COOPERATION AGREEMENT BETWEEN THE GOVERNMENT OF THE REPUBLIC OF INDIA AND THE GOVERNMENT OF THE FRENCH REPUBLIC ON THE DEVELOPMENT OF PEACEFUL USES OF NUCLEAR ENERGY

The Government of the Republic of India and the Government of the French Republic, hereinafter referred to as the "Parties",

NOTING the deep ties of friendship and cooperation between the Republic of India and the French Republic, and the Strategic Partnership established between them in January 1998;

NOTING further the existence of a long-standing cooperation between the Parties in the use of nuclear energy for peaceful purposes;

RECOGNISING that nuclear energy provides a safe, environment friendly and sustainable source of energy and the need to further develop international cooperation in promoting the use of nuclear energy for peaceful purposes;

RECOGNISING also that nuclear energy will provide an indispensable source of energy to future generations;

RECALLING the ongoing dialogue on civil nuclear cooperation and on nuclear safety and the ongoing projects that are taking place as a result of this dialogue;

RECOGNISING that both Parties are States with comprehensive capabilities in advanced nuclear technologies, including in the nuclear fuel cycle;

DETERMINED that further development of international cooperation in promoting the use of nuclear energy for peaceful purposes shall equally benefit both Parties;

DESIRING to have further bilateral cooperation for expanding and deepening full civil nuclear cooperation for the development and use of nuclear energy for peaceful purposes with a view to achieving sustainable development and strengthening energy security on a reliable, stable and predictable basis;

DESIRING, in the interest of the two States to develop such cooperation on the basis of mutual respect for sovereignty, non-interference in each other's internal affairs, equality, mutual benefit, reciprocity, with due respect for each other's nuclear programs and in accordance with the principles governing their respective nuclear policies and their respective international obligations;

RECALLING further the Joint Statement issued by the Prime Minister of the Republic of India and the President of the French Republic on the 12th of September 2005 and the India-France Declaration on the Development of

Nuclear Energy for Peaceful Purposes signed in New Delhi on the 20th of February 2006 in which both Parties called for the conclusion of a bilateral nuclear cooperation agreement between the two countries;

NOTING that the two States share common concerns and objectives of non-proliferation of weapons of mass destruction and their means of delivery including in view of possible linkages to terrorism and that international cooperation in peaceful uses of nuclear energy should be consistent with these objectives.

HAVE AGREED as follows

Article I

1. The Parties shall cooperate in the use of nuclear energy for peaceful and non-explosive purposes in accordance with the provisions of this Agreement, having due regard for the principles of international law, in good faith, in accordance with the principles governing their respective nuclear policies as well as with their respective relevant international obligations.

2. Cooperation as referred to in paragraph 1 of this Article may cover the following areas:

- Basic and applied research not requiring the supply of uranium enriched to twenty (20) per cent or greater in the isotope U-235;
- The development and use of nuclear energy applications in the fields of agronomy, biology, earth sciences and medicine, and in industry;
- Full civil nuclear cooperation activities covering nuclear reactors, nuclear fuel supply and other aspects as agreed between the Parties;
- Nuclear fuel and nuclear fuel cycle management including through the development of strategic reserve of nuclear fuel to guard against any disruption of supply over the life time of India's safeguarded nuclear reactors;
- Nuclear waste management;
- Nuclear safety, radiation and environment protection;
- The prevention of, and response to, emergency situations resulting from radioactive or nuclear accidents;
- Controlled thermonuclear fusion in particular in multilateral projects such as ITER;
- Public awareness and acceptance of the benefits of the use of nuclear energy for peaceful and non-explosive purposes;

and any other field as jointly agreed by the Parties.

