SCHEDULE 1

PROHIBITED GOODS

PART III

GROUP 2

ATOMIC ENERGY MINERALS AND MATERIALS AND NUCLEAR FACILITIES, EQUIPMENT, APPLIANCES AND SOFTWARE

Interpretations and definitions

In this Group:

"boron equivalent" (BE) is defined as:

BE = CF × Concentration of element Z in ppm

$$\text{where CF is the conversion factor} = \frac{\text{gamma}_Z \times A_B}{\text{gamma}_B \times A_Z}$$

and gamma_B and gamma_Z are the thermal neutron capture cross sections (in barns) for boron and element Z respectively; and A_B and A_Z are the atomic weights of boron and element Z respectively;

"depleted uranium" means uranium depleted in the isotope 235 below that occurring in nature;

"effective gramme" of **special fissile material** or **other fissile material** means:

a. for plutonium isotopes and uranium-233, the isotope weight in grammes;

b. for uranium enriched 1 per cent or greater in the isotope U-235, the element weight in grammes multiplied by the square of its enrichment expressed as a decimal weight fraction;

c. for uranium enriched below 1 per cent in the isotope U-235, the element weight in grammes multiplied by 0.0001;

d. for americium-242m, curium-245 and curium-247, californium-249 and californium-251, the isotope weight in grammes multiplied by 10;

"fibrous or filamentary materials" include:

a. continuous monofilaments;

b. continuous yarns and rovings;

c. tapes, fabrics, random mats and braids;

d. chopped fibres, staple fibres and coherent fibre blankets;

e. whiskers, either monocrystalline or polycrystalline, of any length;

f. aromatic polyamide pulp;

"laser" means an assembly of components which produce both spatially and temporally coherent light which is amplified by stimulated emission of radiation;

"natural uranium" means uranium containing the mixtures of isotopes occurring in nature;

"nuclear reactor" means 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, come into direct contact with or control the primary coolant of the reactor core;

"other fissile materials" means **previously separated** americium-242m, curium-245 and curium-247, californium-249 and californium-251, isotopes of plutonium other than plutonium-238 and plutonium-239, and any material containing the foregoing;

"previously separated" means the application of any process intended to increase the concentration of the controlled isotope;

"special fissile material" means plutonium-239, uranium-233, **uranium enriched in the isotopes 235 or 233,** and any material containing the foregoing;

"specific modulus" means Young's modulus in pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K ((23 ± 2)C)and a relative humidity of (50 ± 5)%;

"specific tensile strength" means ultimate tensile strength in pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K ((23 ± 2)[a]wC) and a relative humidity of (50 ± 5)%;

"uranium enriched in the isotopes 235 or 233" means uranium containing the isotopes 235 or 233, or both, in an amount such that the abundance ratio of the sum of these isotopes to the isotope 238 is more than the ratio of the isotope 235 to the isotope 238 occurring in nature (isotopic ratio 0.72%).

2A Atomic Energy Minerals and Materials

(A10) **Natural uranium** or **depleted uranium** or thorium, in the form of metal, alloy, chemical compound, or concentrate and any other material containing one or more of the foregoing;

except:

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

b. **Depleted uranium** specially fabricated for the following civil non-nuclear applications:

1. Shielding;
2. Packaging;
3. Ballasts;
4. Counter-weights.

(A20) **Special fissile materials** and **other fissile materials;**

except:

Four **effective grammes** or less when contained in a sensing component in instruments.

(a) (A30) (a) Plutonium in any form with a plutonium isotopic assay of plutonium-238 of more than 50%;

except:

Three grammes or less when contained in a sensing component in instruments;

(b) **Previously separated** neptunium-237 in any form;

except:

Shipments with a neptunium-237 content of one gramme or less.

(A40) Deuterium, heavy water, deuterated paraffins and other compounds of deuterium, and mixtures and solutions containing deuterium, in which the isotopic ratio of deuterium to hydrogen exceeds 1:5,000.

(A50) Graphite, nuclear-grade, having a purity level of less than 5 parts per million **boron equivalent** and with a density greater than 1.5 g/cm^3.

(A60) Nickel powder and porous nickel metal, as follows:

(a) Powder with a nickel purity content of 99.9 weight percent or more and a mean particle size of less than 10 micrometres measured by American Society for Testing and Materials (ASTM) B330 standard and a high degree of particle size uniformity;

(b) Porous nickel metal produced from materials specified in head a. above;

except:

Single porous nickel sheets not exceeding 930 cm^2 intended for use in batteries for civil applications.

