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COMMUNICATION RECEIVED FROM CERTAIN MEMBER STATES REGARDING GUIDELINES FOR THE EXPORT OF NUCLEAR MATERIAL, EQUIPMENT AND TECHNOLOGY

Nuclear Transfers

1. The Director General has received notes verbales dated 17 October 1996 Representatives to the Agency of Argentina, Australia, Austria, Belgium, I Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Irelanc Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Po Romania, the Russian Federation, the Slovak Republic, South Africa, Spain, Ukraine, the United Kingdom of Great Britain and Northern Ireland, and tl America relating to the export of nuclear material, equipment and techno General has received a similar note verbale dated 30 July 1997 from the Res the Agency of Brazil.

2. The purpose of the notes verbales is to provide further information or Guidelines for Nuclear Transfers.

3. In the light of the wish expressed at the end of each note verbale, verbales is enclosed. The attachment to these notes verbales is also re enclosure.

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*/ INFCIRC/254/Rev.2/Part 2/Mod.1 contains Guidelines for Transfers of Nuclear-related Material and related Technology.

The Permanent Mission of [Member State] presents its compliments General of the International Atomic Energy Agency and has the honour to information on its government's nuclear export policies and practices.

The Government of [Member State] has decided that the current Para Guidelines should be deleted, since it is redundant on the grounds that th current Paragraph 16 is covered by Paragraph 11 - Non-proliferation Principl

Developments in nuclear technology have brought about the need to fu amend parts of the Trigger List which is incorporated in Annexes A and B currently published in document INFCIRC/254/Rev. 2/Part 1.

In the interest of clarity, the complete text of the Guidelines includi is reproduced in the attachment.

The Government of [Member State] has decided to act in accordance wi for Nuclear Transfers so revised.

In reaching this decision, the Government of [Member State] is fully contribute to economic development while avoiding contributing in any way proliferation of nuclear weapons or other nuclear explosive devices, and non-proliferation assurances from the field of commercial competition.

[The Government of (Member State), so far as trade within the Eur concerned, will implement this decision in the light of its commitments as Union[1].]

The Government of [Member State] would be grateful if the Director this Note and its attachment to the attention of the Members States of the

The Permanent Mission of [Member State] avails itself of this opport Director General of the Atomic Energy Agency the assurances of its highest c

[1] This paragraph is included in notes verbales from members of the European Union

1. The following fundamental principles for safeguards and export controls shou transfers for peaceful purposes to any non-nuclear-weapon State and, in the retransfer, to transfers to any State. In this connection, suppliers have def

Prohibition on nuclear explosives

2. Suppliers should authorize transfer of items or related technology identified i formal governmental assurances from recipients explicitly excluding uses whicl nuclear explosive device.

Physical protection

3. (a) All nuclear materials and facilities identified by the agreed trigger lis effective physical protection to prevent unauthorized use and handling. protection to be ensured in relation to the type of materials, equipment a agreed by the suppliers, taking account of international recommendations.

   (b) The implementation of measures of physical protection in the recipient coun responsibility of the Government of that country. However, in order to agreed upon amongst suppliers, the levels of physical protection on which to be based should be the subject of an agreement between supplier and rec

   (c) In each case special arrangements should be made for a clear definition the transport of trigger list items.

Safeguards

4. (a) Suppliers should transfer trigger list items or related technology to a non-nuclea only when the receiving State has brought into force an agreement with the application of safeguards on all source and special fissionable material peaceful activities.

   (b) Transfers covered by paragraph 4 (a) to a non-nuclear-weapon State withou agreement should be authorized only in exceptional cases when they are de the safe operation of existing facilities and if safeguards are applic Suppliers should inform and, if appropriate, consult in the event that the to deny such transfers.

   (c) The policy referred to in paragraph 4 (a) and 4 (b) does not apply to ag drawn up on or prior to April 3, 1992. In case of countries that have ad INFCIRC/254/Rev. 1/Part 1 later than April 3, 1992, the policy only appli be) drawn up after their date of adherence.

   (d) Under agreements to which the policy referred to in paragraph 4 (a) do paragraphs 4 (b) and (c)) suppliers should transfer trigger list items or when covered by IAEA safeguards with duration and coverage provisions in IAEA doc. GOV/1621. However, suppliers undertake to strive for the e implementation of the policy referred to in paragraph 4 (a) under such agr

   (e) Suppliers reserve the right to apply additional conditions of supply as a matter of nati policy.

5. Suppliers will jointly reconsider their common safeguards requirements, wheneve

Safeguards triggered by the transfer of certain technology

6. (a) The requirements of paragraphs 2, 3 and 4 above should also apply t reprocessing, enrichment, or heavy-water production, utilizing technology by the supplier or derived from transferred facilities, or major critical

(b) The transfer of such facilities, or major critical components thereof, or re should require an undertaking (1) that IAEA safeguards apply to any facili (i.e. if the design, construction or operating processes are based on the or chemical processes, as defined in the trigger list) constructed during recipient country and (2) that there should at all times be in effect permitting the IAEA to apply Agency safeguards with respect to such facili recipient, or by the supplier in consultation with the recipient, as using

Special controls on sensitive exports

7. Suppliers should exercise restraint in the transfer of sensitive facilities, te materials. If enrichment or reprocessing facilities, equipment or technolog suppliers should encourage recipients to accept, as an alternative to na involvement and/or other appropriate multinational participation in resultin should also promote international (including IAEA) activities concerned with fuel cycle centres.

Special controls on export of enrichment facilities, equipment and technology

8. For a transfer of an enrichment facility, or technology therefor, the recipie neither the transferred facility, nor any facility based on such technology, w for the production of greater than 20% enriched uranium without the consent of which the IAEA should be advised.

Controls on supplied or derived weapons-usable material

9. Suppliers recognize the importance, in order to advance the objectives of t provide opportunities further to reduce the risks of proliferation, of includi of nuclear materials or of facilities which produce weapons-usable material, mutual agreement between the supplier and the recipient on arrangements for r alteration, use, transfer or retransfer of any weapons-usable material invo endeavour to include such provisions whenever appropriate and practicable.

Controls on retransfer

10. (a) Suppliers should transfer trigger list items or related technology, inclu
under paragraph 6, only upon the recipient's assurance that in the case of

(1) retransfer of such items or related technology,

or

(2) transfer of trigger list items derived from facilities originally tra
or with the help of equipment or technology originally transferred by

the recipient of the retransfer or transfer will have provided the sam
required by the supplier for the original transfer.

(b) In addition the supplier's consent should be required for: (1) any retra
or related technology and any transfer referred to under paragraph 10 (a
which does not require full scope safeguards, in accordance with paragr
Guidelines, as a condition of supply; (2) any retransfer of the fac
components, or technology described in paragraph 6; (3) any transfer o
critical components derived from those items; (4) any retransfer of hea
usable material.

(c) To ensure the consent right as defined under paragraph 10 (b), governme
assurances will be required for any relevant original transfer.

Non-proliferation Principle

11. Notwithstanding other provisions of these Guidelines, suppliers should authori
related technology identified in the trigger list only when they are satisfied
contribute to the proliferation of nuclear weapons or other nuclear explosive d

SUPPORTING ACTIVITIES

Physical Security

12. Suppliers should promote international co-operation on the exchange of physical security information,
protection of nuclear materials in transit, and recovery of stolen nuclear mate

Support for effective IAEA safeguards

13. Suppliers should make special efforts in support of effective implementation
Suppliers should also support the Agency's efforts to assist Member States in t
national systems of accounting and control of nuclear material and to in
effectiveness of safeguards.

Similarly, they should make every effort to support the IAEA in increasing further
safeguards in the light of technical developments and the rapidly growing numb
and to support appropriate initiatives aimed at improving the effectiveness of

Sensitive plant design features

14. Suppliers should encourage the designers and makers of sensitive equipment to
way as to facilitate the application of safeguards.

Consultations

15. (a) Suppliers should maintain contact and consult through regular channels on matt
with the implementation of these Guidelines.

(b) Suppliers should consult, as each deems appropriate, with other Governme
specific sensitive cases, to ensure that any transfer does not contribut
instability.

(c) In the event that one or more suppliers believe that there has be
supplier/recipient understandings resulting from these Guidelines, particu
explosion of a nuclear device, or illegal termination or violation of I
recipient, suppliers should consult promptly through diplomatic channels i
and assess the reality and extent of the alleged violation.

Pending the early outcome of such consultations, suppliers will not act i
prejudice any measure that may be adopted by other suppliers concerning th
with that recipient.

Upon the findings of such consultations, the suppliers, bearing in mind Article XII of the
Statute, should agree on an appropriate response and possible action whi
termination of nuclear transfers to that recipient.

16. Unanimous consent is required for any changes in these Guidelines, including a
from the reconsideration mentioned in paragraph 5.

TRIGGER LIST REFERRED TO IN GUIDELINES

GENERAL NOTE

The object of these controls should not be defeated by the transfer of component pa
take such actions as it can to achieve this aim and will continue to seek a workab
parts, which could be used by all suppliers.

