M – Export Controls

The Zangger Committee: A History 1971-1990

[Reproduced from Annex attached to INFCIRC/209/Rev.1, November 1990]

The Origins.

1. The origins of the Zangger Committee, also known as the Nuclear Exporters' Committee, sprang from Article III.2 of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) which entered into force on 5 March 1970. Under the terms of Article III.2:

> 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 I II2 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 I II2(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 I II.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 next 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
[Germany][1]
Greece
Hungary
Ireland
Italy
Japan
Luxembourg
Netherlands
Norway

Poland
[Russian Federation][2]
Sweden
Switzerland
United Kingdom
United States of America

Chairman

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

Notes:

1. Following unification of the German Democratic Republic and the Federal Republic of Germany.
2. Successor state to the Union of Soviet Socialist Republics.

Communications Received from Member States Regarding the Export of Nuclear Material and of Certain Categories of Equipment and Other Material

[Reproduced from INFCIRC/209/Rev.2, 9 March 2000]

1. The Director General of the International Atomic Energy Agency has received letters of 15 November 1999 from the Resident Representatives of Argentina, Australia, Austria, Belgium, Bulgaria, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, the Slovak Republic, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom, and the United States of America, concerning the export of nuclear material and of certain categories of equipment and other material.
2. In light of the wish expressed at the end of each letter, the text of the letter is attached hereto.

[*Editorial note:* China and the Russian Federation subsequently sent similar letters]

Attachment Letter

Sir,

I have the honour to refer to relevant previous communications from the Resident Representative of [Member State] to the International Atomic Energy Agency. In the years since the procedures described in INFCIRC/209 were formulated for the export of certain categories of equipment and material especially designed or prepared for the processing, use or production of special fissionable material, developments in nuclear technology have brought about the need to clarify parts of the Trigger List originally incorporated in Memorandum B of INFCIRC/209. Such clarifications have been covered in INFCIRC/209/Mods. 1, 2, 3, and 4 (consolidated in INFCIRC/209/Rev. 1) and in INFCIRC/209/Rev. 1/Mods. 1, 2, 3 and 4/Corr.1.

My Government now thinks it desirable to amend the Trigger List to include a new entry entitled “plants for the conversion of uranium and plutonium and equipment especially designed or prepared therefor”. I therefore wish to inform you that a new section 2.7 should be added to Memorandum B and a new section 7 to its Annex, as set out in the attachment to the letter to you from the Secretary of the Committee, dated 5 November 1999. In connection with these changes, section 3 of the Annex should be amended to delete sections 3.5 and 3.6 which have been incorporated into the new section 7.

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

[The Government of (Member State) so far as trade within the European Union is concerned, will implement these procedures in the light of its commitments as a Member State of that Union.][1]

My Government considers it opportune for the Agency to re-issue the whole Memoranda A and B, as amended, as INFCIRC/209/Rev. 2 in order to have available a comprehensive document for States Parties to the Nuclear Non-Proliferation Treaty (NPT) at the NPT Review Conference in 2000. I should be grateful if you would circulate the text of this letter and the amended Memoranda A and B referred to above to all Member States for their information.

[1] *This paragraph is included only in the letters from EU Members.*

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 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 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 (i) below, and exports of source or special fissionable to a given country, within a period of 12 months, below the limes 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 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 Especialy 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 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, designed or prepared therefor (See Annex, section 5);
2.6. Plants for the production of heavy water, deuterium and deuterium compounds and equipment designed or prepared therefor (see Annex, section 6.).
2.7. Plants for the conversion of uranium and plutonium for use in the fabrication of fuel elements and the separation of uranium isotopes as defined in Annex sections 4 and 5 respectively, and equipment especially designed or prepared therefor (see Annex, section 7.)

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 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 items is supplied shall not be diverted to weapons or other nuclear explosive devices; and

(b) Satisfy itself that safeguards to that end, under an agreement with the Agency and in accordance 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 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)

[*Editorial Note:* The items contained in this annex are now identical to those in Sections 1–6 of the NSG Guidelines, published in INFCIRC/254 — see below.]

Working Paper on Multilateral Nuclear Supply Principles of the Zangger Committee

[Reproduced from NPT/CONF.2005/WP.15, 27 April 2005]

Working paper submitted by Argentina, Australia, Austria, Belgium, Bulgaria, Canada, China, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Republic of Korea, Romania, the Russian Federation, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland and the United States of America as members of the Zangger Committee

Introduction

1. Previous review conferences of the parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), when reviewing the implementation of the Treaty in the area of export controls, have repeatedly noted the role of the Zangger Committee. The Committee, also known as the “NPT Exporters Committee”, essentially contributes to the interpretation of article III, paragraph 2, of the Treaty and thereby offers guidance to all parties to the Treaty. The Committee and its work were mentioned in final documents or in Committee reports of review conferences from 1975, 1985, 1990, 1995 and 2000.

2. The purpose of this paper is to describe the work of the Zangger Committee in order to provide better insight into the Committee’s objectives. Furthermore, it is consistent with one of the calls of the 1995 Review and Extension Conference of the Parties to the Treaty, which in paragraph 17 of its decision on “Principles and objectives for nuclear non-proliferation and disarmament” stated that “transparency in nuclear export controls should be promoted within the framework of dialogue and cooperation among all interested States party to the Treaty”.

3. Attached to this paper are the statements of previous NPT review conferences referring to the Zangger Committee.

Article III, paragraph 2

4. Article III, paragraph 2 of the NPT performs a vital function in helping to ensure the peaceful use of nuclear material and equipment. Specifically, it provides:

“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."

5. The main significance of this paragraph is that parties to the Treaty should not export, directly or indirectly, nuclear material and equipment or material especially designed or prepared for the processing, use, or production of special fissionable material to non-nuclear-weapon States not parties to the NPT unless the export is subject to International Atomic Energy Agency (IAEA) safeguards as required by article III. This is an important provision because recipient countries not parties to the Treaty may not have accepted any other nuclear non-proliferation obligations. By interpreting and implementing article III, paragraph 2, the Zangger Committee helps to prevent the diversion of exported nuclear material and equipment or material from peaceful purposes to nuclear weapons or other nuclear explosive devices, which furthers the objectives of the Treaty and enhances the security of all States.

6. The Zangger Committee understandings, in line with article III, paragraph 2, also relate to exports to non-nuclear-weapon States parties to the Treaty insofar as the recipient should recognize the items on the trigger list as a basis for its export control decisions in the case of re-exports.

Zangger Committee understandings

7. Between 1971 and 1974 a group of 15 States — some already parties to the Treaty, others prospective parties — 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:

(a) The definition of what constituted "equipment or material especially designed or prepared for the processing, use or production of special fissionable material" (as it was not defined anywhere in the Treaty);

(b) The conditions and procedures that would govern exports of such equipment or material in order to meet the obligations of article III, paragraph 2 on a basis of fair commercial competition.

8. 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.

9. In 1972, the Committee reached consensus on basic "understandings" contained in two separate memorandums. Together, these memorandums form the guidelines of the Zangger Committee today. Each memorandum defines and provides for procedures for the export of materials and equipment described in article III, paragraph 2. The first memorandum concerns source and special fissionable material (article III, paragraph 2 (a)), the second, equipment and material especially designed or prepared for the processing, use or production of special fissionable material (article III, paragraph 2 (b)).

10. The consensus which formed the basis of the Committee's understandings was formally accepted by individual States members of the Committee by an exchange of notes among themselves. These amounted to unilateral declarations that the understandings would be given effect through respective domestic export control legislation. In parallel with this procedure, most member States wrote identical letters to the Director General of IAEA informing him of their decision to act in conformity with the conditions set out in the understandings. These letters also asked the Director General to communicate their decision to all States members of the Agency, which he did through an information circular dated 3 September 1974 (IAEA document INFCIRC/209).

11. Memorandum A defines the following categories of nuclear material:

(a) Source material: natural or depleted uranium and thorium;

(b) Special fissionable material: plutonium-239, uranium-233, uranium enriched in the isotopes 235 or 233.

12. Memorandum B, as clarified since 1974 (see paras. 16 and 17 below), contains plants, equipment and, as appropriate, material in the following categories: nuclear reactors, non-nuclear materials for reactors, reprocessing, fuel fabrication, uranium enrichment, heavy water production, and conversion.

13. To fulfil the requirements of article III, paragraph 2, the Zangger Committee understandings contain three basic conditions of supply for these items:

(a) For exports to a non-nuclear-weapon State not party to the Treaty, source or special fissionable material either directly transferred, or produced, processed, or used in the facility for which the transferred item is intended, shall not be diverted to nuclear weapons or other nuclear explosive devices;

(b) For exports to a non-nuclear-weapon State not party to the Treaty, such source or special fissionable material, as well as transferred equipment and non-nuclear material, shall be subject to safeguards under an agreement with the IAEA;

(c) Source or special fissionable material, and equipment and non-nuclear material shall not be re-exported to a non-nuclear-weapon State not party to the Treaty unless the recipient State accepts safeguards on the re-exported item.

