

capable of vibrating a system at 10 g RMS or more between 20 Hz and 2000 Hz, imparting forces of 50 kN (11,250 lbs) or greater.

4501. 8. Vacuum and controlled atmosphere metallurgical melting and casting furnaces as follows; and specially configured computer control and monitoring systems and "specially designed software" therefor:
- Arc remelt and casting furnaces with consumable electrode capacities between 1000 cm<sup>3</sup> and 20,000 cm<sup>3</sup> and capable of operating with melting temperatures above 1700°C,
  - Electron beam melting and plasma atomization and melting furnaces with a power of 50 kW or greater and capable of operating with melting temperatures above 1200°C.

## 4502. NUCLEAR-RELATED DUAL-USE MATERIALS

4502. 1. Aluminum alloys capable of an ultimate tensile strength of 460 Mpa (.46 x 10<sup>9</sup> N/m<sup>2</sup>) or more at 293K (20°C), in the form of tubes or solid forms (including forgings) with an outside diameter of more than 75 mm (3 in.)

### NOTE 1:

"Capable of" encompasses aluminum alloys before or after heat treatment.

4502. 2. Beryllium:  
Beryllium metal, alloys that contain more than 50 weight per cent beryllium, compounds that contain beryllium, and manufactures thereof, except:
- Beryllium metal windows for X-ray machines;
  - Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits.

### NOTE 2:

Item 4502.2 includes waste and scrap containing beryllium as defined above.

4502. 3. Bismuth (high-purity:99.99% or greater) with less than 10 parts per million silver content.
4502. 4. Boron and boron compounds, mixtures and loaded materials in which the boron-10 isotope content is more than 20 weight per cent of the total boron content.
4502. 5. Calcium (high-purity) containing both, less than 1000 parts per million by weight of metallic impurities other than magnesium, and less than 10 parts per million of boron.
4502. 6. Chlorine trifluoride (ClF<sub>3</sub>)
4502. 7. Crucibles made of materials resistant to liquid actinide metals, as follows:
- Crucibles with a volume of between 150 ml and 8 liters and made of or coated with any of the following materials having a purity of 98% or greater:
    - Calcium fluoride (CaF<sub>2</sub>),
    - Calcium zirconate (metazirconate) (Ca<sub>2</sub>ZrO<sub>3</sub>)
    - Cerium sulfide (Ce<sub>2</sub>S<sub>3</sub>)
    - Erbium oxide (erbia) (Er<sub>2</sub>O<sub>3</sub>),
    - Hafnium oxide (hafnia) (HfO<sub>2</sub>),
    - Magnesium oxide (MgO),
    - Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30%Ti, 20%W)
    - Yttrium oxide (yttria) (Y<sub>2</sub>O<sub>3</sub>)
    - Zirconium oxide (zirconia) (ZrO<sub>2</sub>)

- Crucibles with a volume of between 50 ml and 2 liters and made of or lined with tantalum, having a purity of 99.9% or greater.
- Crucibles with a volume of between 50 ml and 2 liters and made of or lined with tantalum (having a purity of 98% or greater) coated with tantalum carbide, nitride, or boride (or any combination of these).

4502. 8. Fibrous and filamentary, composite structures as follows:
- Carbon or aramid fibrous and filamentary materials having a "specific modulus" of 12.7 x 10<sup>6</sup>m or greater or a "specific tensile strength" of 23.5 x 10<sup>4</sup>m or greater; or
  - Glass fibrous and filamentary materials having a "specific modulus" of 3.18 x 10<sup>6</sup>m or greater or a "specific tensile strength" of 7.62 x 10<sup>4</sup>m or greater
  - composite structures in the form of tubes with an inside diameter of between 75 mm (3 in.) and 400 mm (16 in.) made with "fibrous and filamentary" materials controlled in (a.) above

### NOTE 3:

- "Fibrous and filamentary" materials include continuous monofilaments, continuous yarns and tapes.
- "Specific modulus" is the Young's modulus in N/m<sup>2</sup> divided by the specific weight in N/m<sup>3</sup> when measured at a temperature of 23±2°C and a relative humidity of 50±5%
- "Specific tensile strength" is the ultimate tensile strength in N/m<sup>2</sup> divided by the specific weight in N/m<sup>3</sup> when measured at a temperature of 23±2°C and a relative humidity of 50±5%

4502. 9. Hafnium metal, alloys and compounds that contain more than 60 weight percent hafnium and manufactures thereof.

4502. 10. Lithium (isotopically enriched in lithium-6), as follows:
- Metal hydrides or alloys containing lithium enriched in the 6 isotope <sup>6</sup>Li to a concentration higher than the one existing in nature, (7.5% on an atom-percentage basis); and
  - Any other materials that contain lithium enriched in the 6 isotope, <sup>6</sup>Li (including compounds, mixtures, and concentrates) except where incorporated in thermoluminescent dosimeters.

11. Magnesium (high-purity) containing both less than 200 parts per million by weight of metallic impurities other than calcium and less than 10 parts per million of boron.

12. Maraging steel capable of an ultimate tensile strength of 2050 Mpa (2.050 x 10<sup>9</sup> N/m<sup>2</sup>) (300,000 lb/in.<sup>2</sup>) or more at 293K (20°C) except forms in which no linear dimension exceeds 75 mm.

### NOTE 4:

"Capable of" encompasses maraging steel before or after heat treatment.

13. Radium-226 except radium contained in medical applications.

14. Titanium alloys capable of an ultimate tensile strength of 900 MPa (.9 x 10<sup>9</sup> N/m<sup>2</sup>) (130,500 lb/in.<sup>2</sup>) or more at 293K (20°C), in the form of tubes or solid forms (including forgings) with an outside diameter of more than 75 mm (3 in.)

### NOTE 5:

"Capable of" encompasses titanium alloys before or after heat treatment.

15. Tungsten as follows:

Parts made of tungsten, tungsten carbide, or tungsten alloys containing more than 90 weight percent, having a mass greater than 20 kg and a hollow cylindrical symmetry (including cylinder segments) with an inside diameter greater than 100 mm (4 in.) but less than 300 mm (12 in.), except parts specifically designed for use as weights or gamma-ray collimators.

16. Zirconium: (see also item 4004)

Zirconium metal, alloys containing more than 50 weight percent zirconium, and compounds in which the ratio of hafnium content to zirconium content is less than 1 part to 500 parts by weight, and manufactures wholly thereof; except zirconium in the form of foil having a thickness not exceeding .10 mm (.004 in.)

### NOTE 6:

Item 4502.16 includes waste and scrap containing zirconium as defined above.

## 4503. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS

4503. 1. Electrolytic cells for fluorine production with a production capacity greater than 250 g of fluorine per hour.

4503. 2. Rotor fabrication and assembly equipment and bellows-forming mandrels and dies, as follows:

- Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles, and end caps. Such equipment includes precision mandrels, clamps, and shrink fit machines.

- Rotor straightening equipment for alignment of gas centrifuge rotor tube sections to a common axis. (Note: Normally such equipment will consist 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.)

- Bellows-forming mandrels and dies for producing single-convolution bellows (bellows made of high-strength aluminum alloys, maraging steel, or high-