **or**
      4. Telephone call transactions; **and**
   b. Designed for installation by the user without further substantial support by the supplier; **or**
2. 'In the public domain'.

7-15. Technology

Technology, including licenses, directly associated with

- AG-controlled biological agents specified by 7-13; **or**
- AG-controlled dual-use biological equipment items specified by 7-12.

This includes

a. transfer of technology (technical data) by any means, including electronic media, fax or telephone
b. transfer of technology in the form of technical assistance.

Notes:

1. *Controls on 'technology' do not apply to information 'in the public domain' or to 'basic scientific research', or the minimum necessary information for patent application.*
2. *The approval for export of any AG-controlled item of dual-use equipment also authorises the export to the same end-user of the minimum 'technology' required for the installation, operation, maintenance, or repair of that item.*

GROUP 7 – DEFINITIONS

"Basic scientific research"

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

"Development"

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

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

"In the public domain"

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

"Lighter than air vehicles"

Balloons and airships that rely on hot air or on lighter-than-air gases such as helium or hydrogen for their lift.

"Microprogramme"

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

"Production"

Means all production phases such as:

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

"Programme"

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

"Software"

A collection of one or more 'programmes' or 'microprogrammes' fixed in any tangible medium of expression.

"Technical assistance"

May take forms, such as: instruction, skills, training, working knowledge, consulting services.

N.B.: *"Technical assistance" may involve transfer of "technical data".*

"Technical data"

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

"Technology"

Specific information necessary for the "development", "production" or "use" of a product. The information takes the form of "technical data" or "technical assistance".

"UAVs"

Unmanned Aerial Vehicles.

"Use"

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

"VMD"

Volume Median Diameter.

Note: *For water-based systems, VMD equates to MMD - the Mass Median Diameter.*

INDEX

This non-exhaustive index is provided as a guide only.