Development of the conditions of supply

14. The Committee is holding discussions on possible amendments to its understandings during which it is considering a number of potential elements as conditions of supply, among which are: (a) full-scope safeguards; (b) the Additional Protocol; (c) physical protection as a condition of supply; and (d) "Supporting Activities", containing commitments to, inter alia, (i) assist other States parties in establishing and implementing national rules and regulations on nuclear transfers, and (ii) support IAEA in its safeguards task in accordance with repeated calls by review conferences. The Committee would welcome the Conference's continued support for its efforts.

"Trigger list" and its clarification

15. The two memorandums (see paras. 9-12 above) became known as the "trigger list", since the export of listed items "triggers" IAEA safeguards. In other words, as described above, they will be exported only if (a) the transferred equipment or source or special fissionable material or (b) the material produced, processed or used in the facility for which the item is supplied, is subject to safeguards under an agreement with IAEA based on the IAEA safeguards system for NPT purposes.

16. Attached to the trigger list is an annex "clarifying", or defining, the equipment and material of memorandum B in some detail. The passage of time and successive developments in technology have meant that the Committee is periodically engaged in considering possible revisions to the trigger list, and the original annex has thus become increasingly detailed. To date, eight clarification exercises have taken place. Clarifications are conducted on the basis of consensus, using the same procedure followed in the adoption of the original understandings.

17. A summary of these clarifications reflects both some detail on the contents of the trigger list and an idea of the work of the Zangger Committee (dates are for publication of modifications and revisions of INFCIRC/209):

(a) In **December 1978**, the annex was updated to add heavy water production plants and equipment, and a few specific items of isotope separation equipment for uranium enrichment;

(b) In **February 1984**, further detail was added to the annex to take account of technological developments during the preceding decade in the area of uranium enrichment by the gas centrifuge process;

(c) In **August 1985**, a similar clarification was made to the annex section on irradiated fuel reprocessing;

(d) In **February 1990**, the uranium enrichment section was further elaborated by the identification of items of equipment used for isotope separation by the gaseous diffusion method;

(e) In **May 1992**, specific items of equipment were added to the section on heavy water production;

(f) In **April 1994**, the enrichment section of the annex was subject to its most significant expansion yet. Existing portions of the section were updated, and detailed lists of equipment were added for the enrichment processes of aerodynamic, chemical and ion exchange, laser-based plasma, and electromagnetic separation. A significant modification was also made to the entry for primary coolant pumps;

(g) In **May 1996**, the sections on reactors and reactor equipment, on non-nuclear materials, on the fabrication of fuel elements as well as on heavy water production were reviewed.

Parts of these sections were updated and new, detailed equipment was added;

(h) In **March 2000**, a new section on uranium conversion was added. This section also contains elements transferred from section 3 (reprocessing).

All these changes to the list were included in the version of the Zangger Committee understandings published as IAEA document INFCIRC/209/Rev.2.

Membership

18. All Zangger Committee members are parties to the Treaty that are capable of supplying trigger list items. Currently there are 35 members (Argentina, Australia, Austria, Belgium, Bulgaria, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Poland, Portugal, Republic of Korea, Romania, Russian Federation, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States). The Commission of the European Union attends the meetings as permanent observer. Any party that is an actual or potential nuclear supplier and is prepared to implement the Committee's understandings is eligible for membership. Decisions to invite new members of the Committee are taken by consensus of existing members. In the interest of strengthening the Treaty and the nuclear non-proliferation regime in general, Zangger Committee members have urged parties to the Treaty that are nuclear suppliers to consider seeking membership. NPT parties interested in doing so should visit the Committee's website (www.zanggercommittee.org) and may contact the Secretariat (the United Kingdom Mission in Vienna) or any State member of the Committee.

Outreach

19. Late in 2001, the Zangger Committee decided to launch an outreach programme between the Zangger Committee and third countries. The outreach programme has three objectives:

(a) To build a strong and sustainable relationship between the Zangger Committee and third countries;

(b) To increase the transparency of the activities of the Committee by explaining its role, purpose and functions, in particular its role as technical interpreter of article III, paragraph 2 of the Treaty;

(c) To provide opportunities for open dialogue on issues of common interest and concern on non-proliferation and nuclear export controls. In conducting this exercise, the Zangger Committee wishes to underline that (a) the outreach programme reflects the fact that the Committee is a technical body with a remit to interpret article III, paragraph 2 of the Treaty and as such outreach will not be a political dialogue; (b) the programme is restricted to States parties to the Treaty; and (c) the programme is informal.

Subjects for discussion include:

- The role and purpose of the Zangger Committee
- The trigger list and its clarification
- Conditions of supply
- Membership of the Committee
- The Committee and NPT conferences.

Zangger Committee and NPT conferences

20. At the first NPT Review Conference in 1975, a brief paragraph in the Final Document referenced the work of the Zangger Committee without naming it. Paraphrasing, this paragraph stated that, with regard to implementation of article III, paragraph 2, the Conference noted that a number of nuclear suppliers had adopted certain minimum requirements for IAEA safeguards in connection with their nuclear exports to non-NPT non-nuclear-weapon States. The Conference went on to attach particular importance to the fact that those suppliers had established as a supply condition an undertaking of non-diversion to nuclear weapons.

21. In 1980, the Review Conference produced no consensus final document. However, in 1985, the Final Document contained a short reference to the Committee's activities, again without naming it. This time the Conference in effect endorsed the main activity of the Zangger Committee by indicating that further improvement of the trigger list should take account of advances in technology.

22. In 1990 the Zangger Committee was mentioned by name and the Conference provided a brief description of its aims and practices. While the Conference did not adopt a final declaration, Main Committee II agreed on language pertaining to a number of ideas and proposals concerning the implementation of the Treaty in the areas of the non-proliferation of nuclear weapons and safeguards. Main Committee II observed that Zangger Committee members had met regularly to coordinate the implementation of article III, paragraph 2 and had adopted nuclear supply requirements and a trigger list. It recommended that this list be reviewed periodically to take into account advances in technology and changes in procurement practices, a recommendation that the Zangger Committee has continued to pursue. Main Committee II also urged all States to adopt the Zangger Committee's requirements for any nuclear cooperation with a non-nuclear-weapon State not party to the Treaty.

23. At the 1995 NPT Review and Extension Conference, the work of the Zangger Committee was also referenced in Main Committee II and, more specifically, in the working group established by Main Committee II to consider export control issues. While the Conference did not adopt a final declaration similar to those of previous conferences, a consensus text on the Zangger Committee was attained. (The unofficial text emerging from this exercise was subsequently published in IAEA document INFCIRC/482 for information purposes.) The working group noted that a number of States suppliers had formed an informal group known as the Zangger Committee and had adopted certain understandings. It invited States to consider applying those understandings and recommended that the list of items and the procedures for implementation be reviewed from time to time. The working further noted that the application by all States of the understandings of the Zangger Committee would contribute to the strengthening of the non-proliferation regime. At the same time it called for international consultations among all interested States.

24. The Conference approved, inter alia, decision 2, which contains a set of principles and objectives, and decision 3, which provides the basis for the adopted "Enhanced Review Mechanism" of the implementation of the Treaty.

25. Decision 2 contains several principles of particular relevance to the work of the Zangger Committee, in the fields of safeguards and export controls (see annex II to this paper, principles 9 to 13). In particular, principle 17 calls upon all States to promote transparency in nuclear-related export controls through cooperation and dialogue. Members of the Committee have worked to promote transparency through international seminars and other forms of dialogue.

26. At the 2000 Review Conference, export control issues were discussed by an informal, open-ended working group established by Main Committee II. The working group did not reach final agreement on a text mentioning the Zangger Committee. In the end, only two paragraphs of the Final Document referenced indirectly the work of the Zangger Committee without naming it: the Conference recommended that the list of items triggering IAEA safeguards and the procedures for implementation be reviewed from time to time, and it requested that any supplier arrangement should be transparent

27. The statements of review conferences on the Zangger Committee are attached as annex I to this working paper.

Annex I

References to Zangger Committee activities in NPT Review

Conference documents

First NPT Review Conference (1975)

A paragraph in the Final Document referenced the work of the Zangger Committee without naming it:

"With regard to the implementation of article III (2) of the Treaty, the Conference notes that a number of states suppliers of material or equipment have adopted certain minimum, standard requirements for IAEA safeguards in connection with their exports of certain such items to non-nuclear-weapon states not party to the Treaty (IAEA document INFCIRC/209 and addenda). The Conference attaches particular importance to the condition, established by those states, of an undertaking of non-diversion to nuclear weapons or other nuclear explosive devices, as included in the said requirements" (NPT/CONF.35/I, annex I, p. 3).

Third NPT Review Conference (1985)

The 1980 NPT Review Conference produced no final document, but the 1985 Final Document contained a reference to the Committee without naming it:

"The Conference believes that further improvement of the list of materials and equipment which, in accordance with article III (2) of the Treaty, calls for the application of IAEA safeguards should take account of advances in technology" (NPT/CONF.III/64/I, annex I, p. 5, para. 13).

