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COMMUNICATIONS RECEIVED FROM MEMBERS REGARDING THE EXPORT OF NUCLEAR MATERIAL AND OF CERTAIN CATEGORIES OF EQUIPMENT AND OTHER MATERIAL

1. The Director General has received letters dated 3 September 1990 from the Resident Representatives to the Agency of Australia, Canada, Czechoslovakia, Denmark, Finland, the German Democratic Republic, the Federal Republic of Germany, Greece, Hungary, Ireland, Japan, Luxembourg, the Netherlands, Norway, Poland, Sweden, the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland, and the United States of America concerning the commitments of these Member States under Article III, paragraph 2, of the Treaty on the Non-Proliferation of Nuclear Weapons.

2. The purpose of the letters is to consolidate and clarify the information contained in documents INFCIRC/209/Mod.1,2,3 and 4 into a single document and to provide information on the functioning of the "Zangger Committee", also known as the "Nuclear Exporters' Committee", with regard to the commitments of the Committee's members under Article III, paragraph 2, of the Treaty.

3. In the light of the wish expressed at the end of each letter, the text of the letters is annexed hereto.

LETTER

I have the honour to refer to [relevant previous communication] in which the Government of [Member State] informed you that it had decided to act in accordance with certain procedures in relation to exports of nuclear material and certain categories of equipment and other material which you circulated to all Member States of the Agency as document INFCIRC/209, and to [relevant subsequent communications] informing you of its desire to clarify certain items described in the Annex "Clarification of Items on the Trigger List" to Memorandum B and circulated as documents INFCIRC/209/Mods.1,2,3 and 4.

In the interests of clarity it has become desirable, in the view of my Government, to consolidate these communications, without change in their substance, in a single document a copy of which is attached hereto.

As hitherto, my Government reserves to itself the right to exercise discretion with regard to the interpretation and implementation of the procedures set out and the right to control, if it wishes, the export of relevant items other than those specified in the aforementioned attachment to this letter.

I should be grateful if you would circulate the text of this letter and its attachment, together with the appended background paper, to all Member States for their information.

CONSOLIDATED TRIGGER LIST
MEMORANDUM A

1. INTRODUCTION

The Government has had under consideration procedures in relation to exports of nuclear materials in the light of its commitment not to provide source or special fissionable material to any non-nuclear-weapon State for peaceful purposes unless the source or special fissionable material is subject to safeguards under an agreement with the International Atomic Energy Agency.

2. DEFINITION OF SOURCE AND SPECIAL FISSIONABLE MATERIAL

The definition of source and special fissionable material adopted by the Government shall be that contained in Article XX of the Agency's Statute:

(a) "SOURCE MATERIAL"

The term "source material" means uranium containing the mixture of isotopes occurring in nature: uranium depleted in the isotope 235, thorium; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate; any other material containing one or more of the foregoing in such concentration as the Board of Governors shall from time to time determine; and such other material as the Board of Governors shall from time to time determine.

(b) "SPECIAL FISSIONABLE MATERIAL"

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

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

3. THE APPLICATION OF SAFEGUARDS

The Government is solely concerned with ensuring, where relevant, the application of safeguards in non-nuclear-weapon States not party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)* with a view to preventing diversion of the safeguarded nuclear material from peaceful purposes to nuclear weapons or other nuclear explosive devices. If the Government wishes to supply source or special fissionable material for peaceful purposes to such a State, it will:

(a) Specify to the recipient State, as a condition of supply, that the source or special fissionable material, or special fissionable material produced in or by the use thereof, shall not be diverted to nuclear weapons or other nuclear explosive devices; and

(b) Satisfy itself that safeguards to that end, under an agreement with the Agency and in accordance with its safeguards system, will be applied to the source or special fissionable material in question.

4. DIRECT EXPORTS

In the case of direct exports of source or special fissionable material to non-nuclear-weapon States not party to the NPT, the Government will satisfy itself, before authorizing the export of the material in question, that such material will be subject to a safeguards agreement with the Agency, as soon as the

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recipient State takes over responsibility for the material, but no later than the time the material reaches its destination.