TECHNOLOGY CONTROLS

The transfer of "technology" directly associated with any item in the List will be
of scrutiny and control as will the item itself, to the extent permitted by nationa

Controls on "technology" transfer do not apply to information "in the public domai
research".

DEFINITIONS

"Technology" means specific information required for the "development", "production
contained in the List. This information may take the form of "technical data", or

"Basic scientific research" - Experimental or theoretical work undertaken prin
knowledge of the fundamental principles of phenomena and observable facts, not prim
specific practical aim or objective.

"development" - is related to all phases before "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

"in the public domain" - "In the public domain, "as it applies herein, means techn
available without restrictions upon its further dissemination. (Copyright res
technology from being in the public domain.)

"production" - means all production phases such as:

- construction
- production engineering
- manufacture
- integration
- assembly (mounting)
- inspection
- testing
- quality assurance

"technical assistance" - "Technical assistance" may take forms such as: instructi
knowledge, consulting services.

Note: "Technical assistance" - may involve transfer of "technical data".

"technical data" - "Technical data" may take forms such as blueprints, plans, dia
engineering designs and specifications, manuals and instructions written or reco
devices such as disk, tape, read-only memories.

"use" - Operation, installation (including on-site installation), maintenance (che
refurbishing.

1. Source and special fissionable material

As defined in Article XX of the Statute of the International Atomic Energy Ager

1.1. “Source material”

The term “source material” means uranium containing the mixture of isotopes o uranium depleted in the isotope 235; any of the foregoing in the form of compound, or concentrate; any other material containing one or more of th concentration as the Board of Governors shall from time to time determine; an the Board of Governors shall from time to time determine.

1.2. “Special fissionable material”

i) The term “special fissionable material” means plutonium-239; uranium-233; enriched in the isotopes 235 or 233; any material containing one or more such other fissionable material as the Board of Governors shall from time but the term “special fissionable material” does not include source materi

ii) The term “uranium enriched in the isotopes 235 or 233” means uranium conta 235 or 233 or both in an amount such that the abundance ratio of the sum the isotope 238 is greater than the ratio of the isotope 235 to the is nature.

However, for the purposes of the Guidelines, items specified in subparagraph of source or special fissionable material to a given recipient country, with below the limits specified in subparagraph (b) below, shall not be included:

(a) Plutonium with an isotopic concentration of plutonium-238 exceeding 80%.

Special fissionable material when used in gram quantities or less as a sensing comp instruments; and

Source material which the Government is satisfied is to be used only in n such as the production of alloys or ceramics;

(b) Special fissionable material 50 effective grams;
Natural uranium 500 kilograms;
Depleted uranium 1000 kilograms; and
Thorium 1000 kilograms.

2. Equipment and Non-nuclear Materials

The designation of items of equipment and non-nuclear materials adopted by the Government is as follows (quantities below the levels indicated in the Annex B being regarde
practical purposes):

2.1. Nuclear reactors and especially designed or prepared equipment and components
Annex B, section 1.);

2.2. Non-nuclear materials for reactors (see Annex B, section 2.);

2.3. Plants for the reprocessing of irradiated fuel elements, and equipment espec
prepared therefor (see Annex B, section 3.);

2.4. Plants for the fabrication of nuclear reactor fuel elements, and equipment especially d
prepared therefor (see Annex B, section 4.);

2.5. Plants for the separation of isotopes of uranium and equipment, other th
instruments, especially designed or prepared therefor (see Annex B, sectio

2.6. Plants for the production or concentration of heavy water, deuterium and deuter
and equipment especially designed or prepared therefor (see Annex B, secti

2.7. Plants for the conversion of uranium and equipment especially designed or prepared ther
(see Annex B, section 7.).

(1) "Major critical components" are:

(a) in the case of an isotope separation plant of the gas centrifuge type: g corrosion-resistant to UF_6;

(b) in the case of an isotope separation plant of the gaseous diffusion type:

(c) in the case of an isotope separation plant of the jet nozzle units; t

(d) in the case of an isotope separation plant of the vortex type: the vortex

(2) For facilities covered by paragraph 6 of the Guidelines for which no major described in paragraph 2 above, if a supplier nation should transfer in the fraction of the items essential to the operation of such a facility, togeth construction and operation of that facility, that transfer should be deemed to or major critical components thereof".

(3) For the purposes of implementing paragraph 6 of the Guidelines, the followin deemed to be "of the same type (i.e. if their design, construction or operati the same or similar physical or chemical processes)";

Where the technology transferred is such as to make possible the construction in the recipient State of a facility of the following type, or major critical components thereof:	The following will be deemed to be facilities of the same type:
(a) an isotope separation plant of the gaseous diffusion type…………..	any other isotope separation plant using the gas centrifuge process.
(b) an isotope separation plant of the gas centrifuge type……………………..	any other isotope separation plant using the gas centrifuge process.
(c) an isotope separation plant of the jet nozzle type………………………	any other isotope separation plant using the jet nozzle process.
(d) an isotope separation plant of the vortex type………………………	any other isotope separation plant using the vortex process.
(e) a fuel reprocessing plant using the solvent extraction process………….	any other fuel reprocessing plant using the solvent extraction process.
(f) a heavy water plant using the exchange process…………………..	any other heavy water plant using the exchange process.
(g) a heavy water plant using the electrolytic process…………………	any other heavy water plant using the electroytic process.
(h) a heavy water plant using the hydrogen distillation process………	any other heavy water plant using the hydrogen distillation process.

Note:In the case of reprocessing, enrichment, and heavy water facilities whose
or operation processes are based on physical or chemical processes other th
above, a similar approach would be applied to define facilities "of the same ty
major critical components of such facilities might arise.

(4) The reference in paragraph 6 (b) of the Guidelines to "any facilities of th during an agreed period in the recipient's country" is understood to refer to critical components thereof), the first operation of which commences within a years from the date of the first operation of (1) a facility which has been transferred major critical components or of (2) a facility of the same type technology. It is understood that during that period there would be a conclus facility of the same type utilized transferred technology. But the agreed per the duration of the safeguards imposed or the duration of the right to ide constructed or operated on the basis of or by the use of transferred techno paragraph 6 (b) of the Guidelines.

NNEX B

CLARIFICATION OF ITEMS ON THE TRIGGER LIST
(as designated in Section 2 of Part A of Annex A)

1. Nuclear reactors and especially designed or prepared equipment and components t

1.1. Complete nuclear reactors

Nuclear reactors capable of operation so as to maintain a controlled self-s
reaction, excluding zero energy reactors, the latter being defined as reactors
rate of production of plutonium not exceeding 100 grams per year.

EXPLANATORY NOTE

A “nuclear reactor” basically includes the items within or attached directly to the reactor vessel,
controls the level of power in the core, and the components which normally contain or come
control the primary coolant of the reactor core.

It is not intended to exclude reactors which could reasonably be capable of modification to pr
100 grams of plutonium per year. Reactors designed for sustained operation at significant pow
capacity for plutonium production are not considered as “zero energy reactors”.

EXPORTS

The export of the whole set of major items within this boundary will take place only in accor
the Guidelines. Those individual items within this functionally defined boundary which w
accordance with the procedures of the Guidelines are listed in paragraphs 1.2 to 1.10. The G
the right to apply the procedures of the Guidelines to other items within the functionally def

1.2. Nuclear reactor vessels

Metal vessels, or major shop-fabricated parts therefor, especially designed o
core of a nuclear reactor as defined in paragraph 1.1 above, as well as rele
defined in paragraph 1.8 below.

EXPLANATORY NOTE

The reactor vessel head is covered by item 1.2. as a major shop-fabricated part of a reactor ve

1.3. Nuclear reactor fuel charging and discharging machines

Manipulative equipment especially designed or prepared for inserting or removing
reactor as defined in paragraph 1.1. above.

EXPLANATORY NOTE

The items noted above are capable of on-load operation or of employing technically sophisticat
features to allow complex off-load fueling operations such as those in which direct viewing o
normally available.

1.4. Nuclear reactor control rods and equipment

Especially designed or prepared rods, support or suspension structures therefor, rod drive me
or rod guide tubes to control the fission process in a nuclear reactor as defi

1.5. Nuclear reactor pressure tubes

Tubes which are especially designed or prepared to contain fuel elements and t
reactor as defined in paragraph 1.1. above at an operating pressure in excess

1.6. Zirconium tubes

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

1.7. Primary coolant pumps

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

EXPLANATORY NOTE

Especially designed or prepared pumps may include elaborate sealed or multi-sealed systems to prevent leakage of primar
coolant, canned-driven pumps, and pumps with inertial mass systems. This definition encompasse
1 or equivalent standards.

1.8. Nuclear reactor internals

“Nuclear reactor internals” especially designed or prepared for use in a nucl
paragraph 1.1 above, including support columns for the core, fuel channels, t
core grid plates, and diffuser plates.

EXPLANATORY NOTE

“Nuclear reactor internals” are major structures within a reactor vessel which have one or more
supporting the core, maintaining fuel alignment, directing primary coolant flow, providing rac
vessel, and guiding in-core instrumentation.