Fourth NPT Review Conference (1990)

While the Conference did not adopt a final document, Main Committee II did agree on a number of ideas and proposals, including the following language on the Zangger Committee:

"The Conference notes that a number of States parties engaged in the supply of nuclear material and equipment have met regularly as an informal group which has become known as the Zangger Committee in order to coordinate their implementation of article III, paragraph 2. To this end, these states have adopted certain requirements, including a list of items triggering IAEA safeguards, for their export to non-nuclear-weapon States not party to the treaty, as set forth in the IAEA document INFCIRC/209 as revised. The Conference urges all States to adopt these requirements in connection with any nuclear cooperation with non-nuclear-weapon states not party to the Treaty. The Conference recommends that the list of items triggering IAEA safeguards and the procedures for implementation be reviewed from time to time to take into account advances in technology and changes in procurement practices. The Conference recommends the States parties to consider further ways to improve the measures to prevent diversion of nuclear technology for nuclear weapons, other nuclear explosive purposes or nuclear weapon capabilities. While recognizing the efforts of the Zangger Committee in the non-proliferation regime, the Conference also notes that items included in the 'trigger list' are essential in the development of nuclear energy programmes for peaceful uses. In this regard, the Conference requests that the Zangger Committee should continue to take appropriate measures to ensure that the export requirements laid down by it do not hamper the acquisition of such items by states parties for the development of nuclear energy for peaceful uses" (NPT/CONF.IV/DC/1/Add.3 (a), p. 5, para. 27).

NPT Review and Extension Conference (1995)

While the Conference did not adopt a final declaration similar to those of previous conferences, Main Committee II and its subsequent working group did agree on a number of ideas and proposals, including the following language on the Zangger Committee, which reached informal consensus in the working group of Main Committee II and was separately published in IAEA document INFCIRC/482:

"The Conference notes that a number of States Parties engaged in the supply of nuclear material and equipment have met regularly as an informal group known as the Zangger Committee. These States have adopted certain understandings, including a list of items triggering IAEA safeguards, for their export to non-nuclear-weapon States not parties to the Treaty, as set forth in IAEA document INFCIRC/209, as amended. The Conference invites all States to consider applying these understandings of the Zangger Committee in connection with any nuclear cooperation with non-nuclear-weapon States not parties to the Treaty. The Conference recommends that the list of items triggering IAEA safeguards and the procedures for implementation be reviewed from time to time to take into account advances in technology and changes in procurement practices."

"The Conference notes that the application by all States of the understandings of the Zangger Committee would contribute to the strengthening of the non-proliferation regime. The Conference calls for wider participation in international consultations among all interested States parties concerning the formulation and review of such guidelines, which relate to the implementation of States parties obligations under article III, paragraph 2" (INFCIRC/482, attachment, paras. 5 and 7).

The Conference adopted in decision 2 a number of principles and objectives related to safeguards and export controls, which are reproduced in annex II below.

Sixth NPT Review Conference (2000)

Main Committee II and its working group discussed a number of ideas and proposals, including the following language on the Zangger Committee, without reaching final agreement:

"The Conference notes that a number of States parties engaged in the supply of nuclear material and equipment have met regularly as an informal group known as the Zangger Committee, in order to coordinate their implementation of article III, paragraph 2 of the Treaty. To this end, these States have adopted certain understandings, including a list of items triggering IAEA safeguards, for their export to non-nuclear-weapon States not parties to the Treaty, as set forth in IAEA document INFCIRC/209 as amended. The Conference invites all States to adopt the understandings of the Zangger Committee in connection with any nuclear cooperation with non-nuclear-weapon States not parties to the Treaty."

In the Final Document, two paragraphs referenced indirectly the work of the Zangger Committee without naming it:

"52. The Conference recommends that the list of items triggering IAEA safeguards and the procedures for implementation, in accordance with article III (2), be reviewed from time to time to take into account advances in technology, the proliferation sensitivity, and changes in procurement practices.

"53. The Conference requests that any supplier arrangement should be transparent and should continue to take appropriate measures to ensure that the export guidelines formulated by them do not hamper the development of nuclear energy for peaceful uses by States parties, in conformity with articles I, II, III, and IV of the Treaty."

Annex II

Principles and objectives related to safeguards and export controls, as contained in decision 2 of the 1995 NPT Review and Extension Conference

Safeguards

9. The International Atomic Energy Agency is the competent authority responsible to verify and assure, in accordance with the statute of the Agency and the Agency's safeguards system, compliance with its safeguards agreements with States parties undertaken in fulfilment of their obligations under article III, paragraph 1, of the Treaty, with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. Nothing should be done to undermine the authority of the International Atomic Energy Agency in this regard. States parties that have concerns regarding non-compliance with the safeguards agreements of the Treaty by the States parties should direct such concerns, along with supporting evidence and information, to the Agency to consider, investigate, draw conclusions and decide on necessary actions in accordance with its mandate.

10. All States parties required by article III of the Treaty to sign and bring into force comprehensive safeguards agreements and which have not yet done so should do so without delay.

11. International Atomic Energy Agency safeguards should be regularly assessed and evaluated. Decisions adopted by its Board of Governors aimed at further strengthening the effectiveness of Agency safeguards should be supported and implemented and the Agency's capability to detect undeclared nuclear activities should be increased. Also, States not party to the Treaty on the Non-Proliferation of Nuclear Weapons should be urged to enter into comprehensive safeguards agreements with the Agency.

12. New supply arrangements for the transfer of source or special fissionable material or equipment or material especially designed or prepared for the processing, use or production of special fissionable material to non-nuclear-weapon States should require, as a necessary precondition, acceptance of the Agency's full-scope safeguards and internationally legally binding commitments not to acquire nuclear weapons or other nuclear explosive devices.

13. Nuclear fissile material transferred from military use to

peaceful nuclear activities should, as soon as practicable, be placed under Agency safeguards in the framework of the voluntary safeguards agreements in place with the nuclear-weapon States. Safeguards should be universally applied once the complete elimination of nuclear weapons has been achieved.

The Nuclear Suppliers Group: Its Origins, Role and Activities

[Circulated by Sweden on Behalf of the Member States of the Nuclear Suppliers Group, Reproduced from INFCIRC/539/Rev. 3, 30 May 2005]

Overview

1. The Nuclear Suppliers Group (NSG) is a group of nuclear supplier countries that seeks to contribute to the non-proliferation of nuclear weapons through the implementation of two sets of Guidelines for nuclear exports and nuclear-related exports. NSG Participating Governments (hereinafter referred to as "NSG participants") are listed in the Annex. NSG participants pursue the aims of the NSG through adherence to the NSG Guidelines, which are adopted by consensus, and through an exchange of information, notably on developments of nuclear proliferation concern.

2. The first set of NSG Guidelines[1] governs the export of items that are especially designed or prepared for nuclear use. These include: (i) nuclear material; (ii) nuclear reactors and equipment therefor; (iii) non-nuclear material for reactors; (iv) plants and equipment for the reprocessing, enrichment and conversion of nuclear material and for fuel fabrication and heavy water production; and (v) technology associated with each of the above items.

3. The second set of NSG Guidelines[2] governs the export of nuclear-related dual-use items and technologies, that is, items that can make a major contribution to an un-safeguarded nuclear fuel cycle or nuclear explosive activity**,** but that have non-nuclear uses as well, for example in industry.

4. The NSG Guidelines are consistent with, and complement, the various international, legally binding instruments in the field of nuclear non-proliferation. These include the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco), the South Pacific Nuclear-Free-Zone Treaty (Treaty of Rarotonga), the African Nuclear-Weapon-Free Zone Treaty (Treaty of Pelindaba) and the Treaty on the Southeast Asia Nuclear-Weapon-Free Zone (Treaty of Bangkok).

5. The aim of the NSG Guidelines is to ensure that nuclear trade for peaceful purposes does not contribute to the proliferation of nuclear weapons or other nuclear explosive devices, and that international trade and cooperation in the nuclear field is not hindered unjustly in the process. The NSG Guidelines facilitate the development of trade in this area by providing the means whereby obligations to facilitate peaceful nuclear cooperation can be implemented in a manner consistent with international nuclear non-proliferation norms. The NSG urges all States to adhere to the Guidelines.

6. The commitment of NSG participants to rigorous conditions of supply, in the context of the further development of the applications of nuclear energy for peaceful purposes, makes the NSG one of the elements of the international nuclear non-proliferation regime

Background to Present Paper

7. The purpose of this paper is to contribute to a broader understanding of the NSG and its activities as part of an overall effort to promote dialogue and cooperation between NSG participants and non-NSG participants. This document provides information on actions taken by NSG participants to give effect to their commitment to improve transparency in nuclear-related export controls and to cooperate more closely with non-NSG participants to achieve this objective. In so doing, it aims to encourage wider adherence to the NSG Guidelines

8. The paper's purpose is therefore consistent with Decision 2 on "Principles and Objectives for Nuclear Non-Proliferation and Disarmament," agreed at the 1995 Review and Extension Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPTREC) where Paragraph 17 of that document states that "transparency in nuclear-related export controls should be promoted within the framework of dialogue and cooperation among all interested States party to the Treaty." In this connection, NSG participants also take into account Paragraph 16 of that document, which calls for preferential treatment to be accorded to non-nuclear weapon States party to the Treaty in the promotion of peaceful uses of nuclear energy, taking the needs of developing countries particularly into account. This paper is likewise consistent with Paragraph 9 of United Nations Security Council Resolution 1540 on the Non-proliferation of Weapons of Mass Destruction, which "calls upon all States to promote dialogue and cooperation on non-proliferation" so as to address the threats posed by proliferation of nuclear weapons.