5. RETRANSFERS

The Government, when exporting source or special fissionable material to a nuclear-weapon State not party to the NPT, will require satisfactory assurances that the material will not be re-exported to a non-nuclear-weapon State not party to the NPT unless arrangements corresponding to those referred to above are made for the acceptance of safeguards by the State receiving such re-export.

6. MISCELLANEOUS

Exports of the items specified in sub-paragraph (a) below, and exports of source or special fissionable material to a given country, within a period of 12 months, below the limits specified in sub-paragraph (b) below, shall be disregarded for the purpose of the procedures described above:

(a) Plutonium with an isotopic concentration of plutonium-238 exceeding 80%;
Special fissionable material when used in gram quantities or less as a sensing component in instruments; and
Source material which the Government is satisfied is to be used only in non-nuclear activities, 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.

MEMORANDUM B

1. INTRODUCTION

The Government has had under consideration procedures in relation to exports of certain categories of equipment and material, in the light of its commitment not to provide equipment or material especially designed or prepared for the processing, use or production of special fissionable material to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material produced, processed or used in the equipment or material in question is subject to safeguards under an agreement with the International Atomic Energy Agency.

2. THE DESIGNATION OF EQUIPMENT OR MATERIAL ESPECIALLY DESIGNED OR PREPARED FOR THE PROCESSING, USE OR PRODUCTION OF SPECIAL FISSIONABLE MATERIAL

The designation of items of equipment or material especially designed or prepared for the processing, use or production of special fissionable material (hereinafter referred to as the "Trigger List") adopted by the Government is as follows (quantities below the levels indicated in the Annex being regarded as insignificant for practical purposes):

2.1. **Reactors and equipment therefor (see Annex, section 1.);**

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

2.3. **Plants for the reprocessing of irradiated fuel elements, and equipment especially designed or prepared therefor (see Annex, section 3.);**

2.4. **Plants for the fabrication of fuel elements (see Annex, section 4.);**

2.5. **Plants for the separation of isotopes of uranium and equipment, other than analytical instruments, especially designed or prepared therefor (see Annex, section 5.);**

2.6. **Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared therefor (see Annex, section 6.).**

3. THE APPLICATION OF SAFEGUARDS

The Government is solely concerned with ensuring, where relevant, the application of safeguards in non-nuclear-weapon States not party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) with a view to preventing diversion of the safeguarded nuclear material from peaceful purposes to nuclear weapons or other nuclear explosive devices. If the Government wishes to supply Trigger List items for peaceful purposes to such a State, it will:

(a) Specify to the recipient State, as a condition of supply, that the source or special fissionable material produced, processed or used in the facility for which the item is supplied shall not be diverted to nuclear weapons or other nuclear explosive devices; and

(b) Satisfy itself that safeguards to that end, under an agreement with the Agency and in accordance with its safeguards system, will be applied to the source or special fissionable material in question.

4. DIRECT EXPORTS

In the case of direct exports to non-nuclear-weapon States not party to the NPT, the Government will satisfy itself, before authorizing the export of the equipment or material in question, that such equipment or material will fall under a safeguards agreement with the Agency.

5. RETRANSFERS

The Government, when exporting Trigger List items, will require satisfactory assurances that the items will not be re-exported to a non-nuclear-weapon State not party to the NPT unless arrangements corresponding to those referred to above are made for the acceptance of safeguards by the State receiving such re-export.

6. MISCELLANEOUS

The Government reserves to itself discretion as to interpretation and implementation of its commitment referred to in paragraph 1 above and the right to require, if it wishes, safeguards as above in relation to items it exports in addition to those items specified in paragraph 2 above.

ANNEX
CLARIFICATION OF ITEMS ON THE TRIGGER LIST
(as designated in Section 2 of Memorandum B)

1. Reactors and equipment therefor

1.1. Complete nuclear reactors

Nuclear reactors capable of operation so 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.

EXPLANATORY NOTE

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

It is not intended to exclude reactors which could reasonably be capable of modification to produce significantly more than 100 grams of plutonium per year. Reactors designed for sustained operation at significant power levels, regardless of their 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 accordance with the procedures of the Memorandum. Those individual items within this functionally defined boundary which will be exported only in accordance with the procedures of the Memorandum are listed in paragraphs 1.2. to 1.7. Pursuant to paragraph 6 of the Memorandum, the Government reserves to itself the right to apply the procedures of the Memorandum to other items within the functionally defined boundary.