1.9. Heat exchangers

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

EXPLANATORY NOTE

Steam generators are especially designed or prepared to transfer the heat generated in the reactor (primary
water (secondary side) for steam generation. In the case of a liquid metal fast breeder rea
liquid metal coolant loop is also present, the heat exchangers for transferring heat from the
coolant circuit are understood to be within the scope of control in addition to the steam gene
this entry does not include heat exchangers for the emergency cooling system or the decay heat

1.10. Neutron detection and measuring instruments

Especially designed or prepared neutron detection and measuring instruments fo
flux levels within the core of a reactor as defined in paragraph 1.1 above.

EXPLANATORY NOTE

The scope of this entry encompasses in-core and ex-core instrumentation which measure flux
typically from 10^4 neutrons per cm^2 per second to 10^{10} neutrons per cm^2 per second or more. Ex-core refers to tho
instruments outside the core of a reactor as defined in paragraph 1.1 above, but located withi

2. Non-nuclear materials for reactors

2.1. Deuterium and heavy water

Deuterium, heavy water (deuterium oxide) and any other deuterium compound in deuterium to hydrogen atoms exceeds 1:5000 for use in a nuclear reactor as de above, in quantities exceeding 200 kg of deuterium atoms for any one recipient of 12 months.

2.2. Nuclear grade graphite

Graphite having a purity level better than 5 parts per million boron equiva greater than 1.50 g/cm^3 for use in a nuclear reactor as defined in paragraph 1.1 abo exceeding 30 metric tons for any one recipient country in any period of 12 mont

EXPLANATORY NOTE

For the purpose of export control, the Government will determine whether or not the exports of specifications are for nuclear reactor use.

Boron equivalent (BE) may be determined experimentally or is calculated as the sum of BE_Z for impurities (excluding BE_{carbon} since carbon is not considered an impurity) including boron, where:

BE_Z (ppm) = CF $\times$ concentration of element Z (in ppm);
CF is the conversion factor: ($\sigma_Z \times A_B$) divided by ($\sigma_B \times A_Z$);
σ_B and σ_Z are the thermal neutron capture cross sections (in barns) for naturally occurrin
respectively; A_B and A_Z are the atomic masses of naturally occurring boron and element Z resp

3. Plants for the reprocessing of irradiated fuel elements, and equipment espec prepared therefor

INTRODUCTORY NOTE

Reprocessing irradiated nuclear fuel separates plutonium and uranium from intensely radioactive transuranic elements. Different technical processes can accomplish this separation. Howeve become the most commonly used and accepted process. Purex involves the dissolution of irradi acid, followed by separation of the uranium, plutonium, and fission products by solvent ext tributyl phosphate in an organic diluent.

Purex facilities have process functions similar to each other, including: irradiated fuel ele solvent extraction, and process liquor storage. There may also be equipment for thermal den conversion of plutonium nitrate to oxide or metal, and treatment of fission product waste liqu term storage or disposal. However, the specific type and configuration of the equipment perf differ between Purex facilities for several reasons, including the type and quantity of i reprocessed and the intended disposition of the recovered materials, and the safety and incorporated into the design of the facility.

A "plant for the reprocessing of irradiated fuel elements", includes the equipment and components which normally c direct contact with and directly control the irradiated fuel and the major nuclear material streams.

These processes, including the complete systems for plutonium conversion and plutonium meta identified by the measures taken to avoid criticality (e.g., by geometry), radiation exposure hazards (e.g., by containment).

EXPORTS

The export of the whole set of major items within this boundary will take place only in accordance with the Guidelines.

The Government reserves to itself the right to apply the procedures of the guidelines to other defined boundary as listed below.

Items of equipment that are considered to fall within the meaning of the p especially designed or prepared" for the reprocessing of irradiated fuel elemen

3.1. Irradiated fuel element chopping machines

INTRODUCTORY NOTE

This equipment breaches the cladding of the fuel to expose the irradiated nuclear material designed metal cutting shears are the most commonly employed, although advanced equipment, su used.

Remotely operated equipment especially designed or prepared for use in a re identified above and intended t cut, chop or shear irradiated nuclear fuel asse

INTRODUCTORY NOTE

Dissolvers normally receive the chopped-up spent fuel. In these critically safe vessels, the irr
dissolved in nitric acid and the remaining hulls removed from the process stream.

Critically safe tanks (e.g., small diameter, annular or slab tanks) especiall
use in a reprocessing plant as identified above, intended for dissolution of
which are capable of withstanding hot, highly corrosive liquid, and which can
maintained.

3.3. Solvent extractors and solvent extraction equipment

INTRODUCTORY NOTE

Solvent extractors both receive the solution of irradiated fuel from the dissolvers and the or
the uranium, plutonium, and fission products. Solvent extraction equipment is normally desig
parameters, such as long operating lifetimes with no maintenance requirements or adaptabil
simplicity of operation and control, and flexibility for variations in process conditions.

Especially designed or prepared solvent extractors such as packed or pulse co
centrifugal contactors for use in a plant for the reprocessing of irradiated f
be resistant to the corrosive effect of nitric acid. Solvent extractors a
extremely high standards (including special welding and inspection and quality
control techniques) out of low carbon stainless steels, titanium, zirconium
materials.

3.4. Chemical holding or storage vessels

INTRODUCTORY NOTE

Three main process liquor streams result from the solvent extraction step. Holding or stor
further processing of all three streams, as follows:

(a) The pure uranium nitrate solution is concentrated by evaporation and passed to a denitr
converted to uranium oxide. This oxide is re-used in the nuclear fuel cycle.

(b) The intensely radioactive fission products solution is normally concentrated by evaporation and stored
concentrate. This concentrate may be subsequently evaporated and converted to a form s
disposal.

(c) The pure plutonium nitrate solution is concentrated and stored pending its transfer to
particular, holding or storage vessels for plutonium solutions are designed to avoid cr
from changes in concentration and form of this stream.

Especially designed or prepared holding or storage vessels for use in a plant for th
irradiated fuel. The holding or storage vessels must be resistant to the cor
The holding or storage vessels are normally fabricated of materials such as lo
titanium or zirconium, or other high quality materials. Holding or storage ve
remote operation and maintenance and may have the following features for c
criticality:

(1) walls or internal structures with a boron equivalent of at least two per cen

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

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

3.5. Plutonium nitrate to oxide conversion system

INTRODUCTORY NOTE

In most reprocessing facilities, this final process involves the conversion of the plutonium dioxide. The main functions involved in this process are: process feed storage and adj solid/liquor separation, calcination, product handling, ventilation, waste management, and proc

Complete systems especially designed or prepared for the conversion of plutoniu oxide, in particular adapted so as to avoid criticality and radiation effect hazards.

3.6. Plutonium oxide to metal production system

INTRODUCTORY NOTE

This process, which could be related to a reprocessing facility, involves the fluorination o tonium dioxide, normally with highly corrosive hydrogen fluoride, to produce plutonium fluoride which is subsequently calcium metal to produce metallic plutonium and a calcium fluoride slag. The main functions i fluorination (e.g., involving equipment fabricated or lined with a precious metal), metal redu crucibles), slag recovery, product handling, ventilation, waste management and process control.

Complete systems especially designed or prepared for the production of plutonium me adapted so as to avoid criticality and radiation effects and to minimize toxic

4. Plants for the fabrication of nuclear reactor fuel elements, and equipment esp
prepared therefor

INTRODUCTORY NOTE

Nuclear fuel elements are manufactured from one or more of the source or materials mentioned in Part A of this annex. For oxide fuels, the mot common for pressing pellets, sintering, grinding and grading will be present. Mixed glove boxes (or equivalent containment) until they are sealed in the cladding. hermetically sealed inside a suitable cladding which is designed to be the pr the fuel so as to provide suitable performance and safety during reactor opera precise control of processes, procedures and equipment to extremely high star order to ensure predictable and safe fuel performance.

EXPLANATORY NOTE

Items of equipment that are considered to fall within the meaning of the phrase "and equipme prepared" for the fabrication of fuel elements include equipment which:

a. normally comes in direct contact with, or directly processes, or controls, the production

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.

Such equipment of systems of equipment may include, for example:

1) fully automatic pellet inspection stations especially designed or prepared for checking f defects of fuel pellets;

2) automatic welding machines especially designed or prepared for welding end caps onto the

3) automatic test and inspection stations especially designed or prepared for checking the pins (or rods).

Item 3 typically includes equipment for: a) x-ray examination of pin (or rod) end cap welds, pressurized pins (or rods), and c) gamma-ray scanning of the pins (or rods) to check for corr inside.

instruments, especially designed or prepared therefor

Items of equipment that are considered to fall within the meaning of the phras analytical instruments, especially designed or prepared" for the separation include:

5.1. Gas centrifuges and assemblies and components especially designed or prepared centrifuges

INTRODUCTORY NOTE

The gas centrifuge normally consists of a thin-walled cylinder(s) of between 75 mm (3 in) anc contained in a vacuum environment and spun at high peripheral speed of the order of 300 m/s or vertical. In order to achieve high speed the materials of construction for the rotating cor strength to density ratio and the rotor assembly, and hence its individual components, have close tolerances in order to minimize the unbalance. In contrast to other centrifuges, th enrichment is characterized by having within the rotor chamber a rotating disc-shaped baffl arrangement for feeding and extracting the UF6 gas and featuring at least 3 separate channels, scoops extending from the rotor axis towards the periphery of the rotor chamber. Also cont environment are a number of critical items which do not rotate and which although they are e difficult to fabricate nor are they fabricated out of unique materials. A centrifuge facility of these components, so that quantities can provide an important indication of end use.