3. Cooperation under the Agreement may take the following forms:

- Technology transfer on an industrial or commercial scale between the Parties or persons designated by them;
- Exchange and training of scientific and technical staff;
- Exchange of scientific and technical information;
- Participation by scientific and technical staff of one Party in research and development activities conducted by the other Party;
- Joint conduct of research and engineering activities, including joint research and experimentation based on balanced contributions;
- Organization of scientific and technical conferences and symposia;
- Supply of material, nuclear material, equipment, technology, facilities and services including setting up of nuclear power projects;
- Progressive localization in the territory of the recipient Party by persons designated by the Parties through sourcing of equipment and components including through transfer of technology for the implementation of nuclear projects;
- Consultations and cooperation in relevant international fora;
- Nuclear cooperation projects in third countries;

and any other form of cooperation as jointly agreed by the Parties.

4. The Parties affirm that the purpose of this Agreement is to provide for peaceful nuclear cooperation and not to affect the unsafeguarded nuclear activities of either Party. Accordingly, nothing in this Agreement shall be interpreted as affecting the rights of the Parties to use for their own purposes nuclear material, material, equipment, components, information or technology produced, acquired or developed by them independent of any nuclear material, material, equipment, components, information or technology transferred to them pursuant to this Agreement. This Agreement shall be implemented in a manner so as not to hinder or otherwise interfere with any other activities involving the use of nuclear material, material, equipment, components, information or technology and unsafeguarded nuclear facilities produced, acquired or developed by them independent of this Agreement for their own purposes.

Article II

1. Cooperation between the Parties as defined in Article I shall be implemented in accordance with the provisions of this Agreement through:

- specific agreements between the Parties or persons designated by the Parties with implementing this Agreement, intended in particular to detail scientific and technical programmes and arrangements for scientific and technical exchanges;

- memoranda of understanding or contracts signed by the persons designated by the Parties on industrial realizations and the supply of material, nuclear material, services, equipment, setting up of facilities and localization issues and transfer of technology as appropriate.

2. Specific agreements, memoranda of understanding and contracts already concluded between the persons designated by the Parties shall be governed by the provisions of this Agreement at the time it enters into force.

3. Transfer of nuclear material, material, equipment, components and technology under this Agreement may be undertaken directly between the Parties or through persons designated by them. Nuclear material, material, equipment, components and technology transferred from the territory of one Party to the territory of the other Party, whether directly or through a third country, will be regarded as having been transferred pursuant to the Agreement only upon confirmation, by the appropriate authority of the recipient Party to the appropriate authority of the supplier Party, that such nuclear material, material, equipment, components and technology both will be subject to this Agreement and have been received.

Article III

In compliance with their respective national legislation, the Parties shall adopt all the administrative, tax and customs measures within their jurisdiction required for the proper implementation of this Agreement.

Article IV

1. Both Parties shall cooperate in the design, construction and commissioning of nuclear power plants in conformity with appropriate regulatory requirements.

2. The Parties encourage their operators to develop cooperation between them in this field on mutually acceptable terms and conditions.

Article V

1. The Party supplying nuclear power plant shall facilitate reliable, uninterrupted and continued access to the Party on whose territory the nuclear power plant is located, to nuclear fuel supplies, reactor systems and components for the lifetime of the supplied nuclear power plant. In respect of supply of nuclear fuel for the lifetime of India's safeguarded reactors, long-term contracts in accordance with Article II (1) will be established between respective designated entities of the Parties.

2. To further guard against any disruption of supply over the lifetime of India's safeguarded reactors, France will support an Indian effort to develop a strategic reserve of nuclear fuel. This support includes France convening a group of friendly countries or joining such a group convened by others to pursue such measures as would restore fuel supply to India in the event of disruption of fuel supplies to India.

3. Reprocessing and any other alteration in form or content of nuclear material transferred pursuant to this Agreement and nuclear material used in or produced through the use of material, nuclear material, equipment or technology so transferred shall be carried out in a national nuclear facility under IAEA safeguards. Any special fissionable material that may be separated thereby may be stored and utilized in national facilities in the recipient country under IAEA safeguards.