1.2. Reactor pressure vessels

Metal vessels, as complete units or as major shop-fabricated parts therefor, which are especially designed or prepared to contain the core of a nuclear reactor as defined in paragraph 1.1. above and are capable of withstanding the operating pressure of the primary coolant.

EXPLANATORY NOTE

A top plate for a reactor pressure vessel is covered by item 1.2. as a major shop-fabricated part of a pressure vessel.

Reactor internals (eg support columns and plates for the core and other vessel internals, control rod guide tubes, thermal shields, baffles, core grid plates, diffuser plates, etc.) are normally supplied by the reactor supplier. In some cases, certain internal support components are included in the fabrication of the pressure vessel. These items are sufficiently critical to the safety and reliability of the operation of the reactor (and, therefore, to the guarantees and liability of the reactor supplier), so that their supply, outside the basic supply arrangement for the reactor itself, would not be common practice. Therefore, although the separate supply of these unique, especially designed and prepared, critical, large and expensive items would not necessarily be considered as falling outside the area of concern, such a mode of supply is considered unlikely.

1.3. 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 capable of on-load operation or employing technically sophisticated positioning or alignment features to allow complex off-load fuelling operations such as those in which direct viewing of or access to the fuel is not normally available.

1.4. Reactor control rods

Rods especially designed or prepared for the control of the reaction rate in a nuclear reactor as defined in paragraph 1.1. above.

EXPLANATORY NOTE

This item includes, in addition to the neutron absorbing part, the support or suspension structures therefor if supplied separately.

1.5. 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 in any 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 liquid metal as primary coolant for nuclear reactors 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 in quantities exceeding $3 \cdot 10^4$ kg (30 metric tons) for any one recipient country in any period of 12 months.

3. Plants for the reprocessing of irradiated fuel elements, and equipment especially designed or prepared therefor

INTRODUCTORY NOTE

Reprocessing irradiated nuclear fuel separates plutonium and uranium from intensely radioactive fission products and other transuranic elements. Different technical processes can accomplish this separation. However, over the years Purex has become the most commonly used and accepted process. Purex involves the dissolution of irradiated nuclear fuel in nitric acid, followed by separation of the uranium, plutonium, and fission products by solvent extraction using a mixture of tributyl phosphate in an organic diluent.

Purex facilities have process functions similar to each other, including: irradiated fuel element chopping, fuel dissolution, solvent extraction, and process liquor storage. There may also be equipment for thermal denitration of uranium nitrate, conversion of plutonium nitrate to oxide or metal, and treatment of fission product waste liquor to a form suitable for long term storage or disposal. However, the specific type and configuration of the equipment performing these functions may differ between Purex facilities for several reasons, including the type and quantity of irradiated nuclear fuel to be reprocessed and the intended disposition of the recovered materials, and the safety and maintenance philosophy incorporated into the design of the facility.

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

These processes, including the complete systems for plutonium conversion and plutonium metal production, may be identified by the measures taken to avoid criticality (eg by geometry), radiation exposure (eg by shielding), and toxicity hazards (eg by containment).

EXPORTS

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

Items of equipment that are considered to fall within the meaning of the phrase "and equipment especially designed or prepared" for the reprocessing of irradiated fuel elements include:

3.1. Irradiated fuel element chopping machines

INTRODUCTORY NOTE

This equipment breaches the cladding of the fuel to expose the irradiated nuclear material to dissolution. Especially designed metal cutting shears are the most commonly employed, although advanced equipment, such as lasers, may be used.

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

INTRODUCTORY NOTE

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

Critically safe tanks (eg 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

INTRODUCTORY NOTE

Solvent extractors both receive the solution of irradiated fuel from the dissolvers and the organic solution which separates the uranium, plutonium, and fission products. Solvent extraction equipment is normally designed to meet strict operating parameters, such as long operating lifetimes with no maintenance requirements or adaptability to easy replacement, simplicity of operation and control, and flexibility for variations in process conditions.

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

INTRODUCTORY NOTE

Three main process liquor streams result from the solvent extraction step. Holding or storage vessels are used in the further processing of all three streams, as follows:

(a) The pure uranium nitrate solution is concentrated by evaporation and passed to a denitration process where it is 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 as a liquor concentrate. This concentrate may be subsequently evaporated and converted to a form suitable for storage or disposal.

