Republic of the Philippines
Department of Science and Technology
PHILIPPINE NUCLEAR RESEARCH INSTITUTE
Commonwealth Avenue,
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PNRI ADMINISTRATIVE ORDER NO. 2 Series of 2009

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

WHEREAS, the Philippine Nuclear Research Institute (PNRI) is mandated by Republic Act No. 5207, as amended by P.D. 1484, to protect the health and safety of workers and of the general public, and to protect against the use of atomic energy facilities and materials for unauthorized purposes;

WHEREAS, the PNRI has published in the Official Gazette the Code of PNRI Regulations (CPR) Part 3, "Standards for Protection Against Radiation", which set requirements to ensure the protection of workers occupationally exposed to radiation, the general public, and the environment against the harmful effects of ionizing radiation;

WHEREAS, the PNRI has published in the Official Gazette CPR Part 26, "Security of Radioactive Sources", which set requirements to prevent unauthorized access or damage to, and loss, theft or unauthorized transfer of radioactive sources, so as to reduce the likelihood of accidental harmful exposure to such sources or the malicious use of such sources to cause harm to individuals, society or the environment;

WHEREAS, the PNRI has established Requirements on the Import and Export of Radioactive Sources in an Appendix to CPR Parts 11, 12, 14 and 15;

WHEREAS, the PNRI adopts **IAEA Information Circular/254/Rev.7/Part2 entitled "Guidelines for Transfers of Nuclear-Related Dual-Use Equipment, Materials, Software, and Related Technology"** to avert the proliferation of nuclear weapons and prevent acts of nuclear terrorism, and in the interest of international peace and security;

WHEREAS, the PNRI authorizes the transfers of equipment, materials, software, or related technology identified in the **Annex except:** for use in a non-nuclear-weapon state in a nuclear explosive activity or an unsafeguarded nuclear fuel-cycle activity, or in general, when there is unacceptable risk of diversion to such an activity, or when the transfers are contrary to the objective of averting the proliferation of nuclear weapons, or when there is an unacceptable risk of diversion to acts of nuclear terrorism;

WHEREAS, the definitions, technical notes, explanatory notes and other information in the Annex to IAEA Information Circular/254/Rev.7/Part2 shall be applicable when addressed in the Annex herein;

WHEREAS, "nuclear explosive activity" includes research on or development, design, manufacture, construction, testing or maintenance of any nuclear explosive device or components or subsystems of such a device; and "unsafeguarded nuclear fuel-cycle ativity" includes research on or development, design, manufacture, construction, operation or maintenance of any reactor, critical facility, conversion plant, fabrication plant, reprocessing plant, plant for the separation of isotopes of source or special fissionable material, or separate storage installation;

WHEREAS, the PNRI will make verification of the following information in considering whether to authorize transfers:

(a) Whether the recipient state is a party to the Nuclear Non-Proliferation Treaty (NPT) or to the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco), or to a similar international legally-binding nuclear non-proliferation agreement, and has an IAEA safeguards agreement in force applicable to all its peaceful nuclear activities;

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

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

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

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

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

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

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

(i) Whether there is a risk of retransfers of equipment, material, software, or related technology identified in the Annex or of transfers of any replica thereof contrary to the provisions in this authorization, as a result of a failure by the recipient State to develop and maintain appropriate, effective national export and transshipment controls.

WHEREAS, transfer will be authorized by PNRI only after it has obtained from the end-user a statement specifying the uses and end-use locations of the proposed transfer and an assurance explicitly stating that the proposed transfer or any replica thereof will not be used in any nuclear explosive activity or unsafeguarded nuclear fuel-cycle activity;

WHEREAS, before authorizing the transfer of equipment, materials, software, or related technology identified in the Annex to a country not adhering to the IAEA Guidelines, the PNRI requires assurances that its consent will be secured, prior to any transfer to a third country of the equipment, materials, software, or related technology, or any replica thereof;

WHEREAS, transfer of items not listed in the Annex which are or may be intended, in their entirety or in part, for use in connection with a “nuclear explosive activity” shall require an authorization from PNRI;

WHEREAS, the PNRI reserves to itself discretion as to the application of the requirements stated herein to other items of significance in addition to those identified in the Annex, and as to the application of other conditions for transfer that it may consider necessary;

ANNEX

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

1. INDUSTRIAL EQUIPMENT

1.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

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

a. A `cold area´ greater than 0.09 m2;
b. A density greater than 3 g/cm3; and
c. A thickness of 100 mm or greater.

1.A.2. **Radiation-hardened TV cameras**, or lenses therefore, specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5 x 104 Gy (silicon) without operational degradation.