(A70) Specially prepared compounds or powders, other than nickel, resistant to corrosion by UF_6 (e.g. aluminium oxide and fully fluorinated hydrocarbon polymers), for the manufacture of gaseous diffusion barriers, having a purity content of 99.9 weight percent or more and a mean particle size of less than 10 micrometres measured by American Society for Testing and Materials (ASTM) B330 standard and a high degree of particle size uniformity.

2B Nuclear Facilities, Equipment, Appliances and Software

(B10) Plant for the separation of isotopes of **natural uranium, depleted uranium, special fissile materials** or **other fissile materials,** and specially designed or prepared equipment and components therefor, as follows:

(a) Plant specially designed for separating isotopes of **natural uranium, depleted uranium, special fissile materials** or **other fissile materials,** as follows:

(1) Gaseous diffusion separation plant;

(2) Gas centrifuge separation plant;

(3) Aerodynamic separation plant;

(4) Chemical exchange separation plant;

(5) Ion-exchange separation plant;

(6) Atomic vapour **laser** isotopic separation plant;

(7) Molecular **laser** isotopic separation plant;

(8) Plasma separation plant;

(9) Electromagnetic separation plant;

(b) Equipment and components, as follows, specially designed or prepared for:

(1) Gaseous diffusion separation process:

(a) Valves wholly made of or lined with aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel, 40 mm or more in diameter, with bellows seals;

(b) Blowers and compressors (turbo, centrifugal and axial flow types) wholly made of or lined with materials resistant to UF_6 (e.g. aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel), having a capacity of 1,000 litres per minute or more, and seals therefor designed for a buffer gas in-leakage rate of less than 1,000 cm^3/min;

(c) Gaseous diffusion barriers made of porous metallic, polymer or ceramic materials resistant to corrosion by UF_6 with a pore size of less than 100 nm, a thickness of 5 mm or less, and, for tubular forms, a diameter of 25 mm or less;

(d) Gaseous diffuser housings;

(e) Heat exchangers made of aluminium, copper, nickel or alloys containing more than 60 weight percent nickel, or combinations of these metals as clad tubes, designed to operate

at sub-atmospheric pressure with a leak rate that limits the pressure rise to less than 10 Pa per hour under a pressure differential of 100 kPa;

(2) Gas centrifuge separation process:

(a) Gas centrifuges;

(b) Complete rotor assemblies;

(c) Rotor tube cylinders with a thickness of 12 mm or less, a diameter of between 75 mm and 400 mm, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(d) Magnetic suspension bearings consisting of an annular magnet suspended within a housing containing a damping medium, and having the magnet coupling with a pole piece or second magnet fitted to the top cap of the rotor;

(e) Specially prepared bearings comprising a pivot-cup assembly mounted on a damper;

(f) Rings or bellows with a wall thickness of 3 mm or less and a diameter of between 75 mm and 400 mm and designed to give local support to a rotor tube or to join a number together, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(g) Baffles of between 75 mm and 400 mm diameter for mounting inside a rotor tube, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(h) Top and bottom caps of between 75 mm and 400 mm diameter to fit the ends of a rotor tube, made from any of the following high strength-to-density ratio materials:

(1) Maraging steel capable of an ultimate tensile strength of 2,050 MPa or more;

(2) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more; or

(3) **Fibrous or filamentary materials** with a **specific modulus** of more than 3.18×10^6 m and a **specific tensile strength** greater than 76.2×10^3 m;

(i) Molecular pumps comprised of cylinders having internally machined or extruded helical grooves and internally machined bores;

(j) Ring-shaped motor stators for multiphase AC hysteresis (or reluctance) motors for synchronous operation within a vacuum in the frequency range of 600 to 2,000 Hz and a power range of 50 to 1,000 Volt-Amps;

(k) Frequency changers (converters or inverters) specially designed or prepared to supply motor stators for gas centrifuge enrichment, having all of the following characteristics, and specially designed components therefor:

(1) Multiphase output of 600 Hz to 2 kHz;

(2) Frequency control better than 0.1%;

(3) Harmonic distortion of less than 2%; and

(4) An efficiency greater than 80%;

(3) Aerodynamic separation process:

(a) Separation nozzles consisting of slit-shaped, curved channels having a radius of curvature less than 1 mm and having a knife-edge contained within the nozzle which separates the gas flowing through the nozzle into two streams;

(b) Tangential inlet flow-driven cylindrical or conical tubes, specially designed for uranium isotope separation;

(c) UF_6-hydrogen helium compressors wholly made of or lined with aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel, including compressor seals;

(d) Aerodynamic separation element housings, designed to contain vortex tubes or separation nozzles;