Article VI

1. The Parties shall facilitate nuclear trade between themselves in the mutual interests of their respective industry, utilities and consumers and also, where appropriate, trade between third countries and either Party of items obligated to the other Party.

2. The Parties recognize that reliability of supplies is essential and that industry in both Parties need continuing reassurance that deliveries can be made on time, including where appropriate, through progressive localization and indigenisation of production, in order to plan for the efficient operation of nuclear installations.

Article VII

1. The Parties or persons designated by the Parties with implementing this Agreement shall protect in an adequate and effective manner intellectual property created and technology transferred within the framework of the cooperation undertaken pursuant to this Agreement and the specific Agreements, memoranda of understanding and contracts referred to in article II.

2. The parties shall endeavor to reach an agreement on intellectual property rights to provide the necessary framework for implementing the provisions of this article.

3. This Agreement shall not affect the right of use of intellectual property rights gained by persons prior to this Agreement. The conditions of use, conferment and transfer of intellectual property rights shall be specified on a case-by-case basis in the specific agreements and contracts referred to in Article II of this Agreement.

Article VIII

1. The Parties or persons designated by the Parties with implementing this Agreement shall deal with liability issues, including civil nuclear liability, in specific agreements.

2. The Parties agree that, for the purpose of compensating for damage caused by a nuclear incident involving material, nuclear material, equipment, facilities and technology referred to in Article IX, each Party shall create a civil nuclear liability regime based upon established international principles.

Article IX

The Parties shall ensure that the material, nuclear material, equipment, facilities and technology transferred under this Agreement, as well as the nuclear material recovered or obtained as by-products, are used for peaceful and non-explosive purposes.

Article X

1. Taking into account the provisions mentioned in Article V, all the material, nuclear material, equipment, facilities and technology transferred to the Republic of India under this Agreement and notified by the supplier Party to that end, as well as all the successive generations of nuclear material recovered or obtained as by-products, shall be and remain subject to IAEA safeguards pursuant to the agreements already entered into by the Republic of India and to the agreements the Republic of India has agreed to enter into with the IAEA and a additional protocol when in force.

2. All the nuclear material transferred to the French Republic under this Agreement and notified by the supplier Party to that end, as well as all successive generations of nuclear material recovered or obtained as by-products from the nuclear material transferred shall be subject to IAEA safeguards pursuant to the Agreement on the application of safeguards in France signed by France, the European Atomic Energy Community (EURATOM) and the IAEA on 20 and 27 July 1978, as supplemented by the additional protocol to this agreement, signed by France, EURATOM and the IAEA on 22 September 1998.

3. If the IAEA decides that the application of safeguards is not possible, the supplier and the recipient country should consult and agree on appropriate verification measures.

Article XI

The material, nuclear material, equipment, facilities and technology referred to in Article IX of this Agreement, as well as the nuclear material recovered or obtained as by-products shall remain subject to the provisions of this Agreement until:

(a) They have been transferred or retransferred beyond the jurisdiction of the recipient Party in accordance with the provisions of Article XV of this Agreement, or returned to the Party having initially transferred them, or until

(b) The Parties decide by mutual agreement that they are no longer subject to this Agreement and withdraw them from that jurisdiction, or until

(c) It has been established by the IAEA, in accordance with the provisions for the termination of safeguards of the agreements between the Government of the Republic of India and the Agency or between the Government of the French Republic, EURATOM and the Agency, concerning nuclear material, that it has been consumed or diluted to the extent that it is no longer usable for any nuclear activity relevant from the point of view of Agency safeguards, or that it is no longer practicably recoverable.

Article XII

The Parties shall guarantee the security and preserve the confidentiality of technical data and information designated as confidential by the party having provided that data and information under this Agreement. The technical data and information exchanged shall not be communicated to third parties, whether public or private, without prior written approval from the Party providing that technical data or information.

Article XIII

Each Party shall ensure that the material, nuclear material, equipment, facilities and technology referred to in Article IX of this Agreement, as well as the nuclear material recovered or obtained as by-products, are exclusively held by persons under its jurisdiction and authorized by it to hold those items.