5.1.1. Rotating components

(a) Complete rotor assemblies:

Thin-walled cylinders, or a number of interconnected thin-walled cylinders one or more of the high strength to density ration materials described in NOTE to this Section. If interconnected, the cylinders are joined togethe rings as described in section 5.1.1(c) following. The rotor is fitted wit end caps, as described in section 5.1.1.(d) and (e) following, if in fi complete assembly may be delivered only partly assembled.

(b) Rotor tubes:

Especially designed or prepared thin-walled cylinders with thickness of 12 diameter of between 75 mm (3 in) and 400 mm (16 in), and manufactured from the high strength to density ratio materials described in the EXPLANATOR Section.

(c) Rings or Bellows:

Components especially designed or prepared to give localized support to join together a number of rotor tubes. The bellows is a short cylinder c (0.12 in) or less, a diameter of between 75 mm (3 in) and 400 mm (16 in), and manufactured from one of the high strength to density ratio materia EXPLANATORY NOTE to this Section.

(d) Baffles:

Disc-shaped components of between 75 mm (3 in) and 400 mm (16 in) diame designed or prepared to be mounted inside the centrifuge rotor tube, in or off chamber from the main separation chamber and, in some cases, to as circulation within the main separation chamber of the rotor tube, and manu the high strength to density ratio materials described in the EXPLANATOR Section.

(e) Top caps/Bottom caps:

Disc-shaped components of between 75 mm (3 in) and 400 mm (16 in) diame
designed or prepared to fit to the ends of the rotor tube, and so contain
tube, and in some cases to support, retain or contain as an integrated
upper bearing (top cap) or to carry the rotating elements of the motor
(bottom cap), and manufactured from one of the high strength to densi
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 109 N/m2 (300,000 psi) o

(b) Aluminium alloys capable of an ultimate tensile strength of 0.46 x 109 N/m2 (67,000 psi) or mor

c) Filamentry materials suitable for use in composite structures and having a specific mod
greater and a specific ultimate tensile strength of 0.3 x 106 m or greater ('Specific Mod
in N/m2 divided by the specific weight in N/m3; 'Specific Ultimate Tensile Strength'
strength in N/m2 divided by the specific weight in N/m3).

5.1.2. Static components

(a) Magnetic suspension bearings:

Especially designed or prepared bearing assemblies consisting of an annula
within a housing containing a damping medium. The housing will be manu
UF6-resistant material (see EXPLANATORY NOTE to Section 5.2.). The magn
with a pole piece or a second magnet fitted to the top cap described in
magnet may be ring-shaped with a relation between outer and inner diameter
1.6:1. The magnet may be in a form having an initial permeability of 0.
CGS units) or more, or a remanence of 98.5% or more, or an energy product
kJ/m3 (107 gauss-oersteds). In addition to the usual material properties,
the deviation of the magnetic axes from the geometrical axes is limited to
(lower than 0.1 mm or 0.004 in) or that homogeneity of the material of th
called for.

(b) Bearings/Dampers:

Especially designed or prepared bearings comprising a pivot/cup assembly moun
damper. The pivot is normally a hardened steel shaft with a hemisphere
means of attachment to the bottom cap described in section 5.1.1.(e) at
may however have a hydrodynamic bearing attached. The cup is pellet-
hemispherical indentation in one surface. These components are often supp
damper.

(c) Molecular pumps:

Especially designed or prepared cylinders having internally machined or extruded helic
grooves and internally machined bores. Typical dimensions are as follows
400 mm (16 in) internal diameter, 10 mm (0.4 in) or more wall thickness, w
to or greater than the diameter. The grooves are typically rectangular
mm (0.08 in) or more in depth.

(d) Motor stators:

Especially designed or prepared ring-shaped stators for high speed multiph reluctance) motors for synchronous operation within a vacuum in the frequ 2000 Hz and a power range of 50 - 1000 VA. The stators consist of multi-p laminated low loss iron core comprised of thin layers typically 2.0 mm (0.

(e) Centrifuge housing/recipients:

Components especially designed or prepared to contain the rotor tube as centrifuge. The housing consists of a rigid cylinder of wall thickness up precision machined ends to locate the bearings and with one or more flange machined ends are parallel to each other and perpendicular to the cylinder within 0.05 degrees or less. The housing may also be a honeycomb ty accommodate several rotor tubes. The housings are made of or protected by to corrosion by UF_6

(f) Scoops:

Especially designed or prepared tubes of up to 12 mm (0.5 in) interna extraction of UF_6 gas from within the rotor tube by a Pitot tube action (that i facing into the circumferential gas flow within the rotor tube, for exampl a radially disposed tube) and capable of being fixed to the central gas tubes are made of or protected by materials resistant to corrosion by UF_6

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

INTRODUCTORY NOTE

The auxiliary systems, equipment and components for a gas centrifuge enrichment plant are the systems of plant r
feed UF_6 to the centrifuges, to link the individual centrifuges to each other to form cascade
progressively higher enrichments and to extract the 'product' and 'tails' UF_6 from the centrifuges, together with the
equipment required to drive the centrifuges or to control the plant.

Normally UF_6 is evaporated from the solid using heated autoclaves and is distributed in gaseous f
way of cascade header pipework. The 'product' and 'tails' UF_6 gaseous streams flowing from the centrifuges are also
by way of cascade header pipework to cold traps (operating at about 203 K (- 70 °C)) where th
onward transfer into suitable containers for transportation or storage. Because an enrichm
thousands of centrifuges arranged in cascades there are many kilometers of cascade header
thousands of welds with a substantial amount of repetition of layout. The equipment, componen
fabricated to very high vacuum and cleanliness standards.

5.2.1. Fee systems/product and tails withdrawal systems

Especially designed or prepared process systems including:

Feed autoclaves (or stations), used for passing UF_6 to the centrifuge cascades at up to 100
(15 psi) and at a rate of 1 kg/h or more;

Desublimers (or cold traps) used to remove UF_6 from the cascades at up to 3 KPa (0.5
pressure. The desublimers are capable of being chilled to 203 K (- 70 °C
(70 °C);

'Product' and 'Tails' stations used for trapping UF_6 into containers.

This plant, equipment and pipework is wholly made of or lined with UF6-resi
EXLPANATORY NOTE to this section) and is fabricated to very high vacuum an
standards.

5.2.2. Machine header piping systems

Especially designed or prepared piping systems and header systems for handlUF_6 within the
centrifuge cascades. The piping network is normally of the 'triple' header sy
connected to each of the headers. There is thus a substantial amount of rep
wholly made of UF_6-resistant materials (see EXLPANATORY NOTE to this section)
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 capab
samples of feed, product or tails, from UF_6 gas streams and having all of the following charac

1. Unit resolution for atomic mass unit greater than 320;

2. Ion sources constructed of or line 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 motor stators as defined under 5.1.2.(d), or parts, components and sub-assemb 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 UF_6 process gas or directly control the centrifuges 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 60% or more nickel.

enrichment

INTRODUCTORY NOTE

In the gaseous diffusion method of uranium isotope separation, the main technological assembly
diffusion barrier, heat exchanger for cooling the gas (which is heated by the process of co
control valves, and pipelines. Inasmuch as gaseous diffusion technology uses uranium hexafluo $_6$), all equipment,
pipeline and instrumentation surfaces (that come in contact with the gas) must be made of mat
contact with UF_6. A gaseous diffusion facility requires a number of these assemblies, so that qu
important indication of end use.

5.3.1. Gaseous diffusion barriers

(a) Especially designed or prepared thin, porous filters, with a pore siz
(angstroms), a thickness of 5 mm (0.2 in) or less, and for tubular forms,
(1 in) or less, made of metallic, polymer or ceramic materials resistant t $_6$, and

(b) especially prepared compounds or powders for the manufacture of such
compounds and powders include nickel or alloys containing 60 per cent
aluminium oxide, or UF6-resistant fully fluorinated hydrocarbon polymers
99.9 per cent or more, a particle size less than 10 microns, and a high
uniformity, which are especially prepared for the manufacture of gaseous d

5.3.2. Diffuser housings

Especially designed of prepared hermetically sealed cylindrical vessels greate
diameter and greater than 900 mm (35 in) in length, or rectangular vessels of
which have an inlet connection and two outlet connections all of which are gre
in diameter, for containing the gaseous diffusion barrier, made of or lined wi
and designed for horizontal or vertical installation.

5.3.3. Compressors and gas blowers

Especially designed or prepared axial, centrifugal, or positive displacemen
blowers with a suction volume capacity of 1 m^3/min or more of UF_6, and with a discharge pressure o
up to several hundred kPa (100 psi), designed for long-term operation in the UF$_6$ environment with or
without and electrical motor of appropriate power, as well as separate assembl
and gas blowers. These compressors and gas blowers have a pressure ratio bet
are made of, or lines with, materials resistant to UF_6.