(e) Heat exchangers made of aluminium, copper, nickel, or alloys containing more than 60 weight percent nickel, or combinations of these metals as clad tubes, designed to operate at pressures of 600 kPa or less;

(4) Chemical exchange separation process:

(a) Fast-exchange liquid-liquid centrifugal contactors or fast exchange liquid-liquid pulse columns made of fluorocarbon lined materials;

(b) Electrochemical reduction cells designed to reduce uranium from one valence state to another;

(5) Ion-exchange separation process including fast reacting ion-exchange resins, pellicular and reticulated resins in which the active chemical exchange groups are limited to a coating on the surface of an inert particle or fibre;

(6) Atomic vapour **laser** isotopic separation process:

(a) High power electron beam guns with total power of more than 50 kW and strip or scanning electron beam guns with a delivered power of more than 2.5 kW/cm for use in uranium vaporization systems;

(b) Trough shaped crucible and cooling equipment for molten uranium;

(c) Product and tails collector systems made of or lined with materials resistant to the heat and corrosion of uranium vapour, such as yttria-coated graphite;

(7) Molecular **laser** isotopic separation process:

(a) Supersonic expansion nozzles designed for UF_6 carrier gas;

(b) Uranium fluoride (UF5) product filter collectors;

(c) Equipment for fluorinating UF5 to UF6;

(d) UF_6 carrier gas compressors wholly made of or lined with aluminium, aluminium alloys, nickel or alloy containing 60 weight percent or more nickel, including compressor seals;

(8) Plasma separation process:

(a) Product and tails collectors made of or lined with materials resistant to the heat and corrosion of uranium vapour such as yttria-coated graphite;

(b) Radio frequency ion excitation coils for frequencies of more than 100 kHz and capable of handling more than 40 kW power.

(B20) Specially designed or prepared auxiliary systems, equipment and components, as follows, for gas centrifuge or gaseous diffusion enrichment plants, made from or lined with UF_6 resistant materials:

(a) Feed autoclaves, for passing UF_6 to gaseous diffusion or centrifuge cascades, capable of operating at pressures of 300 kPa or less;

(b) Desublimers or cold traps, used to remove UF_6 from gaseous diffusion or centrifuge cascades, capable of operating at pressures of 300 kPa or less;

(c) Product and tails stations for trapping and transferring UF_6 into containers;

(d) Liquefaction stations, where UF_6 gas from gaseous diffusion or centrifuge cascades is compressed and cooled to form liquid UF_6, capable of operating at pressures of 300 kPa or less;

(e) Piping systems and header systems specially designed for handling UF_6 within gaseous diffusion or centrifuge cascades;

(f) Specially designed vacuum manifolds or vacuum headers having a suction capacity of 5 m^3/minute or more or specially designed vacuum pumps;

(g) UF_6 mass spectrometers/ion sources specially designed or prepared for 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 of more than 320 amu;

(2) Ion sources constructed of or lined with nichrome or monel, or nickel plated; and

(3) Electron bombardment ionization sources.

(B30) Plant for the production of uranium hexafluoride (UF_6) and specially designed or prepared equipment and components therefor, as follows:

(a) Plant for the production of UF_6;

(b) Equipment and components, as follows, specially designed or prepared for UF_6 production:

(1) Fluorination and hydrofluorination screw and fluid bed reactors and flame towers;

(2) Distillation equipment for the purification of UF_6.

(B40) Plant for the production of heavy water, deuterium or deuterium compounds, and specially designed or prepared equipment and components therefor, as follows:

(a) Plant for the production of heavy water, deuterium or deuterium compounds, as follows:

(1) Hydrogen sulphide-water exchange plant;

(2) Ammonia-hydrogen exchange plant;

(3) Hydrogen distillation plant;

(b) Equipment and components, as follows, designed for:

(1) Hydrogen sulphide-water exchange process:

(a) Tray exchange towers;

(b) Hydrogen sulphide gas compressors;

(2) Ammonia-hydrogen exchange process:

(a) High-pressure ammonia-hydrogen exchange towers;

(b) High-efficiency stage contactors;

(c) Submersible stage recirculation pumps;

(d) Ammonia crackers designed for pressures of more than 3 MPa;

(3) Hydrogen distillation process:

(a) Hydrogen cryogenic distillation towers and cold boxes designed for operation below 35 K (-238°C);

(b) Turboexpanders or turboexpander-compressor sets designed for operation below 35 K (-238°C);

(4) Heavy water concentration process to reactor grade level (99.75 weight percent deuterium oxide):

(a) Water distillation towers containing specially designed packings;

(b) Ammonia distillation towers containing specially designed packings;

(c) Catalytic burners for conversion of fully enriched deuterium to heavy water;

(d) Infrared absorption analysers capable of on-line hydrogen-deuterium ratio analysis where deuterium concentrations are equal to or more than 90 weight per cent.