Article XIV

1. Each Party shall make sure that, within its territory, or outside its territory to the point where that responsibility is taken over by the other Party or by a third State, adequate measures to ensure the physical protection of the material, nuclear material, equipment and facilities referred to in this Agreement are adopted, in accordance with its national legislation and the international commitments to which it is a signatory, in particular the Convention on the Physical Protection of Nuclear Material of 26 October 1979 and its amendment adopted on 8 July 2005 (hereinafter referred to as "the Convention").

2. In regard to nuclear material, the minimum levels of physical protection shall be those specified in annex I of the Convention. Each Party reserves the right, where necessary and in accordance with its national regulations, to apply stricter physical protection criteria.

3. Implementing measures of physical protection is the responsibility of each Party within its jurisdiction. In the implementation of those measures, each Party will be guided by the IAEA recommendations contained in the Agency document INFCIRC 225/Rev.4.

4. Amendments to IAEA recommendations on physical protection shall only be effective under the terms of this Agreement following mutual written notification by the two Parties of their approval of these amendments.

Article XV

Should one of the Parties consider retransferring material, nuclear material, equipment, facilities and technology referred to in Article IX to a third State, or transferring material, nuclear material, equipment, facilities and technology retrieved from equipment and facilities transferred originally or obtained from transferred equipment, facilities and technology, referred to in Article IX, that Party shall only do so after being given by the recipient of those transfers the assurance of a commitment to peaceful and non-explosive use, of the implementation of IAEA safeguards and of adequate physical protection measures. Furthermore, it shall first be given the written consent of the other Party, except if the planned transfer or retransfer is destined for a member State of the European Union.

Article XVI

Nothing in this Agreement shall be interpreted as affecting the obligations which, on the date of signature thereof, result from the participation by either of the Parties in other international agreements on the use of nuclear energy for peaceful purposes, including those arising from France's membership of the European Communities.

Article XVII

1. The Parties undertake to consult at the request of either Party regarding the implementation of this Agreement and the development of further cooperation in the field of peaceful uses of nuclear energy on a stable, reliable and predictable basis. The Parties recognize that such cooperation is between two states possessing advanced nuclear technology and while ensuring that the Parties have the same benefits and advantages, shall consult in a manner and through arrangement specified in paragraph 2 of this Article in order to realize full cooperation envisaged under Articles I and II and effective implementation of this Agreement. Such consultations shall be formalized through a Joint Committee established for this purpose.

2. Representatives of the Parties shall meet at the request of either Party with a view to consulting on matters arising from the application of this Agreement.

3. Each Party shall endeavour to avoid any action that affects cooperation specified under Article I of this Agreement. If either Party, at any time following the entry into force of this Agreement decides that the other Party does not comply with any of the provisions of this Agreement, the Parties shall promptly hold consultations with a view to resolving the matter in a way that protects the legitimate interests of both Parties, it being understood that rights of either Party under Article XX(6) remain unaffected.

4. The dispute settlement procedures resulting from contractual obligations relating to the implementation of this Agreement shall be specified in the concerned commercial contracts between the persons designated by the respective Parties.

Article XVIII

1. Both Parties agree that terms and provisions contained in this Agreement shall not be amended through out the period this Agreement is in force unless both Parties decide otherwise by mutual consent through written agreement between the Parties.

2. Any amendment to this Agreement shall be subject to ratification, acceptance or approval by the Parties, in accordance with their respective constitutional provisions. Each Party shall notify the other of the completion of these procedures. Amendments shall enter into force on the date the later of these notifications is received.

Article XIX

The Annexes to this Agreement shall form an integral part of the said Agreement.

Article XX

1. Each Party shall notify the other of the completion of the procedures it requires for the entry into force of this Agreement.