1.A.3. **'Robots', 'end-effectors' and control units** as follows:

a. 'Robots' or 'end-effectors' having either of the following characteristics:
   1. Specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives); or
   2. Specially designed or rated as radiation hardened to withstand a total radiation dose greater than 5 x 104 Gy (silicon) without operational degradation;

b. Control units specially designed for any of the 'robots' or 'end-effectors' specified in Item *2.'End-effectors'.*

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

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

1.B. TEST AND PRODUCTION EQUIPMENT

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

a. Machines having both of the following characteristics:
   1. Three or more rollers (active or guiding); 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.

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:

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;

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".

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.”

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".

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

a. Computer controlled or numerically controlled dimensional inspection machines having both of the following characteristics:
   1. Two or more axes; and
   2. A one-dimensional length "measurement uncertainty" equal to or better (less) than (1.25 + L/1000) µm tested with a probe of an "accuracy" of better (less) than 0.2 µm (L is the measured length in millimeters) (Ref: VDI/VDE 2617 parts 1 and 2);

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);

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

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°.

1.B.4. **Controlled atmosphere (vacuum or inert gas) induction furnaces**, and **power supplies** therefore, 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;

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

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

a. ´Isostatic presses´ having both of the following characteristics:
   1. Capable of achieving a maximum working pressure of 69 MPa or greater; 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 1.B.5.a.

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 1.B.6.a.;

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

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

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

a. Arc remelt and casting furnaces having both of the following characteristics:
   1. Consumable electrode capacities between 1000 and 20000 cm3; 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 1.B.7.a. or 1.B.7.b.

1.C. MATERIALS

None.

1.D. SOFTWARE

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

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

1.D.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".

1.E. TECHNOLOGY

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

2. MATERIALS

2.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

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

a. Crucibles having both of the following characteristics:
   1. A volume of between 150 cm3 (150 ml) and 8000 cm3 (8 liters); and
   2. Made of or coated with any of the following materials, having a purity of 98% or greater byweight:
      (a) Calcium fluoride (CaF2);
      (b) Calcium zirconate (metazirconate) (CaZrO3);
      (c) Cerium sulfide (Ce2S3);
      (d) Erbium oxide (erbia) (Er2O3);
      (e) Hafnium oxide (hafnia) (HfO2);
      (f) Magnesium oxide (MgO);
      (g) Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);
      (h) Yttrium oxide (yttria) (Y2O3); or
      (i) Zirconium oxide (zirconia) (ZrO2);

b. Crucibles having both of the following characteristics:
   1. A volume of between 50 cm3 (50 ml) and 2000 cm3 (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 cm3 (50 ml) and 2000 cm3 (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.A.2. **Platinized catalysts** specially designed or prepared for promoting the hydrogen isotope exchange reaction between hydrogen and water for the recovery of tritium from heavy water or for the production of heavy water.

2.A.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 2.C.7.a. or carbon prepreg materials specified in Item 2.C.7.c.

2.B. TEST AND PRODUCTION EQUIPMENT

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

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

b. Equipment for tritium facilities or plants, as follows:
   1. Hydrogen or helium refrigeration units capable of cooling to 23 K (-250 ºC) or less, with heat removal capacity greater than 150 W;
   2. Hydrogen isotope storage or purification systems using metal hydrides as the storage or purification medium.

2.B.2. Lithium isotope separation facilities or plants, and **equipment** therefore e, 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.

2.C. MATERIALS

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

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

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

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.

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.

2.C.4. **Boron** enriched in the boron-10 (10B) 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.

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.

2.C.6. **Chlorine trifluoride (ClF3).**

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 106 m or greater; or
   2. A ´specific tensile strength´ of 23.5 x 104 m or greater;

b. Glass "fibrous or filamentary materials" having both of the following characteristics:
   1. A ´specific modulus´ of 3.18 x 106 m or greater; and
   2. A ´specific tensile strength´ of 7.62 x 104 m or greater;

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

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

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

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.

2.C.11**. Maraging steel '**capable of**'** an ultimate tensile strength of 2050 MPa or more at 293 K (20 °C).

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

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.

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.

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.

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

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 2.C.16.a.

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.

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

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; and

d. Products or devices containing any of the foregoing.

2.D. SOFTWARE

None

2.E. TECHNOLOGY

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

3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS

3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

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

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%.

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

a. Copper vapor lasers having both of the following characteristics:
   1. Operating at wavelengths between 500 and 600 nm; and
   2. An average output power equal to or greater than 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;

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;

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 m output wavelength and at a repetition rate greater than 250 Hz.

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.

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.

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

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

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

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

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

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

3.A.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.

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 m3/s; and

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

3.B. TEST AND PRODUCTION EQUIPMENT

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

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

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

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

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

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

a. Centrifugal balancing machines designed for balancing flexible rotors having a length of 600 mm or more and having all of the following characteristics:
   1. Swing or journal diameter greater than 75 mm;
   2. Mass capability of from 0.9 to 23 kg; and
   3. Capable of balancing speed of revolution greater than 5000 rpm;

b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics:
   1. Journal diameter greater than 75 mm;
   2. Mass capability of from 0.9 to 23 kg;
   3. Capable of balancing to a residual imbalance equal to or less than 0.010 kg x mm/kg per plane; and
   4. Belt drive type.