5.3.4. Rotary shaft seals

Especially designed or prepared vacuum seals, with seal feed and seal exhaust
the shaft connecting the compressor or the gas blower rotor with the driver m
reliable seal against in-leaking of air into the inner chamber of the compress
filled with UF_6. Such seals are normally designed for a buffer gas in-leakage rat
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 UF_6-resistant materials (except
stainless steel) or with copper or any combination of those metals, and intend
change rate of less than 10 pa (0.0015 psi) per hour under a pressure differen

gaseous diffusion enrichment

INTRODUCTORY NOTE

The auxiliary systems, equipment and components for gaseous diffusion enrichment plants are th to feed UF_6 to the gaseous diffusion assembly, to link the individual assemblies to each other to to allow for progressively higher enrichments and to extract from the diffusion cascades the "product" and "tails" UF_6. Because of the high inertial properties of diffusion cascades, any interruption in their oper down, leads to serious consequences. Therefore, a strict and constant maintenance of vacuum i automatic protection from accidents, and precise automated regulation of the gas flow is of diffusion plant. All this leads to a need to equip the plant with a large number of speci controlling systems.

Normally UF_6 is evaporated from cylinders placed within autoclaves and is distributed in gaseous by way of cascade header pipework. The "product" and "tails" UF_6 gaseous streams flowing from exit points are pass way of cascade header pipework to either cold traps or to compression stations where the UF_6 gas is liquefied prior to onward transfer into suitable containers for transportation or storage. Because a gaseous consists of a large number of gaseous diffusion assemblies arranged in cascades, there are m header pipework, incorporating thousands of welds with substantial amounts of repetition of 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 pressu or less, including:

Feed autoclaves (or systems), used for passing UF_6 to the gaseous diffusion cascades;

Desublimers (or cold traps) used to remove UF_6 from diffusion cascades;

Liquefaction stations where UF_6 gas from the cascade is compressed and cooled to fo UF_6;

"Product" or "tails" stations used for transferring UF_6 into containers.

5.4.2. Header piping systems

Especially designed or prepared piping systems and header systems for handl UF_6 within the gaseous diffusion cascades. This piping network is normally of the "double" h cell connected to each of the headers.

5.4.3. Vacuum systems

(a) Especially designed or prepared large vacuum manifolds, vacuum headers and having a suction capacity of 5 m^3/min (175 ft^3/min) or more.

(b) Vacuum pumps especially designed for service in UF_6-bearing atmospheres made of, or line with, aluminium, nickel, or alloys bearing more than 60% nickel. These p rotary or positive, may have displacement and fluorocarbon seals, and working fluids present.

5.4.4. Special shut-off and control valves

Especially designed or prepared manual or automated shut-off and control bel UF_6-resistant materials with a diameter of 40 to 1500 mm (1.5 to 59 in) for i auxiliary systems of gaseous diffusion enrichment plants.

5.4.3. UF_6 mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers cap
line" samples of feed, product or tails, from UF_6 gas streams and having all of the follo
characteristics:

1. Unit resolution for atomic mass unit greater than 320;

2. Ion sources constructed of or lined with nichrome or monel or nickel plate

3. Electron bombardment ionization sources;

4. Collector system suitable for isotopic analysis.

EXPLANATORY NOTE

The items listed above either come into direct contact with the UF_6 process gas or directly control the flow withi
cascade. All surfaces which come into contact with the process gas are wholly made of, or UF_6-resistant
materials. For the purposes of the sections relating to gaseous diffusion items the material
include stainless steel, aluminium, aluminium alloys, aluminium oxide, nickel or alloys contai
UF6-resistant fully fluorinated hydrocarbon polymers.

enrichment plants.

INTRODUCTORY NOTE

In aerodynamic enrichment processes, a mixture of gaseous UF_6 and light gas (hydrogen or helium) is compressed anc
passed through separating elements wherein isotopic separation is accomplished by the genera
forces over a curved-all geometry. Two processes of this type have been successfully develop
process and the vortex tube process. For both processes the main components of a separation
vessels housing the special separation elements (nozzles or vortex tubes), gas compressors anc
the heat of compression. An aerodynamic plant requires a number of these stages, so that c
important indication of end use. Since aerodynamic processes use UF_6, all equipment, pipeline and instrumentati
surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF_6.

EXPLANATORY NOTE

The items listed in this section either come into direct contact with the UF_6 process gas or directly control the flow wi
the cascade. All surfaces which come into contact with the process gas are wholly made of or
materials. For the purposes of the section relating to aerodynamic enrichment items, the mate
UF6 include copper, stainless steel, aluminium alloys, nickel or alloys containing 60% or mor
fully fluorinated hydrocarbon polymers.

5.5.1. Separation nozzles

Especially designed or prepared separation nozzles and assemblies thereof. The separation nozzle
consist of slit-shaped, curved channels having a radius of curvature less tha
0.05 mm), resistant to corrosion by UF_6 and having a knife-edge within the nozzle that sep
gas flowing through the nozzle into two fractions.

5.5.2. Vortex tubes

Especially designed or prepared vortex tubes and assemblies thereof. The vort
or tapered, made of or protected by materials resistant to corrosion by UF_6, having a diameter of
between 0.5 cm and 4 cm, a length to diameter ratio of 20:1 or less and with
inlets. The tubes may be equipped with nozzle-type appendages at either or bot

EXPLANATORY NOTE

The feed gas enters the vortex tube tangentially at one end or through swirl vanes or at numer
the periphery of the tube.

5.5.3. Compressors and gas blowers

Especially designed or prepared axial, centrifugal or positive displacement cor
made of or protected by materials resistant to corrosion by UF_6 and with a suction volume capacity c
2 m^3/min or more of UF_6/carrier gas (hydrogen or helium) mixture.

EXPLANATORY NOTE

These compressors and gas blowers typically have a pressure ratio between 1.2:1 and 6:1.

5.5.4. Rotary shaft seals

Especially designed or prepared rotary shaft seals, with seal feed and seal
sealing the shaft connecting the compressor rotor or the gas blower rotor with
ensure a reliable seal against out-leakage of process gas or in-leakage of ai
chamber of the compressor or gas blower which is filled with a UF_6/carrier gas mixture.

5.5.5. Heat exchangers for gas cooling

Especially designed or prepared heat exchangers made of or protected by ma
corrosion by UF_6.

5.5.6. Separation element housings

Especially designed or prepared separation element housings, made of or pr
resistant to corrosion by UF_6, for containing vortex tubes or separation nozzles.

EXPLANATORY NOTE

These housings may be cylindrical vessels greater than 300 mm in diameter and greater than 9
be rectangular vessels of comparable dimensions, and may be designed for horizontal or verti

5.5.7. Feed systems/product and talls withdrawal systems

Especially designed or prepared process systems or equipment for enrichment
protected by materials resistant to corrosion by UF_6, including:

(a) Feed autoclaves, ovens, or systems used for passing UF_6 to the enrichment process;

(b) Desublimers (or cold traps) used to remove UF_6 from the enrichment process for subseque
transfer upon heating;

(c) Solidification or liquefaction stations used to remove UF_6 from the enrichment process by
compressing and converting UF_6 to a liquid or solid form;

(d) 'Product' or 'tails' stations used for transferring UF_6 into containers.

5.5.8. Header piping systems

Especially designed or prepared header piping systems, made of or protected by materi
to corrosion by UF_6, for handling UF_6 within the aerodynamic cascades. This piping net
normally of the 'double' header design with each stage or group of stages c
headers.

5.5.9. Vacuum systems and pumps

(a) Especially designed or prepared vacuum systems having a suction capacity ^{3}/min or
more, consisting of vacuum manifolds, vacuum headers and vacuum pumps, an
service in UF_6-bearing atmospheres,

(b) Vacuum pumps especially designed or prepared for service in UF_6-bearing atmospheres and
made of or protected by materials resistant to corrosion by UF_6. 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 control bellow
protected by materials resistant to corrosion by UF_6 with a diameter of 40 to 1500 mm fo
installation in main and auxiliary systems of aerodynamic enrichment plants.

5.5.11. UF_6 mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers ca line' samples of feed, 'product' or 'tails', from UF_6 gas streams and having all of the follo characteristics:

1. Unit resolution for mass greater than 320;

2. Ion sources constructed of or lined with nichrome or monel or nickel plate

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 UF_6 from carrier gas (hydrogen or helium).

EXPLANATORY NOTE

These systems are designed to reduce the UF_6 content in the carrier gas to 1 ppm or less and may in equipment such as:

(a) Cryogenic heat exchangers and cryoseparators capable of temperatures of -120 °C or less,

(b) Cryogenic refrigeration units capable of temperatures of -120 °C or less, or

(c) Separation nozzle or vortex tube units for the separation of UF_6 from carrier gas, or

(d) UF_6 cold traps capable of temperatures of -20 °C or less.

exchange or ion exchange enrichment plants.