2. This Agreement shall enter into force on the date the later of these notifications is received.

3. This Agreement shall remain in force for a period of forty (40) years and it shall be automatically renewable for periods of twenty (20) years. A Party that does not wish to renew this Agreement shall notify the other Party by giving six months' written notice.

4. Either Party shall have the right to terminate this Agreement prior to its expiration on one year's written notice to the other Party. A Party giving notice of termination shall provide the reasons for seeking such termination. Both Parties consider it extremely unlikely that actions would be taken by either Party which would cause the other Party to terminate this Agreement. If a Party seeking termination cites a violation of the Agreement as the reason for notice for seeking termination, Parties shall consider whether the action was caused inadvertently or otherwise and whether the violation could be considered as material.

5. The Agreement shall terminate one year from the date of the written notice, unless the notice has been withdrawn by the providing Party in writing prior to the date of termination. The termination of cooperation shall be without prejudice to the implementation of contracts, ongoing projects and fuel supply commitments made under this Agreement prior to the termination of cooperation.

6. In the event this Agreement is not renewed in accordance with the procedure referred to in paragraph 3 of this Article or is terminated in accordance with the procedure referred to in paragraph 4 of this Article,

- The relevant provisions of this Agreement shall remain applicable to the specific agreements and contracts in force signed under Article II;

- The relevant provisions of Articles VII, VIII, IX, X, XI, XII, XIII, XIV, XV, and XVI shall continue to apply, when applicable, to the material, nuclear material, equipment, facilities and technology referred to in Article IX and transferred pursuant to this Agreement, as well as to the nuclear material recovered or obtained as by-products and will remain in force.

IN WITNESS WHEREOF, the representatives of the two Governments, being duly authorized thereto, have signed this Agreement.

DONE at Paris on 30th September, 2008, in duplicate, in the English, Hindi and French languages, all texts being equally authentic.

For the Government of the Republic of India	For the Government of the French Republic

ANNEX 1

This Annex is an integral part of the Agreement.

For the purposes of this Agreement.

(a) "Person" shall mean any natural person or legal entity subject to the territorial jurisdiction of either Party but does not include the Parties;

(b) "Material" means non-nuclear material for reactors specified in paragraph 2 of the Annex 2 to this Agreement which is an integral part of this agreement;

(c) "Nuclear material" means any "source material" or "special fissionable material" as those terms are defined in Article XX of the Statute of the IAEA;

(d) "Nuclear material recovered or obtained as by-products" means nuclear material obtained from nuclear material transferred under this Agreement, or by processing or reprocessing it once or several times with the help of equipment or facilities transferred under this Agreement or with the help of equipment and facilities based upon technology transferred under this Agreement;

(e) "Equipment" means the major components specified in paragraphs 1, 3 to 7 of Annex 2;

(f) "Facilities' means the plants referred to in paragraphs 1, 3 to 7 of Annex 2;

(g) "Technology" means the specific information necessary for the "development", "production" or "use" of items listed in Annex 2 with the exception of data "In the public domain" or of "Basic scientific research".

"Development" refers to all stages 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.

"Production" shall mean all production phases such as construction, production engineering, manufacture, integration, assembly (mounting), inspection, testing, quality assurance.

"Use" shall mean operation, installation (including on-site installation), maintenance, repairs, overhaul and refurbishing.

"Basic scientific research" means experimental or theoretical work undertaken principally to acquire new knowledge of the fundamental principles of phenomena and observable facts, not primarily directed towards a specific practical aim or objective.

"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.)

(h) "Information" means any information that is not in public domain and is transferred in any form pursuant to this Agreement and is so designated and documented in hard copy or digital form by agreement of the Parties that it shall be subject to this Agreement, but will cease to be information whenever the Party transferring the information or any third party legitimately releases it in public domain.

(i) "Intellectual property" has the meaning given by article 2 of the constituent instrument of the World Intellectual Property Organization (WIPO) signed in Stockholm on 14 July 1967.

ANNEX 2

This Annex is an integral part of the Agreement.