(B50) **Nuclear reactors,** i.e. reactors capable of operation so as to maintain a controlled, self-sustaining fission chain reaction, and equipment and components specially designed or prepared for use in connection with a **nuclear reactor,** including:

(a) Pressure vessels, i.e. metal vessels as complete units or parts therefor, which are specially designed or prepared to contain the core of a **nuclear reactor** and are capable of withstanding the operating pressure of the primary coolant, including the top plate for a reactor pressure vessel;

(b) Fuel element handling equipment, including reactor fuel charging and discharging machines;

(c) Control rods specially designed or prepared for the control of the reaction rate in a **nuclear reactor,** including the neutron absorbing part and the support or suspension structures therefor, and control rod guide tubes;

(d) Electronic controls for controlling the power levels in **nuclear reactors,** including reactor control rod drive mechanisms and radiation detection and measuring instruments to determine neutron flux levels;

(e) Pressure tubes specially designed or prepared to contain fuel elements and the primary coolant in a **nuclear reactor** at an operating pressure in excess of 5.1 MPa;

(f) Tubes, or assemblies of tubes, made from zirconium metal or alloy in which the ratio of hafnium to zirconium is less than 1:500 parts by weight, specially designed or prepared for use in a **nuclear reactor;**

(g) Coolant pumps specially designed or prepared for circulating the primary coolant of **nuclear reactors;**

(h) Internal components specially designed or prepared for the operation of a **nuclear reactor,** including core support structures, thermal shields, baffles, core grid plates and diffuser plates;

(i) Heat exchangers.

(B60) Plant specially designed for the fabrication of **nuclear reactor** fuel elements and specially designed equipment therefor, including equipment which:

(a) Normally comes into direct contact with or directly processes or controls the production flow of nuclear materials;

(b) Seals the nuclear material within the cladding;

(c) Checks the integrity of the cladding or the seal; and

(d) Checks the finish treatment of the solid fuel.

(B70) Plant for the reprocessing of irradiated **nuclear reactor** fuel elements, and specially designed or prepared equipment and components therefor, including:

(a) Fuel element chopping or shredding machines, i.e. remotely operated equipment to cut, chop, shred or shear irradiated **nuclear reactor** fuel assemblies, bundles or rods;

(b) Dissolvers, critically safe tanks (e.g. small diameter, annular or slab tanks) specially designed or prepared for the dissolution of irradiated **nuclear reactor** fuel, which are capable of withstanding hot, highly corrosive liquids, and which can be remotely loaded and maintained;

(c) Counter-current solvent extractors and ion-exchange processing equipment, specially designed or prepared for use in a plant for the reprocessing of irradiated **natural uranium, depleted uranium, special fissile materials** or **other fissile materials;**

(d) Process control instrumentation specially designed or prepared for monitoring or controlling the reprocessing of irradiated **natural uranium, depleted uranium, special fissile materials** or **other fissile materials;**

(e) Holding or storage vessels specially designed to be critically safe and resistant to the corrosive effects of nitric acid;

(f) Systems specially designed or prepared for the conversion of plutonium nitrate to plutonium oxide;

(g) Systems specially designed or prepared for the production of plutonium metal.

(B80) Power generating or propulsion equipment specially designed for use with space, marine or mobile **nuclear reactors.**

(B90) Equipment, as follows, specially designed or prepared for the separation of isotopes of lithium:

(a) Packed liquid-liquid exchange columns specially designed for lithium amalgams;

(b) Amalgam pumps;

(c) Amalgam electrolysis cells;

(d) Evaporators for concentrated lithium hydroxide solution.

(B100) Equipment for **nuclear reactors,** as follows:

(a) Simulators specially designed for **nuclear reactors;**

(b) Ultrasonic or eddy current test equipment specially designed for **nuclear reactors.**

(B110) **Software** specially designed or modified for the **development, production** or **use** of equipment or materials specified in this Group.

(E10) **Technology** applicable to the **development, production** or **use** of **goods** specified in entries A30, B30, B80 to B110, head b. of entry A60, sub-heads b.4. to b.8. of entry B10, head d. of entry B50, head i. of entry B50, or head d. of entry B70 in this Group.

(E20) **Technology** applicable to the **development, production** or **use** of **goods** specified in this Group other than that specified in entry E10.