INTRODUCTORY NOTE

The slight difference in mass between the isotopes of uranium causes small changes in chemic can be used as a basis for separation of the isotopes. Two processes have been successfull chemical exchange and solid-liquid exchange.

In the liquid-liquid exchange process, immiscible liquid phases (aqueous and organic) are co give the cascading effect of thousands of separation stages. The aqueous phase consists hydrochloric acid solution; the organic phase consists of an extractant containing uranium ch The contactors employed in the separation cascade can be liquid-liquid exchange columns (such sieve plates) or liquid centrifugal contactors. Chemical conversions (oxidation and reductior the separation cascade in order to provide for the reflux requirements at each end. A major contamination of the process streams with certain metal ions. Plastic, plastic-lined (in polymers) and/or glass-lined columns and piping are therefore used.

In the solid-liquid ion-exchange process, enrichment is accomplished by uranium adsorption/desorption or fast-acting, ion-exchange resin or adsorbent. A solution of uranium in hydrochloric acid ar passed through cylindrical enrichment columns containing packed beds of the adsorbent. For a c system is necessary to release the uranium from the adsorbent back into the liquid flow so th collected. This is accomplished with the use of suitable reduction/oxidation chemical agents separate external circuits and that may be partially regenerated within the isotopic separat presence of hot concentrated hydrochloric acid solutions in the process requires that the equi by special corrosion-resistant materials.

5.6.1. Liquid-liquid exchange columns (Chemical exchange)

Countercurrent liquid-liquid exchange columns having mechanical power input (i with sieve plates, reciprocating plate columns, and columns with internal tur designed or prepared for uranium enrichment using the chemical exchange proc resistance to concentrated hydrochloric acid solutions, these columns and thei protected by suitable plastic materials (such as fluorocarbon polymers) or gla 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 urani chemical exchange process. Such contactors use rotation to achieve dispersi aqueous streams and then centrifugal force to separate the phases. For c concentrated hydrochloric acid solutions, the contactors are made of or are l materials 9such as fluorocarbon polymers) or are lined with glass. The stag 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 reduc valence state to another for uranium enrichment using the chemical exchan materials in contact with process solutions must be corrosion resist hydrochloric acid solutions.

EXPLANATORY NOTE

The cell cathodic compartment must be designed to prevent re-oxidation of uranium to its higher keep the uranium in the cathodic compartment, the cell may have an impervious diaphragm m of special cation exchange material. The cathode consists of a suitable solid conductor

(b) Especially designed or prepared systems at the product end of the cascade
of the organic stream, adjusting the acid concentration and feeding to
reduction cells.

EXPLANATORY NOTE

These systems consist of solvent extraction equipment for stripping the U^{+4} from the organic stream into an aqueous solution, evaporation and/or other equipment to accomplish solution pH adjustm pumps or other transfer devices for feeding to the electrochemical reduction cells. A avoid contamination of the aqueous stream with certain metal ions. Consequently, for th the process stream, the system is constructed of equipment made of or protected by sui glass, fluorocarbon polymers, polyphenyl sulfate, polyether sulfone, and resin-impregnated

5.6.4. Feed preparation systems (Chemical exchange)

Especially designed or prepared systems for producing high-purity uranium chlo chemical exchange uranium isotope separation plants.

EXPLANATORY NOTE

These systems consist of dissolution, solvent extraction and/or ion exchange equipment for p electrolytic cells for reducing the uranium U^{+6} or U^{+4} to U^{+3}. These systems produce uranium chloride solutions having o parts per million of metallic impurities such as chromium, iron, vanadium, molybdenum and othe valent cations. Materials of construction for portions of the system processing high-purity U^{+3} include glass, fluorocarbon polymers, polyphenyl sulfate or polyether sulfone plastic-lined and resin-impregnated graphite.

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 isotop separation cascade in the chemical exchange enrichment process.

EXPLANATORY NOTE

These systems may incorporate equipment such as:

(a) Equipment for contacting chlorine and oxygen with the aqueous effluent from the isotope and extracting the resultant U+4 into the stripped organic stream returning from the prod

(b) Equipment that separates water from hydrochloric acid so that the water and the concentrated h may be reintroduced to the process at the proper locations.

5.6.6. Fast-reacting ion exchange resins/adsorbents (ion exchange)

Fast-reacting ion-exchange resins or adsorbents especially designed or pr enrichment using the ion exchange process, including porous macroreticular re structures in which the active chemical exchange groups are limited to a coat inactive porous support structure, and other composite structures in any su particles or fibers. These ion exchange resins/adsorbents have diameters of be chemically resistant to concentrated hydrochloric acid solutions as well as so as not to degrade in the exchange columns. The resins/adsorbents are especi very fast uranium isotope exchange kinetics (exchange rate half-time of less t 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 suppo ion exchange resin/adsorbent, especially designed or prepared for uranium enr exchange process. These columns are made of or protected by materials (s fluorocarbon plastics) resistant to corrosion by concentrated hydrochloric capable of operating at a temperature in the range of 100 °C to 200 °C and pr (102 psi).

5.6.8. Ion exchange reflux systems (Ion exchange)

(a) Especially designed or prepared chemical or electrochemical reduction syst of the chemical reducing agent(s) used in ion exchange uranium enrichment

(b) Especially designed or prepared chemical or electrochemical oxidation syst of the chemical oxidizing agent(s) used in ion exchange uranium enrichment

EXPLANATORY NOTE

The ion exchange enrichment process may use, for example, trivalent titanium (Ti^{+3}) as a reducing cation in which case the reduction system would regenerate Ti^{+3} by reducing Ti^{+4}

The process may use, for example, trivalent iron (Fe^{+3}) as an oxidant in which case the oxidation system would r Fe^{+3} by oxidizing Fe^{+2}

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

INTRODUCTORY NOTE

Present systems for enrichment processes using lasers fall into two categories: those in which
atomic uranium vapor and those in which the process medium is the vapor of a uranium co
nomenclature for such processes include: first category - atomic vapor laser isotope separatio
category - molecular laser isotope separation (MLIS or MOOLIS) and chemical reaction by i
activation (CRISLA). The systems, equipment and components for laser enrichment plants embra
uranium-metal vapor (for selective photo-ionization) or devices to feed the vapor of a uran
dissociation or chemical activation); (b) devices to collect enriched and depleted uranium meta
first category, and devices to collect dissociated or reacted compounds as 'product' and unaf
second category; (c) process laser systems to selectively excite the uranium-235 species; an
product conversion equipment. The complexity of uranium atoms and compounds may require inco
number of available laser technologies.

EXPLANATORY NOTE

Many of the items in this section come into direct contact with uranium metal vapor or liquid o
of UF_6 or a mixture of UF_6 and other gases. All surfaces that come into contact with the uranium or UF_6 are wholly made
of or protected by corrosion-resistant materials. For the purposes of the section relating t
the materials resistant to corrosion by the vapor or liquid of uranium metal or uranium alloys
and tantalum; and the materials resistant to corrosion by UF_6 include copper, stainless steel, alumimium, alumi
alloys, nickel or alloys containing 60 % or more nickel and UF_6-resistant fully fluorinated hydrocarbon polymers.

5.7.1. Uranium vaporization systems (AVLIS)

Especially designed or prepared uranium vaporization systems which contain high-power stri
scanning electron beam guns with a delivered power on the target of more than 2

5.7.2. Liquid uranium metal handling systems (AVLIS)

Especially designed or prepared liquid metal handling systems for molten urani
consisting of crucibles and cooling equipment for the crucibles.

EXPLANATORY NOTE

The crucibles and other parts of this systems that come into contact with molten uranium or ur
protected by materials of suitable corrosion and heat resistance. Suitable materials include
graphite coated with other rare earth oxides (see INFCIRC/254/Rev. 1/part 2, item 2.7) or mixtu

5.7.3. Uranium metal 'product' and 'tails' collector assemblies (AVLIS)

Especially designed or prepared 'product' and 'tails' collector assemblies for
solid form.

EXPLANATORY NOTE

Components for these assemblies are made of or protected by materials resistant to the heat and corrosion of uranium m
vapor or liquid (such as yttria-coated graphite or tantalum) and may include pipes, valves, fi
heat exchangers and collector plates for magnetic, electrostatic or other separation methods.

5.7.4. Separator module housings (MLIS)

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

EXPLANATORY NOTE

These housings have multiplicity of ports for electrical and water feed-throughs, laser bea
connections and instrumentation diagnostics and monitoring. They have provisions for openi
refurbishment of internal components.

5.7.5. Supersonic expansion nozzles (MLIS)

Especially designed or prepared supersonic expansion nozzles for cooling mixtu ... $_6$ and carrier
gas to 150 K or less and which are corrosion resistant to UF_6.

5.7.6. Uranium pentafluoride product collectors (MLIS)

Especially designed or prepared uranium pentafluoride (UF_5) solid product collectors consisting
filter, impact, or cyclone-type collectors, or combinations thereof, and which
the UF_5/UF_6 environment.

5.7.7. UF_6/carrier gas compressors (MLIS)

Especially designed or prepared compressors for UF_6/carrier gas mixtures, designed for long
operation in a UF_6 environment. The components of these compressors that come into
process gas are made of or protected by materials resistant to corrosion by UF_6.