1. NUCLEAR REACTORS AND EQUIPMENTS FOR REACTORS

1.1 Complete nuclear reactors

Nuclear reactors capable of operation 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.

1.2. 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 paragraph 1.1. above, as well as relevant reactor internals as defined in paragraph 1.8. below.

1.3. 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 paragraph 1.1. above.

1.4. Nuclear reactor control rods and equipment

Especially designed or prepared rods, supports or suspension structures therefor, rod drive mechanisms or rod guide tubes to control the fission process in a nuclear reactor as defined in paragraph 1.1 above.

1.5. 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 paragraph 1.1. above at an operating pressure in excess of 50 atmospheres.

1.6. Zirconium tubes

Zirconium metal and alloys in the form of tubes or assemblies of tubes, and in quantities exceeding 500 kg for any one recipient country in a period of 12 months, especially designed or prepared for use in a reactor as defined in paragraph 1.1. above, and in which the relation of hafnium to zirconium is less than 1:500 parts by weight.

1.7. Primary coolant pumps

Pumps especially designed or prepared for circulating the primary coolant for nuclear reactors as defined in paragraph 1.1. above.

1.8. Nuclear reactor internals

"Nuclear reactor internals" especially designed or prepared for use in a nuclear reactor as defined in paragraph 1.1. above, including support columns for the core, fuel channels, thermal shields, baffles, core grid plates, and diffuser plates.

1.9. Heat exchangers

Heat exchangers (steam generators) especially designed or prepared for use in the primary coolant circuit of a nuclear reactor as defined in paragraph 1.1. above.

1.10. 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 paragraph 1.1. above.

2. NON NUCLEAR MATERIALS FOR REACTORS

2.1. 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 paragraph 1.1. above, in quantities exceeding 200 kg of deuterium atoms for any one recipient country in any period of 12 months.

2.2. Nuclear grade graphite

Graphite having a purity level better 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 paragraph 1.1 above, in quantities exceeding 30 metric tons for any one recipient country in any period of 12 months.

3. PLANTS FOR THE REPROCESSING OF FUEL ELEMENTS AND EQUPMENT ESPECIALLY DESIGNED OR PREPARED THEREFOR

3.1. Irradiated fuel element chopping machines

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.

3.2. Dissolvers

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.

3.3. Solvent extractors and solvent extraction equipment

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.

3.4. Chemical holding or storage vessels

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,

(2) a maximum diameter of 175 mm (7 in) for cylindrical vessels,

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

4. PLANTS FOR THE FABRICATION OF NUCLEAR REACTOR FUEL ELEMENTS

A "plant for the fabrication of nuclear reactor fuel elements" includes 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.

5. PLANTS FOR THE SEPARATION OF ISOTOPES OF URANIUM AND EQUIPMENT, OTHER THAN ANALYTICAL INSTRUMENTS, ESPECIALLY DESIGNED OR PREPARED THEREFOR

Items of equipment that are considered to fall within the meaning of the phrase "equipment, other than analytical instruments, especially designed or prepared" for the separation of isotopes of uranium include:

5.1. Gas centrifuges and assemblies and components especially designed or prepared for use in gas centrifuges

5.1.1. 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 5.1.1.(c) following. The rotor is fitted with an internal baffle(s) and end caps, as described in section 5.1.1.(d) and (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 UF6 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) 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}).

5.1.2. 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 UF6-resistant material (see EXPLANATORY NOTE to Section 5.2.). The magnet couples with a pole piece or a second magnet fitted to the top cap described in Section 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 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 UF6.

(f) Scoops:

Especially designed or prepared tubes of up to 12 mm (0.5 in) internal diameter for the extraction of UF6 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 UF6.