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

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, or
(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 nitrate solution to plutonium dioxide. The main functions involved in this process are:
process feed storage and adjustment, precipitation and solid/liquor separation, calcination, product handling, ventilation, waste management, and process control.

Complete systems especially designed or prepared for the conversion of plutonium nitrate to plutonium oxide, in particular adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards.

3.6. Plutonium oxide to metal production system

INTRODUCTORY NOTE

This process, which could be related to a reprocessing facility, involves the fluorination of plutonium dioxide, normally with highly corrosive hydrogen fluoride, to produce plutonium fluoride which is subsequently reduced using high purity calcium metal to produce metallic plutonium and a calcium fluoride slag. The main functions involved in this process are: fluorination (eg involving equipment fabricated or lined with a precious metal), metal reduction (eg employing ceramic crucibles), slag recovery, product handling, ventilation, waste management and process control.

Complete systems especially designed or prepared for the production of plutonium metal, in particular adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards.

EXPORTS

Pursuant to paragraph 6 of the Memorandum B, the Government reserves to itself the right to apply the procedures of the Memorandum to other items within the functionally defined boundary.

4. Plants for the fabrication of fuel elements

A "plant for the fabrication of fuel elements" includes the equipment:

(a) Which normally comes in direct contact with, or directly processes, or controls, the production flow of nuclear material, or

(b) Which seals the nuclear material within the cladding.

EXPORTS

The export of the whole set of items for the foregoing operations will take place only in accordance with the procedures of the Memorandum. The Government will also give consideration to application of the procedures of the Memorandum to individual items intended for any of the foregoing operations, as well as for other fuel fabrication operations such as checking the integrity of the cladding or the seal, and the finish treatment to 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

INTRODUCTORY NOTE

The gas centrifuge normally consists of a thin-walled cylinder(s) of between 75 mm (3 in) and 400 mm (16 in) diameter contained in a vacuum environment and spun at high peripheral speed of the order of 300 m/s or more with its central axis vertical. In order to achieve high speed the materials of construction for the rotating components have to be of a high strength to density ratio and the rotor assembly, and hence its individual components, have to be manufactured to very close tolerances in order to minimize the unbalance. In contrast to other centrifuges, the gas centrifuge for uranium enrichment is characterized by having within the rotor chamber a rotating disc-shaped baffle(s) and a stationary tube arrangement for feeding and extracting the UF_6 gas and featuring at least 3 separate channels, of which 2 are connected to scoops extending from the rotor axis towards the periphery of the rotor chamber. Also contained within the vacuum environment are a number of critical items which do not rotate and which although they are especially designed are not difficult to fabricate nor are they fabricated out of unique materials. A centrifuge facility however requires a large number 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, manufactured from one 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 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 UF_6 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 $2.05 \cdot 10^9$ N/m^2 (300,000 psi) or more;
(b) Aluminium alloys capable of an ultimate tensile strength of $0.46 \cdot 10^9$ N/m^2 (67,000 psi) or more;
(c) Filamentary materials suitable for use in composite structures and having a specific modulus of $12.3 \cdot 10^6$ m or greater and a specific ultimate tensile strength of $0.3 \cdot 10^6$ 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 UF_6-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 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 polished into 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, 1 to 1 length to diameter ratio. 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.

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

INTRODUCTORY NOTE

The auxiliary systems, equipment and components for a gas centrifuge enrichment plant are the systems of plant needed to feed UF_6 to the centrifuges, to link the individual centrifuges to each other to form cascades (or stages) to allow for 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 form to the centrifuges by way of cascade header pipework. The 'product' and 'tails' UF_6 gaseous streams flowing from the centrifuges are also passed by way of cascade header pipework to cold traps (operating at about 203 K (-70°C)) where they are condensed prior to onward transfer into suitable containers for transportation or storage. Because an enrichment plant consists of many thousands of centrifuges arranged in cascades there are many kilometers of cascade header pipework, incorporating thousands of welds with a substantial amount of repetition of layout. The equipment, components and piping systems are fabricated to very high vacuum and cleanliness standards.

5.2.1. Feed 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 kN/m^2 (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 kN/m^2 (0.5 lb/in^2) 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 UF_6 into containers.