5.7.8. Rotary shaft seals (MLIS)

Especially designed or prepared rotary shaft seals, with seal feed and seal
sealing the shaft connecting the compressor rotor with the driver motor so as
against out-leakage of process gas or in-leakage of air or seal gas into t
compressor which is filled with a UF_6/carrier gas mixture.

5.7.9. Fluorination systems (MLIS)

Especially designed or prepared systems for fluorinating UF_5 (solid) to UF_6 (gas).

EXPLANATORY NOTE

These systems are designed to fluorinate the collected UF_5 powder to UF_6 for subsequent collection in product contai
or for transfer as feed to MLIS units for additional enrichment. In one approach, the fl
accomplished within the isotope separation system to react and recover directly off the 'pro
approach, the UF_5 powder may be removed/transferred from the 'product' collectors into a suitable
fluidized-bed reactor, screw reactor or flame tower) for fluorination. In both approaches,
transfer of fluorine (or other suitable fluorinating agents) and for collection and transfer of UF_6 are used.

5.7.10. UF_6 mass spectrometers/ion sources (MLIS)

Especially designed or prepared magnetic or quadrupole mass spectrometers ca
line' samples of feed, 'product' or 'tails', from UF_6 gas streams and having all of the follo
characteristics:

1. Unit resolution for mass greater than 320

2. Ion sources constructed of or lined with nichrome or monel or nickel plate

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
protected by materials resistant to corrosion by UF_6, including:

(a) Feed autoclaves, ovens, or systems used for passing UF_6 to the enrichment process

(b) Desublimers (or cold traps) used to remove UF_6 from the enrichment process for subseque
transfer upon heating;

(c) Solidification or liquefaction stations used to remove UF_6 from the enrichment process by
compressing and converting UF_6 to a liquid or solid form;

(d) 'Product' or 'tails' stations used for transferring UF_6 into containers.

5.7.12. UF_6/carrier gas separation systems (MLIS)

Especially designed or prepared process systems for separating UF_6 from carrier gas. The carrier
gas may be nitrogen, argon, or other gas.

EXPLANATORY NOTE

These systems may incorporate equipment such as:

(a) Cryogenic heat exchangers or cryoseparators capable of temperatures of -120 °C or less, o

(b) Cryogenic refrigeration units capable of temperatures of -120 °C or less, or

(c) UF_6 cold traps capable of temperatures of -20 °C or less.

5.7.13. Laser systems (AVLIS, MLIS and CRISLA)

Lasers or laser systems especially designed or prepared for the separation of uraniu

EXPLANATORY NOTE

The lasers and laser components of importance in laser-based enrichment processes include th
or INFCIRC/254/Rev. 1/Part 2. The laser system for the AVLIS process usually consists of tw
laser and a dye laser. The laser system for MLIS usually consists of a CO_2 or excimer laser and a multi-pass optic
cell with revolving mirrors at both ends. Lasers or laser systems for both processes re
stabilizer for operation over extended periods of time.

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

INTRODUCTORY NOTE

In the plasma separation process, a plasma of uranium ions passes through an electric field tu ^{235}U. The plasma, which is made by ionizing uranium vapor, is contained in a vacuum chamber with a high-strength by a superconducting magnet. The main technological systems of the process include the ura system, the separator module with superconducting magnet (see item 3.10 of INFCIRC/254/Rev. removal systems for the collection of 'product' and 'tails'.

5.8.1. Microwave power sources and antennae

Especially designed or prepared microwave power sources and antennae for produ ions and having the following characteristics: greater than 30 GHz frequency mean power output for ion production.

5.8.2. Ion excitation coils

Especially designed or prepared radio frequency ion excitation coils for frequ 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 high-power strip or scanning electron beam guns with a delivered power on the kW/cm.

5.8.4. Liquid uranium metal handling systems

Especially designed or prepared liquid metal handling systems for molten urani consisting of crucibles and cooling equipment for the crucibles.

EXPLANATORY NOTE

The crucibles and other parts of this system that come into contact with molten uranium or ura protected by materials of suitable corrosion and heat resistance. Suitable materials include graphite coated with other rare earth oxides (see INFCIRC/254/Rev. 1/Part 2, item 2.7) or mixtu

5.8.5. Uranium metal 'product' and 'tails' collector assemblies

Especially designed or prepared 'product' and 'tails' collector assemblies fo form. These collector assemblies are made of or protected by materials res 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 collectors.

EXPLANATORY NOTE

These housings have a multiplicity of ports for electrical feed-throughs, diffusion pump conn diagnostics and monitoring. They have provisions for opening and closure to allow for r components and are constructed of a suitable non-magnetic material such as stainless steel.

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

INTRODUCTORY NOTE

In the electromagnetic process, uranium metal ions produced by ionization of
(typically UCl_4) are accelerated and passed through a magnetic field that has the e
ions of different isotopes to follow different paths. The major components
isotope separator include: a magnetic field for ion-beam diversion/separation
source with its acceleration system, and a collection system for the separated
for the process include the magnet power supply system, the ion source high-
system, the vacuum system, and extensive chemical handling systems for recov
cleaning/recycling of components.

5.9.1. Electromagnetic isotope separators

Electromagnetic isotope separators especially designed or prepared for the
isotopes, and equipment and components therefor, including:

(a) Ion sources

Especially designed or prepared single or multiple uranium ion sources co
source, ionizer, and beam accelerator, constructed of suitable materia
stainless steel, or copper, and capable of providing a total ion beam
greater.

(b) Ion collectors

Collector plates consisting of two or more slits and pockets especially de
collection of enriched and depleted uranium ion beams and constructed of
such as graphite or stainless steel.

c) Vacuum housings

Especially designed or prepared vacuum housings for uranium electromagn
constructed of suitable non-magnetic materials such as stainless steel and
at pressures of 0.1 Pa or lower.

EXPLANATORY NOTE

The housings are specially designed to contain the ion sources, collector plates and water-coo
for diffusion pump connections and opening and closure for removal and reinstallation of these

(d) Magnet pole pieces

Especially designed or prepared magnet pole pieces having a diameter great
maintain a constant magnetic field within an electromagnetic isotope sepa
the magnetic field between adjoining separators.

5.9.2. High voltage power supplies

Especially designed or prepared high-voltage power supplies for ion sources
following characteristics: capable of continuous operation, output voltage
output current of 1 A or greater, and voltage regulation of better than 0.01%
hours.

5.9.6 Magnet power supplies

Especially designed or prepared high-power, direct current magnet power suppl
following characteristics: capable of continuously producing a current output
voltage of 100 V or greater and with a current or voltage regulation better th
8 hours.

6. Plants for the production or concentration of heavy water, deuterium and deuteriu
and equipment especially designed or prepared therefor

INTRODUCTORY NOTE

Heavy water can be produced by a variety of processes. However, the two processes that have p
viable are the water-hydrogen sulphide exchange process (GS process) and the ammonia-hydrogen e

The GS process is based upon exchange of hydrogen and deuterium between water and hydrogen su
of towers which are operated with the top section cold and the bottom section hot. Water flow
hydrogen sulphide gas circulates from the bottom to the top of the towers. A series of perfor
mixing between the gas and the water. Deuterium migrates to the water at low temperatures an
at high temperatures. Gas or water, enriched in deuterium, is removed from the first stage to
and cold sections and the process is repeated in subsequent stage towers. The product of the
to 30% in deuterium, is sent to a distillation unit to produce reactor grade heavy water; i.e

The ammonia-hydrogen exchange process can extract deuterium from synthesis gas through contact
in the presence of a catalyst. The synthesis gas is fed into exchange towers and to an amm
towers the gas flows from the bottom to the top while the liquid ammonia flows from the top to
is stripped from the hydrogen in the synthesis gas and concentrated in the ammonia. The amm
ammonia cracker at the bottom of the tower while the gas flows into an ammonia converter at th
takes place in subsequent stages and reactor grade heavy water is produced through final dis
feed can be provided by an ammonia plant that, in turn can be constructed in association wit
hydrogen exchange plant. The ammonia-hydrogen exchange process can also use ordinary water
deuterium.

Many of the key equipment items for heavy water production plants using GS of the ammonia
processes are common to several segments of the chemical and petroleum industries. This is
plants using the GS process. However, few of the items are available “off-the-shell”. The
processes require the handling of large quantities of flammable, corrosive and toxic flui
Accordingly, in establishing the design and operating standards for plants and equipment usi
attention to the materials selection and specifications is required to ensure long service li
factors. The choice of scale is primarily a function of economics and need. Thus, most of t
prepared according to the requirements of the customer.

Finally, it should be noted that, in both the GS and the ammonia-hydrogen exchange processes,
individually are not especially designed or prepared for heavy water production can be assemb
especially designed or prepared for producing heavy water. The catalyst production system use
exchange process and water distillation systems used for the final concentration of heavy wat
process are examples of such systems.