Section I traces the origins and development of the NSG.

Section II describes the structure and current activities of the NSG.

Section III describes the developments of the NSG to date.

Section IV reports on the NSG action to promote openness and transparency.

I. Origins and Development of the NSG

Export Controls

9. From the beginning of international cooperation in the peaceful uses of nuclear energy, supplier countries have recognised the responsibility to ensure that such cooperation does not contribute to the proliferation of nuclear weapons. Shortly after entry into force of the NPT in 1970, multilateral consultations on nuclear export controls led to the establishment of two separate mechanisms for dealing with nuclear exports: the Zangger Committee in 1971 and what has become known as the Nuclear Suppliers Group in 1975. Between 1978 and 1991, the NSG was not active, even though its Guidelines were in place. The Zangger Committee continued to meet on a regular basis during this period to review and amend the list of items subject to export controls, the so-called "Trigger List."

The Zangger Committee

10. The Zangger Committee had its origins in 1971 when major nuclear suppliers regularly involved in nuclear trade came together to reach common understandings on how to implement Article III.2[3] of the NPT with a view to facilitating consistent interpretation of the obligations arising from that Article. In 1974 the Zangger Committee published a "Trigger List," that is, items which would "trigger" a requirement for safeguards and the Zangger guidelines ("common understandings") governing the export, direct or indirect, of those items to non-nuclear-weapon States (NNWS) that are not party to the NPT. The Zangger Understandings establish three conditions for the supply: a non-explosive-use assurance, an IAEA safeguards requirement, and a re-transfer provision that requires the receiving State to apply the same conditions when re-exporting these items. The Zangger Trigger List and the Understandings are published as IAEA document INFCIRC/209, as amended.

The NSG

11. The NSG was created following the explosion in 1974 of a nuclear device by a non-nuclear-weapon State, an event which demonstrated that nuclear technology transferred for peaceful purposes could be misused. It was thus felt that conditions of nuclear supply might need to be adapted so as to better ensure that nuclear cooperation could be pursued without contributing to

[1] These guidelines are contained in INFCIRC/254, Part 1 (as amended).

[2] These guidelines are contained in INFCIRC/254, Part 2 (as amended).

[3] Article III.2 of the NPT states that:
"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."

the risk of nuclear proliferation. This event brought together the major suppliers of nuclear material, non-nuclear material for reactors, equipment and technology who were members of the Zangger Committee, as well as States who were not parties to the NPT.

12. The NSG, taking into account the work already done by the Zangger Committee, agreed on a set of guidelines incorporating a Trigger List. The NSG Guidelines were published in 1978 as IAEA Document INFCIRC/254 (subsequently amended), to apply to nuclear transfers for peaceful purposes to help ensure that such transfers would not be diverted to un-safeguarded nuclear fuel cycle or nuclear explosive activities. There is a requirement for formal government assurances from recipients to this effect. The NSG Guidelines also strengthened re-transfer provisions and adopted a requirement for physical protection measures and an agreement to exercise particular caution in the transfer of sensitive facilities, technology and material usable for nuclear weapons or other nuclear explosive devices. In doing so, the NSG Guidelines recognised the fact that there is a class of technologies and materials that are particularly sensitive—namely, enrichment and reprocessing technologies—because they can lead directly to the creation of material usable for nuclear weapons or other nuclear explosive devices. The implementation of effective physical protection measures is also critical. This can help prevent the theft and illicit transfer of nuclear material.

13. At the 1990 NPT Review Conference (NPTRC), a number of recommendations made by the committee reviewing the implementation of Article III had a significant impact on the NSG's activities in the 1990s. These included the following:

- That NPT parties consider further improvements in measures to prevent the diversion of nuclear technology for nuclear weapons;
- That States engage in consultations to ensure appropriate coordination of their controls on the exports of items, such as tritium, not identified in Article III.2 but still relevant to nuclear weapons proliferation and therefore to the NPT as a whole;
- That nuclear supplier States require, as a necessary condition for the transfer of relevant nuclear supplies to non-nuclear weapon States, the acceptance of IAEA safeguards on all their current and future nuclear activities (i.e. full-scope safeguards or comprehensive safeguards).

14. Shortly thereafter, it became apparent that export control provisions then in force had not prevented Iraq, a party to the NPT, from pursuing a clandestine nuclear weapons programme, which later prompted UN Security Council action. A large part of Iraq's effort had been to acquire dual-use items not covered by the NSG Guidelines and then to build its own Trigger List items. This gave major impetus to the NSG's development of its Dual-Use Guidelines. In doing so, the NSG demonstrated its commitment to nuclear non-proliferation by ensuring that items like those used by Iraq would from now on be controlled to ensure their non-explosive use. These items would, however, continue to be available for peaceful nuclear activities subject to IAEA safeguards, as well as for other industrial activities where they would not contribute to nuclear proliferation.

15. Following these developments, the NSG decided in 1992:

- To establish guidelines for transfers of nuclear-related dual-use equipment, material and technology (items which have both nuclear and non-nuclear applications) that could make a significant contribution to an un-safeguarded nuclear fuel cycle or nuclear explosive activity. These Dual-Use Guidelines were published as Part 2 of INFCIRC/254, and the original Guidelines published in 1978 became Part 1 of INFCIRC/254;
- To establish a framework for consultation on the Dual-Use Guidelines, for the exchange of information on their implementation and on procurement activities of potential proliferation concern;
- To establish procedures for exchanging notifications that have been issued as a result of national decisions not to authorise transfers of dual-use equipment or technology and to ensure that NSG participants do not approve transfers of such items without first consulting with the State that issued the notification;
- To make a full-scope safeguards agreement with the IAEA a condition for the future supply of Trigger List items to any non-nuclear-weapon State. This decision ensured that only NPT parties and other States with full-scope safeguards agreements could benefit from nuclear transfers.

16. The endorsement at the 1995 NPTREC of the full-scope safeguards policy already adopted by the NSG in 1992 clearly reflects the conviction of the international community that this nuclear supply policy is a vital element to promote shared nuclear non-proliferation commitments and obligations. Specifically, Paragraph 12 of Decision 2 on "Principles and Objectives for Nuclear Non-Proliferation and Disarmament" states that full-scope safeguards and international legally binding commitments not to acquire nuclear weapons or other nuclear explosive devices should be a condition for granting licences for Trigger List items under new supply arrangements with non-nuclear-weapon States.

17. The 2000 NPTRC reconfirmed also that any transfer of nuclear-related dual-use items should be in full conformity with the NPT.

The NSG, the Zangger Committee and the NPT

18. The NSG and the Zangger Committee differ slightly in the scope of their Trigger Lists of *especially designed or prepared* (EDP) items and in the export conditions for items on those lists. Concerning the scope of those lists, the Zangger list is restricted to items falling under Article III.2 of the NPT. The NSG Guidelines, in addition to covering equipment and material, also cover the technology for the development, production and use of the items on the list. On export conditions for the items on the Trigger Lists, the NSG has a formal full-scope safeguards requirement as a condition of supply. The NSG Guidelines apply to transfers for peaceful purposes to any NNWS and, in the case of controls on retransfer, to transfers to any State.

19. The NSG Guidelines also contain the so-called "Non-Proliferation Principle," adopted in 1994, whereby a supplier, notwithstanding other provisions in the NSG Guidelines, authorises a transfer only when satisfied that the transfer would not contribute to the proliferation of nuclear weapons. The Non-Proliferation Principle seeks to cover the rare but important cases where adherence to the NPT or to a Nuclear Weapon Free Zone Treaty may not by itself be a guarantee that a State will consistently share the objectives of the Treaty or that it will remain in compliance with its Treaty obligations.

20. The NSG arrangement covering exports of dual-use items is a major difference between the NSG and the Zangger Committee. As dual-use items cannot be defined as EDP equipment, they fall outside the Zangger Committee's mandate. As noted above, the control of dual-use items has been recognised as making an important contribution to nuclear non-proliferation.

21. Despite these differences between the two regimes, it is important to keep in mind that they serve the same objective and are equally valid instruments of nuclear non-proliferation efforts. There is close cooperation between the NSG and the Zangger Committee on the review and amendment of the Trigger Lists.

II. Structure and Current Activities of the NSG

Participation

22. From the initial publication of INFCIRC/254 in 1978 to now, participation has increased steadily. (See full list of NSG participants in the Annex.)

23. Factors taken into account for participation include the following:

- The ability to supply items (including items in transit) covered by the Annexes to Parts 1 and 2 of the NSG Guidelines;
- Adherence to the Guidelines and action in accordance with them;
- Enforcement of a legally based domestic export control system that gives effect to the commitment to act in accordance with the Guidelines;
- Adherence to one or more treaties, such as the NPT, the Treaties of Tlatelolco, Rarotonga, Pelindaba, Bangkok or an equivalent international nuclear non-proliferation agreement, and full compliance with the obligations of such agreement(s);
- Support of international efforts towards non-proliferation of weapons of mass destruction and of their delivery vehicles.