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

5.2.1. Feed systems/product and tails withdrawal systems

Especially designed or prepared process systems including

Feed autoclaves (or stations), used for passing UF6 to the centrifuge cascades at up to 100 kPa (15 psi) and at a rate of 1 kg/h or more;

Desublimers (or cold traps) used to remove UF6 from the cascades at up to 3 kPa (0.5 psi) pressure. The desublimers are capable of being chilled to 203 K (-70°C) and heated to 343 K (70°C);

'Product' and 'Tails' stations used for trapping UF6 into containers.

This plant, equipment and pipework is wholly made of or lined with UF6-resistant materials (see EXPLANATORY NOTE to this section) and is fabricated to very high vacuum and cleanliness standards.

5.2.2. Machine header piping systems

Especially designed or prepared piping systems and header systems for handling UF6 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 UF6-resistant materials (see EXPLANATORY NOTE to this section) and is fabricated to very high vacuum and cleanliness standards.

5.2.3. UF6 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 UF6gas 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.

5.2.4. Frequency changers

Frequency changers (also known as converters or invertors) especially designed or prepared to supply motor stators as defined under 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 UF6 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 UF6 include stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel.

5.3. Especially designed or prepared assemblies and components for use in gaseous diffusion enrichment

5.3.1. 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 UF6, 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 UF6-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.

5.3.2. 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 UF6-resistant materials and designed for horizontal or vertical installation.

5.3.3. 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 UF6, and with a discharge pressure of up to several hundred kPa (100 psi), designed for long-term operation in the UF6 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 UF6.

5.3.4. 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 UF6. Such seals are normally designed for a buffer gas in-leakage rate of less than 1000 cm^3/min (60 in^3/min).

5.3.5. Heat exchangers for cooling UF6

Especially designed or prepared heat exchangers made of or lined with UF6-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).

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 UF6 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' UF6 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 UF6 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' UF6 gaseous streams flowing from exit points are passed by way of cascade header pipework to either cold traps or to compression stations where the UF6 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.

5.4.1. 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:

Feed autoclaves (or systems), used for passing UF6 to the gaseous diffusion cascades;

Desublimers (or cold traps) used to remove UF6 from diffusion cascades;

Liquefaction stations where UF6 gas from the cascade is compressed and cooled to form liquid UF6;

"Product" or "tails" stations used for transferring UF6 into containers.

5.4.2. Header piping systems

Especially designed or prepared piping systems and header systems for handling UF6 within the gaseous diffusion cascades. This piping network is normally of the "double" header system with each cell connected to each of the headers.

5.4.3. 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 UF6-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.

5.4.4. Special shut-off and control valves

Especially designed or prepared manual or automated shut-off and control bellows valves made of UF6-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.

5.4.5. UF6 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 UF6 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.

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

5.5.1. 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 UF6 and having a knife-edge within the nozzle that separates the gas flowing through the nozzle into two fractions.

5.5.2. 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 UF6, 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.

5.5.3. 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 UF6 and with a suction volume capacity of 2 m^3/min or more of UF6/carrier gas (hydrogen or helium) mixture.

5.5.4. 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 UF6/carrier gas mixture.

5.5.5. Heat exchangers for gas cooling

Especially designed or prepared heat exchangers made of or protected by materials resistant to corrosion by UF6.

5.5.6. Separation element housings

Especially designed or prepared separation element housings, made of or protected by materials resistant to corrosion by UF6, for containing vortex tubes or separation nozzles.

5.5.7. 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 UF6, including:

(a) Feed autoclaves, ovens, or systems used for passing UF6 to the enrichment process;

(b) Desublimers (or cold traps) used to remove UF6 from the enrichment process for subsequent transfer upon heating;

(c) Solidification or liquefaction stations used to remove UF6 from the enrichment process by compressing and converting UF6 to a liquid or solid form;

(d) 'Product' or 'tails' stations used for transferring UF6 into containers.

5.5.8. Header piping systems

Especially designed or prepared header piping systems, made of or protected by materials resistant to corrosion by UF6, for handling UF6 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.

5.5.9. 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 UF6-bearing atmospheres.