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

a. Filament winding machines having all of the following characteristics:
   1. Having motions for positioning, wrapping, and winding fibers coordinated and programmed in two or more axes;
   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 3.B.4.a.;

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

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

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

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 UF6;

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 UF6;

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

3.C. MATERIALS

None.

3.D. SOFTWARE

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

3.E. TECHNOLOGY

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

4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT

4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

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

a. Made of phosphor bronze mesh chemically treated to improve wettability; and

b. Designed to be used in vacuum distillation towers.

4.A.2. Pumps capable of circulating solutions of concentrated or dilute potassium amide catalyst in liquid mmonia (KNH2/NH3), having all of the following characteristics:

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

b. A capacity greater than 8.5 m3/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.

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

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

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

4.B. TEST AND PRODUCTION EQUIPMENT

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

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.B.1.a.

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

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

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

c. Constructed of either:
1. Stainless steel of the 300 series with low sulfur content and with an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; or
2. Equivalent materials which are both cryogenic and H2-compatible; and

d. With internal diameters of 1 m or greater and effective lengths of 5 m or greater.

4.B.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.C. MATERIALS

None.

4.D. SOFTWARE

None.

4.E. TECHNOLOGY

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

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

5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

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

a. Photocathode area of greater than 20 cm2; and

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

5.B. TEST AND PRODUCTION EQUIPMENT

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

a. 1. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and
2. With a figure of merit (K) of 0.25 or greater; or

b. 1. An accelerator peak electron energy of 25 MeV or greater; and
2. A peak power greater than 50 MW.

5.B.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.

5.B.3. **Mechanical rotating mirror cameras**, as follows, and specially designed components therefore:

a. Framing cameras with recording rates greater than 225000 frames per second;
b. Streak cameras with writing speeds greater than 0.5 mm/µs.

5.B.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 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 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 5.B.4.c.

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

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

b. Manganin gauges for pressures greater than 10 GPa;

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

5.B.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.

5.C. MATERIALS

None.

5.D. SOFTWARE

None.

5.E. TECHNOLOGY

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

6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES

6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

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

a. Electrically driven explosive detonators, as follows:
   1. Exploding bridge (EB);
   2. Exploding bridge wire (EBW);
   3. Slapper;
   4. Exploding foil initiators (EFI);

b. Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface over an area greater than 5000 mm2 from a single firing signal with an initiation timing spread over the surface of less than 2.5 µs.

6.A.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 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 ºC to 100 ºC) or specified as suitable for aerospace applications.

6.A.3. Switching devices as follows:

a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:
   1. Containing three or more electrodes;
   2. Anode peak voltage rating of 2.5 kV or more;
   3. Anode peak current rating of 100 A or more; and
   4. Anode delay time of 10 µs or less;

b. Triggered spark-gaps having both of the following characteristics:
   1. Anode delay time of 15 µs or less; and
   2. Rated for a peak current of 500 A or more;

c. Modules or assemblies with a fast switching function having all of the following characteristics:
   1. Anode peak voltage rating greater than 2 kV;
   2. Anode peak current rating of 500 A or more; and
   3. Turn-on time of 1 µs or less.

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

a. 1. Voltage rating greater than 1.4 kV;
   2. Energy storage greater than 10 J;
   3. Capacitance greater than 0.5 µF; and
   4. Series inductance less than 50 nH; or

b. 1. Voltage rating greater than 750 V;
   2. Capacitance greater than 0.25 µF; and
   3. Series inductance less than 10 nH.

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

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

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

6.B. TEST AND PRODUCTION EQUIPMENT

None.

6.C. MATERIALS

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

a. Cyclotetramethylenetetranitramine (HMX) (CAS 2691-41-0);
b. Cyclotrimethylenetrinitramine (RDX) (CAS 121-82-4);
c. Triaminotrinitrobenzene (TATB) (CAS 3058-38-6);
d. Hexanitrostilbene (HNS) (CAS 20062-22-0); or
e. Any explosive with a crystal density greater than 1.8 g/cm3 and having a detonation velocity greater than 8000 m/s.

6.D. SOFTWARE

None.

6.E. TECHNOLOGY

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

NOW THEREFORE, pursuant to Section 4 (a) to (c) of R.A. 5207, as amended, the PNRI hereby issues this Order in the interest of national safety and security.

This Order shall take effect fifteen (15) days after its publication in the Official Gazette.

Approved:

ALUMANDA M. DELA ROSA, Ph. D.
Director, PNRI

Date: October 16, 2009