Organisation of Work

24. The NSG works on the basis of consensus. Overall responsibility for activities lies with the NSG participants who meet once a year in a Plenary meeting.

25. A rotating Chair has overall responsibility for coordination of work and outreach activities. (See full list of NSG Chairs in the Annex.)

26. The NSG Plenary can decide to set up technical working groups on matters such as the review of the NSG Guidelines, the Annexes, the procedural arrangements, information sharing and transparency activities. The NSG Plenary can also mandate the Chair to conduct outreach activities with specific countries. The aim of the outreach activities is to promote adherence to the NSG Guidelines.

27. Typically, the agenda of the Plenary meeting focuses on reports from working groups that may be operating or may have concluded their work since previous Plenaries as well as on reports from the previous NSG Chair on outreach activities. Time is also allotted to review items of interests such as trends in nuclear proliferation and developments since the previous Plenary meeting.

28. In addition to the Plenary meeting, the NSG has two other standing bodies that report to the Plenary. These are the Consultative Group (CG) and the Information Exchange Meeting (IEM) with Chairs that also rotate annually. The CG meets at least twice a year and is tasked to hold consultations on issues associated with the Guidelines on nuclear supply and the technical annexes. The IEM precedes the NSG Plenary and provides another opportunity for NSG participants to share information and developments of relevance to the objectives and content of the NSG Guidelines. Under the mandate of information exchange, the Licensing and Enforcement Experts Meeting, or LEEM, discusses issues relating to effective licensing and enforcement practices.

29. NSG participants review the Guidelines in INFCIRC/254 from time to time to ensure that they are up to date to meet evolving nuclear proliferation challenges. The IAEA is notified of agreed amendments to Parts 1 and 2 of the NSG Guidelines and their associated lists and reissues INFCIRC/254 accordingly. Such amendments can be additions, deletions or corrections.

30. The Permanent Mission of Japan in Vienna, acting as a Point of Contact, carries out a practical support function. It receives and distributes NSG documents, notifies meeting schedules and provides practical assistance to the NSG Plenary, the CG and IEM Chairs and Chairs of the various working groups established by the Plenary.

How the Guidelines Work

31. The NSG Guidelines introduce a degree of order and predictability among the suppliers and harmonise standards and interpretations of suppliers' undertakings with the aim of ensuring that the normal process of commercial competition does not lead to outcomes that further the proliferation of nuclear weapons. Consultations among NSG participants are also designed to ensure that any possible impediments to international nuclear trade and cooperation are kept to a minimum.

32. The NSG Guidelines are implemented by each NSG participant in accordance with its national laws and practices. Decisions on export applications are taken at the national level in accordance with national export licensing requirements. This is the prerogative and right of all States for all export decisions in any field of commercial activity and is also in line with the text of Article III.2 of the NPT, which refers to "each State Party," and thus emphasises the sovereign obligation of any party to the Treaty to exercise proper export controls. NSG participants meet regularly to exchange information on issues of nuclear proliferation concern and how these impact on national export control policy and practice. However, it is important to remember that the NSG does not have a mechanism for limiting supply or the coordination of marketing arrangements and does not take decisions on licence applications as a group.

33. The requirement that no transfer of Trigger List items to NNWS takes place unless the recipient State has full-scope safeguards on all its nuclear activities is particularly pertinent because it establishes a uniform standard of supply that is based on the IAEA's international verification system. The strengthened safeguards system of the IAEA, as adopted in 1997, should improve considerably the Agency's ability to exercise its verification role.

34. Contacts and briefings take place with non-participating countries: in addition to the outreach activities conducted with potential NSG participants, the NSG conducts briefings of non-NSG participants with a view to increasing the understanding of and adherence to the NSG Guidelines. States can choose to adhere to the Guidelines without being obliged to participate in the NSG.

III. Developments of the NSG to Date

35. The NSG Guidelines have significantly strengthened international solidarity in the field of transfers of nuclear material. NSG undertakings reflect the non-proliferation and peaceful nuclear cooperation objectives that NSG participants share with all NPT parties and parties to other international legally binding non-proliferation commitments. Controls on the transfer of listed items and technologies provide essential support for the implementation of these treaties and for the continuation and development of peaceful nuclear cooperation, thus also facilitating the utilisation of nuclear energy in developing countries.

36. Contrary to fears that the NSG Guidelines act as an impediment to the transfer of nuclear materials and equipment, they have in fact facilitated the development of such trade. For some time now, supply arrangements have incorporated NSG commitments. Such arrangements are designed to expedite transfers and trade. The NSG commitments, when woven into the supply arrangements with a basis in respective national laws, provide governments with legitimate and defensible arguments that such arrangements diminish proliferation risk. In this manner, non-proliferation and trade purposes are mutually reinforcing.

37. The NSG Guidelines are applied both to NSG participants and non-NSG participants. Most NSG participants do not possess a self-sufficient fuel cycle and are major importers of nuclear items. Accordingly, they are required to provide the same assurances for nuclear transfers as non-NSG participants in accordance with the Guidelines.

38. As practised by NSG participants, export controls operate on the basis that cooperation is the principle and restrictions are the exception. Few NPT parties have been refused controlled items: this has occurred when a supplier had good reason to believe that the item in question could contribute to nuclear proliferation. Almost all rejections by NSG participants of applications for export licences have concerned States with un-safeguarded nuclear programmes.

39. There is close interdependence between the controls in Part 1 of the Guidelines and the effective implementation of comprehensive IAEA safeguards. The NSG supports fully international efforts to strengthen safeguards to detect undeclared activities as well as to monitor declared nuclear activities to ensure that they continue to meet vital nuclear non-proliferation requirements and to provide the assurances needed for the continuation of international nuclear trade.

40. The NSG held an Intersessional Meeting in Vienna in October 1998, following the concern expressed by NSG participants at the nuclear tests conducted by India and Pakistan in May 1998. NSG participants discussed their impact and they reaffirmed their commitment to the NSG Guidelines.

41. The NSG held an Extraordinary Plenary Meeting in Vienna in December 2002 and agreed to several comprehensive amendments to strengthen its Guidelines, intended to prevent and counter the threat of diversion of nuclear exports to nuclear terrorism. The Plenary emphasised that effective export controls are an important tool to combat the threat of nuclear terrorism. While discussing the DPRK nuclear programme, the Participating Governments of the NSG called on all States to exercise extreme vigilance that their exports and any goods or nuclear technologies that transit their territorial jurisdiction do not contribute to any aspect of a North Korean nuclear weapons effort.

42. At the 2004 NSG Plenary in Göteborg, Sweden, the NSG welcomed Libya's voluntary decision to eliminate materials, equipment and programmes leading to the production of nuclear

weapons, while noting with deep concern the discovery of elements of a covert international proliferation trafficking network through which sensitive nuclear-related equipment had found its way to Libya. The Göteborg Plenary also noted the importance of Iran's full compliance with its obligations under the Nuclear Non-Proliferation Treaty (NPT) and called on Iran to implement proactively all of the provisions of the resolutions of the International Atomic Energy Agency (IAEA) Board of Governors and to restore broad international confidence.

43. NSG Participants continue discussions on illicit procurement and trafficking, while calling on all States to exercise extreme vigilance to make best efforts that none of their exports of goods and technologies contribute to nuclear weapons programmes. In this regard, NSG participants welcome UNSCR 1540's affirmation that the prevention of nuclear weapons should not hamper international cooperation in materials, equipment and technology used for peaceful purposes while goals of peaceful utilisation should not be used as a cover for proliferation.

44. NSG participants also welcome UNSCR 1540's recognition of the importance of export controls to non-proliferation efforts, as well as its decision that all States shall take and enforce effective measures to establish domestic controls to prevent the proliferation of nuclear weapons, including establishing end-user controls.

45. To further strengthen Participating Government's national export controls, the 2004 Göteborg Plenary decided to adopt a "catch-all" mechanism in the NSG Guidelines, to provide a national legal basis to control the export of nuclear related items that are not on the control lists, when such items are or may be intended for use in connection with a nuclear weapons programme. Participating Governments also agreed on the importance of effective and consistent Guideline implementation, including requiring the existence of national export licensing regulations, enforcement measures, and penalties for violations

46. In recognition of the threats posed by the proliferation of nuclear weapons and the unrestricted spread of sensitive nuclear technologies, NSG participants continue to discuss ways to further strengthen the NSG Guidelines in order to address these challenges.

IV. NSG Action to Promote Openness and Transparency

47. The NSG is aware that non-NSG participants have in the past expressed concern about the lack of transparency in the NSG's proceedings. Non-NSG participants have not been part of the decision-making process in the establishment of the Guidelines. Concerns have therefore been expressed that the NSG has sought to deprive States of the benefits of nuclear technology or imposed requirements on non-NSG participants, which have been made without their participation.

48. NSG participants understand the reasons for these concerns but state emphatically that the objectives of the NSG have consistently been to fulfil their obligations as suppliers to support nuclear non-proliferation and, in doing so, to facilitate peaceful nuclear cooperation. The growing and diverse participation of the NSG demonstrates that it is not a closed shop.