(b) Vacuum pumps especially designed or prepared for service in UF6-bearing atmospheres and made of or protected by materials resistant to corrosion by UF6. These pumps may use fluorocarbon seals and special working fluids.

5.5.10. 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 UF6 with a diameter of 40 to 1500 mm for installation in main and auxiliary systems of aerodynamic enrichment plants.

5.5.11. UF6 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 UF6 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.

5.5.12. UF6/carrier gas separation systems

Especially designed or prepared process systems for separating UF6 from carrier gas (hydrogen or helium).

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

5.6.1. 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).

5.6.2. 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).

5.6.3. 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.

(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.

5.6.4. 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.

5.6.5. 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.

5.6.6. 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.

5.6.7. 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).

5.6.8. 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.

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

5.7.1. 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.

5.7.2. 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.

5.7.3. 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.

5.7.4. Separator module housings (AVLIS)

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

5.7.5. Supersonic expansion nozzles (MLIS)

Especially designed or prepared supersonic expansion nozzles for cooling mixtures of UF6 and carrier gas to 150 K or less and which are corrosion resistant to UF6.

5.7.6. Uranium pentafluoride product collectors (MLIS)

Especially designed or prepared uranium pentafluoride (UF5) solid product collectors consisting of filter, impact, or cyclone-type collectors, or combinations thereof, and which are corrosion resistant to the UF5/UF6 environment.

5.7.7. UF6/carrier gas compressors (MLIS)

Especially designed or prepared compressors for UF6/carrier gas mixtures, designed for long term operation in a UF6 environment. The components of these compressors that come into contact with process gas are made of or protected by materials resistant to corrosion by UF6.

5.7.8. 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 UF6/carrier gas mixture.

5.7.9. Fluorination systems (MLIS)

Especially designed or prepared systems for fluorinating UF5 (solid) to UF6 (gas).

5.7.10. UF6 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 UF6 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.

5.7.11. 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 UF6, including:

(a) Feed autoclaves, ovens, or systems used for passing UF6 to the enrichment process;

(b) Desublimers (or cold traps) used to remove UF6 from the enrichment process for subsequent transfer upon heating;

(c) Solidification or liquefaction stations used to remove UF6 from the enrichment process by compressing and converting UF6 to a liquid or solid form;

(d) 'Product' or 'tails' stations used for transferring UF6 into containers.

5.7.12. UF6/carrier gas separation systems (MLIS)

Especially designed or prepared process systems for separating UF6 from carrier gas. The carrier gas may be nitrogen, argon, or other gas.

5.7.13. Laser systems (AVLIS, MLIS and CRISLA)

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

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

5.8.1. 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.

5.8.2. 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.

5.8.3. 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.

5.8.4. 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.

5.8.5. 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.

5.8.6. 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.

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

5.9.1. 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 vapor 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.

(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.

5.9.2. 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.

5.9.3. 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.

6. PLANTS FOR THE PRODUCTION OR CONCENTRATION OF HEAVY WATER, DEUTERIUM AND DEUTERIUM COMPOUNDS AND EQUIPMENT ESPECIALLY DESIGNED OR PREPARED THEREFOR

Items especially designed or prepared for heavy water production, either by the water-hydrogen sulphide exchange process, either by the ammonia-hydrogen exchange process:

6.1. 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.

6.2. 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% H2S) 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 H2S service.

6.3. 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.

6.4. 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.

6.5. 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.

6.6. Infrared Absorption Analyzers

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

6.7. 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.

6.8. 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.

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 SECTIONS 4 AND 5 RESPECTIVELY, AND EQUIPMENT ESPECIALLY DESIGNED OR PREPARED THEREFOR

7.1. Plants for the conversion of uranium and equipment especially designed or prepared therefor

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

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

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

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

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

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

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

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

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

7.2. Plants for the conversion of plutonium and equipment especially designed or prepared therefor

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

7.2.2. Especially designed or prepared systems for plutonium metal production