The items of equipment which are especially designed or prepared for the production of heavy
water-hydrogen sulphide exchange process or the ammonia-hydrogen exchange process include the f

6.1. Water - Hydrogen Sulphide Exchange Towers

Exchange towers fabricated from fine carbon steel (such as ASTM A516) with di
ft) to 9 m (30 ft), capable of operating at pressures greater than or equal to
corrosion allowance of 6 mm or grater, especially designed or prepared for h
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 com
sulphide gas circulation (i.e., gas containing more than 70% H_2S) especially designed or prepared f
heavy water production utilizing the water-hydrogen sulphide exchange process
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. MPa (260 psi) suction and
wet H_2S service.

6.3. Ammonia-Hydrogen Exchange Towers

Ammonia-hydrogen exchange towers greater than or equal to 35 m (114,3 ft) in h
of 1.5 m (4.9 ft) to 2.5 m (8.2 ft) capable of operating at pressures greate
especially designed or prepared for heavy water production utilizing the ammon
process. These towers also have at least one flanged, axial opening of the
cylindrical part through which the tower internals an be inserted or withdrawn.

6.4. Tower Internals and Stage Pumps

Tower internals and stage pumps especially designed or prepared for tower
production utilizing the ammonia-hydrogen exchange process. Tower internals
designed stage contactors which promote intimate gas/liquid contact. Stage pu
designed submersible pumps for circulation of liquid ammonia within a contacti
stage towers.

6.5. Ammonia Crackers

Ammonia crackers with operating pressures greater than or equal to 3 MPa (
designed or prepared for heavy water production utilizing the ammonia-hydrogen

6.6. Infrared Absorption Analyzers

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

6.7. Catalytic Burners

Catalytic burners for the conversion of enriched deuterium gas into heavy wate
prepared for heavy water production utilizing the ammonia-hydrogen exchange pro

6.8. Complete heavy water upgrade systems or columns therefor

Complete heavy water upgrade systems, or columns therefor, especially designed
upgrade of heavy water to reactor-grade deuterium concentration.

EXPLANATORY NOTE

These systems, which usually employ water distillation to separate heavy water from light water, are esp
prepared to produce reactor-grade heavy water (i.e., typically 99.75% deuterium oxide) from
lesser concentration.

7. Plants for the conversion of uranium and equipment especially designed or prepa

INTRODUCTORY NOTE

Uranium conversion plants and systems may perform one or more transformations from one uraniu another, including: conversion of uranium ore concentrates to UO_3, conversion of UO_3 to UO_2, conversion of uranium oxides to UF_4 or UF_6, conversion of UF_4 to UF_6, conversion of UF_6 to UF_4, conversion of UF_4 to uranium metal, and conversion of uranium fluorides to UO_2. Many of the key equipment items for uranium conversion plants are several segments of the chemical process industry. For example, the types of equipment employ include: furnaces, rotary kilns, fluidized bed reactors, flame tower reactors, liquid centr liquid-liquid extraction columns. However, few of the items are available “off-the-shelf”; according to the requirements and specifications of the customer. In some instances, speci considerations are required to address the corrosive properties of some of the chemicals h F_2, ClF_3, and uranium fluorides). Finally, it should be noted that, in all of the uranium conversion proces individually are not especially designed or prepared for uranium conversion can be assemblec especially designed or prepared for use in uranium conversion.

7.1. Especially designed or prepared systems for the conversion of uranium ore conce

EXPLANATORY NOTE

Conversion of uranium ore concentrates to UO_3 can be performed by first dissolving the ore in nitric acid purified uranyl nitrate using a solvent such as tributyl phosphate. Next, the uranyl nitrat UO_3 either by concentration and denitration or by neutralization with gaseous ammonia to produce ammonium di filtering, drying, and calcining.

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

EXPLANATORY NOTE

Conversion of UO_3 to UF_6 can be performed directly by fluorination. The process requires a source chlorine trifluoride.

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

EXPLANATOR Y NOTE

Conversion of UO_3 to UO_2 can be performed through reduction of UO_3 with cracked ammonia gas or hydrogen.

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

EXPLANATORY NOTE

Conversion of UO_2 to UF_4 can be performed by reacting UO_2 with hydrogen fluoride gas (HF) at 300-500 °C.

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

EXPLANATORY NOTE

Conversion of UF_4 to UF_6 is performed by exothermic reaction with fluorine in a tower reactor. UF_6 is condensed from the hot effluent gases by passing the effluent stream through a cold trap cooled to -10 °C. The process requires a source of fluorine gas.

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

EXPLANATORY NOTE

Conversion of UF_4 to U metal is performed by reduction with magnesium (large batches) or c batches). The reaction is carried out at temperatures above the melting point of uranium °C)

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

EXPLANATORY NOTE

Conversion of UF_6 to UO_2 can be performed by one of three processes. In the first, UF_6 is reduced and hydrolyzed to UO_2 using hydrogen and steam. In the second, UF_6 is hydrolyzed by solution in water, ammonia is added to precipitate ammonium diuranate, and the diuranate is reduced to UO_2 with hydrogen at 820°C. In the third process, gaseous UF_6, CO_2, and NH_3 are combined in water, precipitate ammonium uranyl carbonate. The ammonium uranyl carbonate is combined with steam and hydrogen at 500-600°C to yield UO_2.

UF_6 to UO_2 conversion is often performed as the first stage of a fuel fabrication plant.

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

EXPLANATORY NOTE

Conversion of UF_6 to UF_4 is performed by reduction with hydrogen.

NNEX C

CRITERIA FOR LEVELS OF PHYSICAL PROTECTION

1. The purpose of physical protection of nuclear materials is to prevent ur handling of these materials. Paragraph 3(a) of the Guidelines document c among suppliers on the levels of protection to be ensured in relation to th equipment and facilities containing these materials, taking account recommendations.

2. Paragraph 3 (b) of the Guidelines document states that implementation of me protection in the recipient country is the responsibility of the Governme However, the levels of physical protection on which these measures have to the subject of an agreement between supplier and recipient. In this conte should apply to all States.

3. The document INFCIRC/225 of the International Atomic Energy Agency entitlec Protection of Nuclear material" and similar documents which from time to ti international groups of experts and updated as appropriate to account for c the art and state of knowledge with regard to physical protection of nuclea basis for guiding recipient States in designing a system of physical pro procedures.

4. The categorization of nuclear material presented in the attached table or from time to time by mutual agreement of suppliers shall serve as the designating specific levels of physical protection in relation to the t equipment and facilities containing these materials, pursuant to paragraph Guidelines document.

5. The agreed levels of physical protection to be ensured by the competent na the use, storage and transportation of the materials listed in the atta minimum include protection characteristics as follows:

CATEGORY III

Use and Storage within an area to which access is controlled.

Transportation under special precautions including prior arrangements among ser and carrier, and prior agreement between entities subject to the jurisdic supplier and recipient States, respectively, in case of international tra place and procedures for transferring transport responsibility.

CATEGORY II

Use and Storage within a protected are to which access is controlled, i.e., an surveillance by guards or electronic devices, surrounded by a physical ba number of points of entry under appropriate control, or any area with an physical protection.

Transportation under special precautions including prior arrangements among ser and carrier, and prior agreement between entities subject to the jurisdic supplier and recipient States, respectively, in case of international tra place and procedures for transferring transport responsibility.

C TEGORY I

Materials in this category shall be protected with highly reliable systems use as follows:

Use and storage within a highly protected area, i.e., a protected area as defi above, to which, in addition, access is restricted to person whose trus determined, and which is under surveillance by guards who are in close co appropriate response forces. Specific measures taken in this context s objective the detection and prevention of any assault, unauthorized acce removal of material.

Transportation under special precautions as identified above for transportatio and III materials and, in addition, under constant surveillance by escorts which assure close communication with appropriate response forces.

6. Suppliers should request identification by recipients of those agencies responsibility for ensuring that levels of protection are adequately met an for internally co-ordinating response/recovery operations in the event of handling of protected materials. Suppliers and recipients should also desi within their national authorities to co-operate on matters of out-of-coun other matters of mutual concern.

TABLE: CATEGORIZATION OF NUCLEAR MATERIAL

Material	Form	Category I	Category II
1. Plutonium*[a]	Unirradiated*[b]	2 kg or more	Less than 2 kg but
2. Uranium-235	Unirradiated*[b]		
	- uranium enriched to 20% ^{235}U or more	5 kg or more	Less than 5 kg but
	- uranium enriched to 10% ^{235}U but less than 20%	-	10 kg or more
	- uranium enriched above natural, but less than 10% ^{235}U [d]	-	-
3. Uranium-233	Unirradiated*[b]	2 kg or more	Less than 2 kg but
4. Irradiated fuel			Depleted or natural low-enriched fuel (content)*[e][f]

[a] As identified in the Trigger List.
[b] Material not irradiated in a reactor or material irradiated in a reactor but w
unshielded.
[c] Less than a radiologically significant quantity should be exempted.
[d] Natural uranium, depleted uranium, and thorium and quantities of uranium enrich
accordance with prudent management practice.
[e] Although this level of protection is recommended, it would be open to States, upon evaluation
of physical protection.
[f] Other fuel which by virtue of its original fissile material content is classifi
while the radiation level from the fuel exceeds 100 rads/hour at one metre unshielded.