49. The NSG has consistently promoted openness and greater understanding of its aims, as well as adherence to its Guidelines and is prepared to support efforts by States to adhere to and implement the Guidelines. In response to the interest shown by individual States and groups of States, a series of contacts have taken place to inform them about the NSG's activities and to encourage them to adhere to the Guidelines. These contacts have been organised through special missions to these countries by successive NSG Plenary Chairs and representatives of NSG participants as well as during NSG seminars specially convened for this purpose (in 1994 and 1995).

50. The NSG welcomes the call in Paragraph 17 of the "Principles and Objectives for Nuclear Non-proliferation and Disarmament" adopted at the 1995 NPTREC for more openness and transparency, and responded substantively to the call at its Buenos Aires Plenary meeting on 25-26 April 1996 by establishing a working group to consider how to promote openness and transparency through further dialogue and cooperation with non-NSG participants.

51. This is in addition to the ongoing NSG outreach programme and regular contacts with specific countries to inform them about NSG practices and to promote adherence to the Guidelines.

52. As a first step, NSG participants have strengthened their dialogue with non-NSG participants through contacts that took place in the margins of the 1996 IAEA General Conference. This dialogue continues in capitals and on other occasions such as regular nuclear and security policy dialogues, as well as during multilateral meetings that deal with these issues. This paper is a further practical contribution to this process.

53. On 7-8 October 1997, immediately following the forty-first session of the IAEA General Conference, the NSG held the "International Seminar on the Role of Export Controls in Nuclear Non-Proliferation" in Vienna. Given the importance of including all actual and potential supplier countries and the wish for a genuine, open and all-inclusive dialogue, it was decided to invite all States to the Seminar, both parties and non-parties to the NPT.

54. On the basis of the dialogue started in Vienna, a second international seminar on the same subject was held in New York on 8-9 April 1999, ahead of the 1999 NPT Preparatory Committee Meeting. As in 1997, speakers were drawn from both NSG participants and non-NSG participants and from a variety of backgrounds so that the debate could cover a broad spectrum of views. Both seminars were attended by representatives from Governments, international organisations, and leading experts from the media, the academic world and industry.

55. The two international seminars were designed to be a further but not final step in promoting the goals of transparency within a framework of dialogue and cooperation on the role of export controls in nuclear non-proliferation and in the promotion of nuclear trade for peaceful purposes. These events proved to be very beneficial in terms of furthering transparency about nuclear export controls.

56. At the 2001 Aspen Plenary the NSG agreed upon the creation of a web site in order to better inform the public of the role and activities of the NSG. The web site, with the following URLs, was opened to the public at the 2002 Prague Plenary. http://www.nuclearsuppliersgroup.org http://www.nsg-online.org

57. Recognising the increased need for transparency, openness and dialogue in order to address export control challenges posed by illicit procurement of nuclear and nuclear-related materials and the globalisation of the nuclear industry, NSG participants agreed at the 2004 Göteborg Plenary to strengthen contacts with non-partners through seminars and other joint activities with States outside of the NSG.

58. NSG participants are also exploring other means of cooperating more closely with non-NSG participants, to promote understanding of the Guidelines as well as adherence and implementation.

Conclusions

59. In its future activities, the NSG will continue to be guided by the objectives of supporting nuclear non-proliferation and facilitating the peaceful applications of nuclear energy.

60. With regard to the future development of the Guidelines, NSG participants will continue to harmonise their national export control policies in a transparent manner. In this way they will continue to contribute to nuclear non-proliferation and at the same time support the development of nuclear trade and cooperation and help sustain genuine commercial competition between suppliers.

61. Universal transparency of the NSG Guidelines and the Annexes will continue through their publication as IAEA Information Circulars.

62. The NSG remains open to admitting further supplier countries in order to strengthen international non-proliferation efforts, as already illustrated by its broadening participation in all regions of the world.

63. The NSG is committed to the further promotion of openness and transparency in its practices and policy.

ANNEX

NSG participants and those who have held the Chair

ARGENTINA (1996 / 97 – BUENOS AIRES)
AUSTRALIA
AUSTRIA
BELARUS
BELGIUM
BRAZIL
BULGARIA
CANADA (1997 / 98 – OTTAWA)
CHINA
CYPRUS
CZECH REPUBLIC (2002 / 03 – PRAGUE)
DENMARK
ESTONIA
FINLAND (1995 / 96 – HELSINKI)
FRANCE (2000 / 01 – PARIS)
GERMANY
GREECE
HUNGARY
IRELAND
ITALY (1999 / 00 – FLORENCE)
JAPAN
KAZAKHSTAN
REPUBLIC OF KOREA (2003 / 04 – BUSAN)
LATVIA
LITHUANIA
LUXEMBOURG
MALTA
NETHERLANDS (1991 / 92 – THE HAGUE)
NEW ZEALAND
NORWAY (2005 / 06 – OSLO)
POLAND (1992 / 93 – WARSAW)
PORTUGAL
ROMANIA
RUSSIAN FEDERATION
SLOVAKIA
SLOVENIA
SOUTH AFRICA
SPAIN (1994 / 95 – MADRID)
SWEDEN (2004 / 05 – GÖTEBORG)
SWITZERLAND (1993 / 94 – LUCERNE)
TURKEY
UKRAINE
UNITED KINGDOM (1998 / 99 – EDINBURGH)
UNITED STATES (2001 / 02 – ASPEN)

Permanent Observer: EUROPEAN COMMISSION

Guidelines for Transfers of Nuclear-Related Dual-Use Equipment, Materials, Software, and Related Technology

[Nuclear Suppliers Group, Reproduced from INFCIRC/254/Rev.7/Part 2, February 2006]

[INFCIRC/254/Part.1, as amended, contains Guidelines for the export of nuclear material, equipment and technology.]

1. The Director General of the International Atomic Energy Agency has received Notes Verbales, dated 1 December 2005, from the Resident Representatives to the Agency of Argentina, Australia, Austria, Belarus, Belgium, Brazil, Bulgaria, Canada, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, New Zealand, Poland, Portugal, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland and the United States of America, relating to transfers of nuclear-related dual-use equipment, materials, software and related technology.

2. The purpose of the Notes Verbales is to provide further information on those Governments' guidelines for transfers of nuclear-related dual-use equipment, materials, software and related technology.

3. In the light of the wish expressed at the end of each Note Verbale, the text of the Notes Verbales is attached. The attachment to the Notes Verbales is also reproduced in full.

NOTE VERBALE

The Permanent Mission of [Country Name] presents its compliments to the Director General of the International Atomic Energy Agency (IAEA) and has the honour to refer to its [relevant previous communication(s)] concerning the decision of the Government of [Country Name] to act in accordance with the Guidelines for Transfers of Nuclear-Related Dual-Use Equipment, Material and Related Technology currently published as document INFCIRC/254/Rev. 6/Part 2, including its Annex.

The Government of [Country Name] has decided to amend the Guidelines to reflect the need for effective export controls as a relevant factor for Part 2 transfers. Accordingly, Paragraph 4 (i) has been introduced.

The Government of [Country Name] has also decided to amend the Annex entries on machine tools (1.B.2.b and 1.B.2.c) to reflect the changes in current technology and to control new technology. Accordingly, a new Paragraph 3 has been added to both 1.B.2.b and 1.B.2.c to reflect new technological characteristics, the Technical note 2 of the Annex entry 1.B.2 has been amended and new Technical notes 4, 5 and 6 have been added to clarify the scope of controls.

The Government of [Country Name] has also clarified the scope of control for laser lights. Item 1.B.3.c. was amended to reflect that the scope of control does not control laser-based autocollimators. This is in accordance with recent changes made in Wassenaar.

In the interest of clarity, the complete text of the modified Guidelines and its Annex is reproduced in the attachment, as well as a "Comparison Table of Changes to the Guidelines for Transfers of Nuclear-Related Dual-Use Equipment, Material and Related Technology (INFCIRC/254/Rev. 6/Part 2)".

The Government of [Country Name] has decided to act in accordance with the Guidelines so revised.

In reaching this decision, the Government of [Country Name] is fully aware of the need to contribute to economic development while avoiding contributing in any way to a proliferation of nuclear weapons or other nuclear explosive devices or the diversion to acts of nuclear terrorism, and of the need to separate the issue of non-proliferation or non-diversion assurances from that of commercial competition.

[The Government of (Country Name), so far as trade within the European Union is concerned, will implement this decision in the light of its commitments as a Member States of the Union.] [This paragraph is included only in notes verbales from members of the European Union.]

The Government of [Country Name] would be grateful if the Director General of the IAEA would bring this Note and its attachment to the attention of all Member States.

The Permanent Mission of [Country Name] avails itself of this opportunity to renew to the Director General of the International Atomic Energy Agency the assurances of its highest consideration.

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

OBJECTIVE

1. With the objective of averting the proliferation of nuclear weapons and preventing acts of nuclear terrorism, suppliers have had under consideration procedures in relation to the transfer of certain equipment, materials, software, and related technology that could make a major contribution to a "nuclear explosive activity," an "un-safeguarded nuclear fuel-cycle activity" or acts of nuclear terrorism. In this connection, suppliers have agreed on the following principles, common definitions, and an export control list of equipment, materials, software, and related technology. The Guidelines are not designed to impede international co-operation as long as such co-operation will not contribute to a nuclear explosive activity, an un-safeguarded nuclear fuel cycle activity or acts of nuclear terrorism. Suppliers intend to implement the Guidelines in accordance with national legislation and relevant international commitments.

