g. Baffles with a diameter of between 75 mm and 400 mm for mounting inside the rotor tube, made from high strength- to-density ratio materials described in the Technical Note below;

3101. b. 2. h. Top and bottom caps with a diameter of between 75 mm and 400 mm to fit the ends of the rotor tube, made from high strength-to-density ratio materials described in the Technical Note below;

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 of more than 80%;

Technical Note: The high strength-to-density ratio materials used for centrifuge rotating components are:

a. Maraging steel capable of an ultimate tensile strength of 2.05×10^9 N/m or more;

b. Aluminium alloys capable of an ultimate tensile strength of 0.46×10^9 N/m or more; or

c. "Fibrous and filamentary materials" with a specific modulus of more than 3.18×10^6m and a specific tensile strength exceeding 7.62×10^4 m.

N.B.:

1. Specific modulus: Young's modulus in pascals, equivalent to N/m divided by specific weight in N/m, measured at a temperature of (296 ± 2) K $((23 \pm 2)$°C) and a relative humidity of (50 ± 5)%.
2. Specific tensile strength: ultimate tensile strength in pascals, equivalent to N/m divided by specific weight in N/m, measured at a temperature of (296 $\pm$ 2) K ((23 $\pm$ 2)°C) and a relative humidity of (50 $\pm$ 5)%.

3. Aerodynamic separation process:

a. Separation nozzles consisting of slit-shaped, curved channels having a radius of curvature less than 1 mm (contained within the nozzle is a knife-edge which separates 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 (o/w) 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 alloy containing more than 60 weight percent (o/w) nickel, or combinations of these metals as clad tubes, designed to operate at pressures of 6×10^5 pascal (6 bar) 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, 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;

3101. b. 7. Molecular "laser" isotopic separation process:

a. Para-hydrogen Raman shifters designed to operate at 16 micrometres output wavelength and at a repetition rate of more than 250 Hz;

b. Supersonic expansion nozzles designed for UF_6 carrier gas;

c. Uranium fluoride (UF_5) product filter collectors;

d. Equipment for fluorinating UF_5 to UF_6;

e. UF_6 carrier gas compressors wholly made of or lined with aluminium, aluminium alloys, nickel or alloy containing 60 weight percent (o/w) 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;

9. UF_6 mass spectrometers or 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:

a. Unit resolution for mass of more than 320;

b. Ion sources constructed of or lined with nichrome or monel, or nickel plated; and

c. Electron bombardment ionization sources.

3101. **Technical Notes:**

1. The following "lasers" and components are important in the atomic vapour "laser" isotopic separation process referred to in 3101.b.6.:

a. "Lasers" to pump dye "lasers":

1. Copper vapour "lasers" of 40 W or more;
2. Argon ion "lasers" of more than 40 W;
3. ND:YAG "lasers" that can be frequency doubled and thereby have an average power of more than 40 W;

b. Other "lasers" and accessories:

1. "Tunable" pulsed dye "laser" amplifiers and oscillators, except single-mode oscillators, with an average power of more than 30 W, a repetition rate of more than 1 kHz and a wavelength between 500 nm and 700 nm;
2. Modulators for controlling and modifying dye "laser" bandwidth;
3. "Tunable" pulsed single-mode dye oscillators capable of an average power of more than 1 W, a repetition rate of more than 1 kHz, a pulse width less than 100 ns, a wavelength between 500 nm and 700 nm and frequency modulation for bandwidth expansion.

(For the embargo status of "lasers", see Category 1061.5.)

2. The following "lasers" are important in the molecular "laser" isotopic separation process referred to in 3101.b.7.:

a. Alexandrite "lasers" with a bandwidth of 0.005 nm (3 GHz) or less, a repetition rate of more than 125 Hz, and an average power of more than 30 W;

b. Pulsed carbon dioxide "lasers" with a repetition rate of more than 250 Hz, an average power of more than 1.2 kW and a pulse length less than 200 ns;

c. Pulsed excimer "lasers" (XeF, XeCl, KrF) with a repetition rate of more than 250 Hz and an average power of more than 250 W;

(For the embargo status of "lasers", see Category 1061. 5.)

3. The following microwave power sources and "superconductive" electromagnets are important in the plasma separation process referred to in 3101.b.8.:

a. Microwave power sources of more than 30 GHz and more than 50 kW for ion production;

b. Solenoidal "superconductive" electromagnets of more than 30 cm inner diameter, with a magnetic field of more than 2 T and uniform to better than 1% over the central 80% of the inner volume;

(For the embargo status of:
Microwave power sources, see Category 1031.1.b.; "Superconductive" electromagnets, see Category 1031.1.e.3.).