This plant, equipment and pipework is wholly made of or lined with UF_6-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 UF_6 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 UF_6-resistant materials (see EXPLANATORY NOTE to this section) and is fabricated to very high vacuum and cleanliness standards.

5.2.3. UF_6 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 UF_6 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. 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 UF_6 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 UF_6 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

INTRODUCTORY NOTE

In the gaseous diffusion method of uranium isotope separation, the main technological assembly is a special porous gaseous diffusion barrier, heat exchanger for cooling the gas (which is heated by the process of compression), seal valves and control valves, and pipelines. Inasmuch as gaseous diffusion technology uses uranium hexafluoride (UF_6), all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF_6. A gaseous diffusion facility requires a number of these assemblies, so that quantities can provide an important indication of end use.

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 or less, and for tubular forms, a diameter of 25 mm or less, made of metallic, polymer or ceramic materials resistant to corrosion by UF_6, and

(b) especially prepared compounds or powders for the manufacture of such filters. Such compounds and powders include nickel or alloys containing 60 per cent or more nickel, aluminium oxide, or UF_6-resistant fully fluorinated hydrocarbon polymers having a purity of 99.9 per cent 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 in diameter and greater than 900 mm 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 in diameter, for containing the gaseous diffusion barrier, made of or lined with UF_6-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 UF_6, and with a discharge pressure of up to several hundred kN/m^2 (100 psi), designed for long-term operation in the UF_6 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 UF_6.

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 UF_6. Such seals are normally designed for a buffer gas in-leakage rate of less than 1000 cm^3/min.

5.3.5. Heat exchangers for cooling UF_6

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 intended for a leakage pressure change rate of less than 10 N/m^2 (0.0015 psi) per hour under a pressure difference of 100 kN/m^2 (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 UF_6 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" UF_6 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 UF_6 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" UF_6 gaseous streams flowing from exit points are passed by 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 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 kN/m^2 (45 lb/in^2) 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 form liquid 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 handling UF_6 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 or more.

(b) Vacuum pumps especially designed for service in UF_6-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 UF_6-resistant materials with a diameter of 40 to 1500 mm for installation in main and auxiliary systems of gaseous diffusion enrichment plants.

5.4.5. UF_6 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 UF_6 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.

EXPLANATORY NOTE

The items listed above either come into direct contact with the UF_6 process gas or directly control the flow within the cascade. All surfaces which come into contact with the process gas are wholly made of, or lined with, UF_6-resistant materials. For the purposes of the sections relating to gaseous diffusion items the materials resistant to corrosion by UF_6 include stainless steel, aluminium, aluminium alloys, aluminium oxide, nickel or alloys containing 60% or more nickel and UF_6-resistant fully fluorinated hydrocarbon polymers.

5.5. Jet nozzle separation units

5.6. Vortex separation units

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

THE ZANGGER COMMITTEE : A HISTORY 1971-1990

The Origins

1. The origins of the Zangger Committee, also known as the Nuclear Exporters' Committee, sprang from Article III2. of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) which entered into force on 5 March 1970. Under the terms of Article III2:

> "Each State Party to the Treaty undertakes not to provide: (a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this Article."

2. Between 1971 and 1974 a group of fifteen states, some already Party, the others prospective Parties to the NPT, held a series of informal meetings in Vienna chaired by Professor Claude Zangger of Switzerland. As suppliers or potential suppliers of nuclear material and equipment their objective was to reach a common understanding on:

- the definition of what constituted "equipment or material especially designed or prepared for the processing, use or production of special fissionable material";
- the conditions and procedures that would govern exports of such equipment or material in order to meet the obligations of Article III2 on a basis of fair commercial competition.

3. The group, which came to be known as the "Zangger Committee", decided that its status was informal, and that its decisions would not be legally binding upon its members.

The Rules of the Game - INFCIRC/209 Series

4. By 1974 the Committee had arrived at a consensus on the basic "rules of the game" which were set out in two separate memoranda dated 14 August 1974. The first defined and dealt with exports of source and special fissionable material (Article III2(a) of the NPT). The second defined and dealt with exports of equipment and non-nuclear material (Article III2(b) of the NPT). The Committee agreed to exchange information about actual exports, or issue of licenses for exports, to any non-nuclear weapon States not Party to the NPT through a system of Annual Returns which are circulated on a confidential basis amongst the membership each year in April.