BASIC PRINCIPLE

2. Suppliers should not authorize transfers of equipment, materials, software, or related technology identified in the Annex:

- for use in a non-nuclear-weapon state in a nuclear explosive activity or an un-safeguarded nuclear fuel-cycle activity, or

- in general, when there is an unacceptable risk of diversion to such an activity, or when the transfers are contrary to the objective of averting the proliferation of nuclear weapons, or

- when there is an unacceptable risk of diversion to acts of nuclear terrorism.

EXPLANATION OF TERMS

3. (a) "Nuclear explosive activity" includes research on or development, design, manufacture, construction, testing or maintenance of any nuclear explosive device or components or subsystems of such a device.

(b) "Un-safeguarded nuclear fuel-cycle activity" includes research on or development, design, manufacture, construction, operation or maintenance of any reactor, critical facility, conversion plant, fabrication plant, reprocessing plant, plant for the separation of isotopes of source or special fissionable material, or separate storage installation, where there is no obligation to accept International Atomic Energy Agency (IAEA) safeguards at the relevant facility or installation, existing or future, when it contains any source or special fissionable material; or of any heavy water production plant where there is no obligation to accept IAEA safeguards on any nuclear material produced by or used in connection with any heavy water produced there-from; or where any such obligation is not met.

ESTABLISHMENT OF EXPORT LICENSING PROCEDURES

4. Suppliers should have in place legal measures to ensure the effective implementation of the Guidelines, including export licensing regulations, enforcement measures, and penalties for violations. In considering whether to authorize transfers, suppliers should exercise prudence in order to carry out the Basic Principle and should take relevant factors into account, including:

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

(b) Whether any recipient state that is not party to the NPT, Treaty of Tlatelolco, or a similar international legally-binding nuclear non-proliferation agreement has any facilities or installations listed in paragraph 3(b) above that are operational or being designed or constructed that are not, or will not be, subject to IAEA safeguards;

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

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

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

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

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

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

(i) Whether there is a risk of retransfers of equipment, material, software, or related technology identified in the Annex or of transfers of any replica thereof contrary to the Basic Principle, as a result of a failure by the recipient State to develop and maintain appropriate, effective national export and transshipment controls, as identified by UNSC Resolution 1540.

5. Suppliers should ensure that their national legislation requires an authorisation for the transfer of items not listed in the Annex if the items in question are or may be intended, in their entirety or in part, for use in connection with a "nuclear explosive activity."

Suppliers will implement such an authorisation requirement in accordance with their domestic licensing practices.

Suppliers are encouraged to share information on "catch all" denials.

CONDITIONS FOR TRANSFERS

6. In the process of determining that the transfer will not pose any unacceptable risk of diversion, in accordance with the Basic Principle and to meet the objectives of the Guidelines, the supplier should obtain, before authorizing the transfer and in a manner consistent with its national law and practices, the following:

(a) a statement from the end-user specifying the uses and end-use locations of the proposed transfers; and

(b) an assurance explicitly stating that the proposed transfer or any replica thereof will not be used in any nuclear explosive activity or unsafeguarded nuclear fuel-cycle activity.

CONSENT RIGHTS OVER RETRANSFERS

7. Before authorizing the transfer of equipment, materials, software, or related technology identified in the Annex to a country not adhering to the Guidelines, suppliers should obtain assurances that their consent will be secured, in a manner consistent with their national law and practices, prior to any retransfer to a third country of the equipment, materials, software, or related technology, or any replica thereof.

CONCLUDING PROVISIONS

8. The supplier reserves to itself discretion as to the application of the Guidelines to other items of significance in addition to those identified in the Annex, and as to the application of other conditions for transfer that it may consider necessary in addition to those provided for in paragraph 5 of the Guidelines.

9. In furtherance of the effective implementation of the Guidelines, suppliers should, as necessary and appropriate, exchange relevant information and consult with other states adhering to the Guidelines.

10. In the interest of international peace and security, the adherence of all states to the Guidelines would be welcome.

ANNEX

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

Note: The International System of Units (SI) is used in this Annex. In all cases the physical quantity defined in SI units should be considered the official recommended control value. However, some machine tool parameters are given in their customary units, which are not SI.

Commonly used abbreviations (and their prefixes denoting size) in this Annex are as follows:

A --- ampere(s)
Bq --- becquerel(s)
ºC --- degree(s) Celsius
CAS --- chemical abstracts service
Ci --- curie(s)
cm --- centimeter(s)
dB --- decibel(s)
dBm --- decibel referred to 1 milliwatt
g --- gram(s); also, acceleration of gravity (9.81 m/s^2)
GBq --- gigabecquerel(s)
GHz --- gigahertz
GPa --- gigapascal(s)
Gy --- gray
h --- hour(s)
Hz --- hertz
J --- joule(s)
K --- kelvin

keV --- thousand electron volt(s)
kg --- kilogram(s)
kHz --- kilohertz
kN --- kilonewton(s)
kPa --- kilopascal(s)
kV --- kilovolt(s)
kW --- kilowatt(s)
m --- meter(s)
mA --- milliampere(s)
MeV --- million electron volt(s)
MHz --- megahertz
ml --- milliliter(s)
mm --- millimeter(s)
MPa --- megapascal(s)
mPa --- millipascal(s)
MW --- megawatt(s)
µF --- microfarad(s)
µm --- micrometer(s)
µs --- microsecond(s)
N --- newton(s)
nm --- nanometer(s)
ns --- nanosecond(s)
nH --- nanohenry(ies)
ps --- picosecond(s)
RMS --- root mean square
rpm --- revolutions per minute
s --- second(s)
T --- tesla(s)
TIR --- total indicator reading
V --- volt(s)
W --- watt(s)

GENERAL NOTE

The following paragraphs are applied to the List of Nuclear-Related Dual-Use Equipment, Material, Software, and Related Technology.

1. The description of any item on the List includes that item in either new or second-hand condition.

2. When the description of any item on the List contains no qualifications or specifications, it is regarded as including all varieties of that item. Category captions are only for convenience in reference and do not affect the interpretation of item definitions.

3. The object of these controls should not be defeated by the transfer of any non-controlled item (including plants) containing one or more controlled components when the controlled component or components are the principal element of the item and can feasibly be removed or used for other purposes.

Note: In judging whether the controlled component or components are to be considered the principal element, governments should weigh the factors of quantity, value, and technological know-how involved and other special circumstances which might establish the controlled component or components as the principal element of the item being procured.

4. The object of these controls should not be defeated by the transfer of component parts. Each government will take such action as it can to achieve this aim and will continue to seek a workable definition for component parts, which could be used by all the suppliers.

TECHNOLOGY CONTROLS

The transfer of "technology" is controlled according to the Guidelines and as described in each section of the Annex. "Technology" directly associated with any item in the Annex will be subject to as great a degree of scrutiny and control as will the item itself, to the extent permitted by national legislation.

The approval of any Annex item for export also authorizes the export to the same end user of the minimum "technology" required for the installation, operation, maintenance, and repair of the item.

Note: Controls on "technology" transfer do not apply to information "in the public domain" or to "basic scientific research".

GENERAL SOFTWARE NOTE

The transfer of "software" is controlled according to the Guidelines and as described in the Annex.

Note: Controls on "software" transfers do not apply to "software" as follows:

1. Generally available to the public by being:
   a. Sold from stock at retail selling points without restriction; and
   b. Designed for installation by the user without further substantial support by the supplier;

or

2. "In the public domain".

DEFINITIONS

"Accuracy" –

Usually measured in terms of inaccuracy, defined as the maximum deviation, positive or negative, of an indicated value from an accepted standard or true value.

"Angular position deviation" –

The maximum difference between angular position and the actual, very accurately measured angular position after the workpiece mount of the table has been turned out of its initial position. (Ref. VDI/VDE 2617 Draft: "Rotary table on coordinate measuring machines")

"Basic scientific research" –

Experimental or theoretical work undertaken principally to acquire new knowledge of the fundamental principles of phenomena and observable facts, not primarily directed toward a specific practical aim or objective.

"Contouring control" –

Two or more "numerically controlled" motions operating in accordance with instructions that specify the next required position and the required feed rates to that position. These feed rates are varied in relation to each other so that a desired contour is generated. (Ref. ISO 2806-1980 as amended)

"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

"Fibrous or filamentary materials" –

means continuous ´monofilaments´, ´yarns´, ´rovings´, ´tows´ or ´tapes´.

N.B.:

1. ´Filament´ or ´monofilament´ –
is the smallest increment of fiber, usually several µm in diameter.

2. ´Roving´ –
is a bundle (typically 12-120) of approximately parallel ´strands´.

3. ´Strand´ –
is a bundle of ´filaments´ (typically over 200) arranged approximately parallel.

4. ´Tape´ –
is a material constructed of interlaced or unidirectional ´filaments´, ´strands´, ´rovings´, ´tows´ or ´yarns´, etc., usually preimpregnated with resin.