5. The consensus, which formed the basis of the Committee's "Understandings" as they are known, was formally accepted by individual Member States of the Committee by an exchange of Notes amongst themselves. These amounted to unilateral declarations that the Understandings would be given effect through respective domestic export control legislation.

6. More or less in parallel with this procedure each Member State (except three) wrote identical letters to the Director General of the IAEA, enclosing edited versions of the two memoranda, informing him of its decision to act in conformity with the conditions set out in them and asking him to communicate this decision to all Member States of the Agency. The letters and memoranda were accordingly published as IAEA document INFCIRC/209 dated 3 September 1974.

7. The three exceptions (Belgium, Italy and Switzerland) subsequently wrote to the Director General informing him of their decision to comply with the undertakings of the Nuclear Suppliers' Group set out in INFCIRC/254 dated February 1978.

The "Trigger List"

8. The memorandum dealing with equipment and non-nuclear material (INFCIRC/209, Memorandum B) became known as the "Trigger List": the export of items listed on it " trigger" IAEA safeguards, ie they will be exported only if the source or special fissionable material produced, processed or used in the equipment or material in question is subject to safeguards under an Agreement with the IAEA.

Trigger List "Clarification"

9. Attached to the original Trigger List was an Annex "clarifying" or defining the items described on it in some detail. The passage of time and successive developments in technology have meant that the Committee is constantly engaged in monitoring the need for revision or further "clarification" of Trigger List items and the original Annex has thus grown considerably. To date, four clarification exercises (conducted on the basis of consensus, through the same procedure of internal notification and, where appropriate, by identical letters to the Director General of the IAEA) have taken place.

Details of the four clarification exercises are set out below:

- In November 1977 the clarifications contained in the Trigger List Annex were updated to bring them into conformity with those of INFCIRC/254. However, three member States (Belgium, Italy and Switzerland) expressed the reserve that, in their opinion, the new item "Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared therefor" (2.6.1) did not fall within the legal scope of Article III.2.(b) of the NPT and would entail an implicit modification of it. Accordingly, they made it clear that they would act on this item on the basis of their commitments under the Nuclear Suppliers' Guidelines.

  The amendments were published in the IAEA document INFCIRC/209/Mod.1. issued on 1 December 1978.

- In order to take account of the technological development which had taken place during the preceding decade in the field of isotope separation by the gas centrifuge process, the clarifications in the Trigger List Annex concerning Isotope Separation Plant Equipment were updated to include additional detail.

  The text of the new clarification was published in the IAEA document INFCIRC/209/Mod.2 of February 1984.

- For similar reasons the clarifications contained in the Trigger List Annex concerning Fuel Reprocessing Plants were updated to include further items of equipment.

  The text of the new clarification was published in the IAEA document INFCIRC/209/Mod.3 of August 1985.

- The clarifications contained in the Trigger List Annex concerning Isotope Separation Plant Equipment were further elaborated by the identification of items of equipment used for isotope separation by the gaseous diffusion method.

  The text of the new clarification was published in the IAEA document INFCIRC/209/Mod.4 of February 1990.

Status of the Committee

10. The Committee's Understandings and the INFCIRC/209 series documents that arise from them have no status in international law but are arrangements unilaterally entered into by Member States. They make an important contribution to the non-proliferation regime, and are continuously adapted in response to evolving circumstances.

Membership

11. A list of the current Member States of the Zangger Committee is set out below.

AUSTRALIA
AUSTRIA
BELGIUM
CANADA
CZECHOSLOVAKIA
DENMARK
FINLAND
GERMAN DEMOCRATIC REPUBLIC
FEDERAL REPUBLIC OF GERMANY
GREECE
HUNGARY
IRELAND
ITALY
JAPAN
LUXEMBOURG
NETHERLANDS
NORWAY
POLAND
SWEDEN
SWITZERLAND
UNITED KINGDOM
UNITED STATES OF AMERICA
UNION OF SOVIET SOCIALIST REPUBLICS

Chairman

12. Mr Ilkka Makipentti of Finland succeeded Professor Zangger as Chairman in 1989.

VIENNA

July 1990