5. ´Tow´ –
is a bundle of ´filaments´, usually approximately parallel.

6. ´Yarn´ –
is a bundle of twisted ´strands´.

'Filament' –
See "Fibrous or filamentary materials".

"In the public domain" –
"In the public domain", as it applies herein, means "technology" or "software" that has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove "technology" or "software" from being "in the public domain".)

"Linearity" –
(Usually measured in terms of non-linearity) is the maximum deviation of the actual characteristic (average of upscale and downscale readings), positive or negative, from a straight line so positioned as to equalize and minimize the maximum deviations.

"Measurement uncertainty" –
The characteristic parameter which specifies in what range around the output value the correct value of the measurable variable lies with a confidence level of 95%. It includes the uncorrected systematic deviations, the uncorrected backlash, and the random deviations. (Ref. VDI/VDE 2617)

"Microprogram" –
A sequence of elementary instructions, maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction into an instruction register.

'Monofilament' –
See "Fibrous or filamentary materials".

"Numerical control" –
The automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress. (Ref. ISO 2382)

"Positioning accuracy" –
of "numerically controlled" machine tools is to be determined and presented in accordance with Item 1.B.2., in conjunction with the requirements below:

(a) Test conditions (ISO 230/2 (1988), paragraph 3):
  (1) For 12 hours before and during measurements, the machine tool and accuracy measuring equipment will be kept at the same ambient temperature. During the pre-measurement time, the slides of the machine will be continuously cycled identically to the way they will be cycled during the accuracy measurements;
  (2) The machine shall be equipped with any mechanical, electronic, or software compensation to be exported with the machine;
  (3) Accuracy of measuring equipment for the measurements shall be at least four times more accurate than the expected machine tool accuracy;
  (4) Power supply for slide drives shall be as follows:
    (i) Line voltage variation shall not be greater than +/- 10% of nominal rated voltage;
    (ii) Frequency variation shall not be greater than +/-2 Hz of normal frequency;
    (iii) Lineouts or interrupted service are not permitted.
(b) Test Program (paragraph 4):
  (1) Feed rate (velocity of slides) during measurement shall be the rapid traverse rate;

N.B.: In the case of machine tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute;

  (2) Measurements shall be made in an incremental manner from one limit of the axis travel to the other without returning to the starting position for each move to the target position;
  (3) Axes not being measured shall be retained at mid-travel during test of an axis.
(c) Presentation of the test results (paragraph 2):
  The results of the measurements must include:
  (1) "positioning accuracy" (A) and
  (2) The mean reversal error (B).

"Production" –
means all production phases such as:

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

"Program" –
A sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer.

"Resolution" –
The least increment of a measuring device; on digital instruments, the least significant bit. (Ref. ANSI B-89.1.12)

“Roving” –
See "Fibrous or filamentary materials".

"Software" –
A collection of one or more "programs" or "microprograms" fixed in any tangible medium of expression.

'Strand' –
See "Fibrous or filamentary materials".

'Tape” –
See "Fibrous or filamentary materials".

"Technical assistance" –
"Technical assistance" may take forms such as: instruction, skills, training, working knowledge, consulting services.

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

"Technical data" –
"Technical data" may take forms such as blueprints, plans, diagrams, models, formulae, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.

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

“Tow” –
See "Fibrous or filamentary materials".

"Use" –
Operation, installation (including on-site installation), maintenance (checking), repair, overhaul, and refurbishing.

“Yarn” –
See "Fibrous or filamentary materials".

ANNEX CONTENTS

2.B.2. Lithium isotope separation facilities or plants, and equipment therefor
2.C. MATERIALS
2.C.1. Aluminium
2.C.2. Beryllium
2.C.3. Bismuth
2.C.4. Boron
2.C.5. Calcium
2.C.6. Chlorine trifluoride
2.C.7. Fibrous or filamentary materials, and prepregs
2.C.8. Hafnium
2.C.9. Lithium
2.C.10. Magnesium
2.C.11. Maraging steel
2.C.12. Radium-226
2.C.13. Titanium
2.C.14. Tungsten
2.C.15. Zirconium
2.C.16. Nickel powder and porous nickel metal
2.C.17. Tritium
2.C.18. Helium-3
2.C.19. Alpha-emitting radionuclides
2.D. SOFTWARE
2.E. TECHNOLOGY 2 – 6

3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS

(Other Than Trigger List Items)
3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS
3.A.1. Frequency changers or generators
3.A.2. Lasers, laser amplifiers and oscillators
3.A.3. Valves
3.A.4. Superconducting solenoidal electromagnets
3.A.5. High-power direct current power supplies
3.A.6. High-voltage direct current power supplies
3.A.7. Pressure transducers
3.A.8. Vacuum pumps
3.B. TEST AND PRODUCTION EQUIPMENT
3.B.1. Electrolytic cells for fluorine production
3.B.2. Rotor fabrication or assembly equipment, rotor straightening equipment, bellows-forming mandrels and dies
3.B.3. Centrifugal multiplane balancing machines
3.B.4. Filament winding machines and related equipment
3.B.5. Electromagnetic isotope separators
3.B.6. Mass spectrometers
3.C. MATERIALS
3.D. SOFTWARE
3.E. TECHNOLOGY

4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT

(Other Than Trigger List Items)
4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS
4.A.1. Specialized packings
4.A.2. Pumps
4.A.3. Turboexpanders or turboexpander-compressor sets
4.B. TEST AND PRODUCTION EQUIPMENT
4.B.1. Water-hydrogen sulfide exchange tray columns and internal contactors
4.B.2. Hydrogen-cryogenic distillation columns
4.B.3. Ammonia synthesis converters or synthesis units
4.C. MATERIALS
4.D. SOFTWARE
4.E. TECHNOLOGY

5. TEST AND MEASUREMENT EQUIPMENT FOR THE DEVELOPMENT OF NUCLEAR EXPLOSIVE DEVICES
5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS
5.A.1. Photomultiplier tubes
5.B. TEST AND PRODUCTION EQUIPMENT
5.B.1. Flash X-ray generators or pulsed electron accelerators
5.B.2. Multistage light gas guns or other high-velocity gun systems
5.B.3. Mechanical rotating mirror cameras
5.B.4. Electronic streak cameras, electronic framing cameras, tubes and devices
5.B.5. Specialized instrumentation for hydrodynamic experiments
5.B.6. High-speed pulse generators
5.C. MATERIALS
5.D. SOFTWARE
5.E. TECHNOLOGY

6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES
6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS
6.A.1. Detonators and multipoint initiation systems
6.A.2. Firing sets and equivalent high-current pulse generators
6.A.3. Switching devices
6.A.4. Pulse discharge capacitors
6.A.5. Neutron generator systems
6.B. TEST AND PRODUCTION EQUIPMENT
6.C. MATERIALS
6.C.1. High explosive substances or mixtures
6.D. SOFTWARE

6.E. TECHNOLOGY

COMPARISON TABLE OF CHANGES TO THE GUIDELINES FOR NUCLEAR TRANSFERS (INFCIRC/254/Rev. 6/Part 2)

Old	New
ESTABLISHMENT OF EXPORT LICENSING PROCEDURES	**ESTABLISHMENT OF EXPORT LICENSING PROCEDURES**
	<u>**4. (i) Whether there is a risk of retransfers of equipment, material, software, or related technology identified in the Annex or of transfers of any replica thereof contrary to the Basic Principle, as a result of a failure by the recipient State to develop and maintain appropriate, effective national export and transshipment controls, as identified by UNSC Resolution 1540.**</u>
1.B.2. Machine tools, as follows, for removing or cutting metals, ceramics, or composites, which, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes: N.B.: For "numerical control" units ...	1.B.2. Machine tools, as follows, <u>**and any combination thereof,**</u> for removing or cutting metals, ceramics, or composites, which, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous "contouring control" in two or more axes: <u>N.B.</u>: For "numerical control" units ...
a. Machine tools for turning, ... <u>Note</u>: Item 1.B.2.a. does not control bar machines ...	a. Machine tools for turning, ... <u>Note</u>: Item 1.B.2.a. does not control bar machines ...
b. Machine tools for milling, ... 1. "Positioning accuracies" with all .. 2. Two or more contouring rotary axes; <u>Note</u>: Item 1.B.2.b. does not control ... characteristics: 1. X-axis travel greater than 2 m; and 2. Overall "positioning accuracy" on ...	b. Machine tools for milling, ... 1. "Positioning accuracies" with all ... 2. Two or more contouring rotary axes; **3. Five or more axes which can be coordinated simultaneously for "contouring control."** <u>Note</u>: Item 1.B.2.b. does not control ...characteristics: 1. X-axis travel greater than 2 m; <u>and</u> 2. Overall "positioning accuracy" on ...

c. Machine tools for grinding, having any of the following characteristics: 1. "Positioning accuracies" with ... 2. Two or more contouring rotary axes;	c. Machine tools for grinding, having any of the following characteristics: 1. "Positioning accuracies" with ... 2. Two or more contouring rotary axes; or
	<u>3 Five or more axes which can be coordinated simultaneously for "contouring control."</u>
Note: Item 1.B.2.c. does not control grinding machines as follows:	<u>Note</u>: Item 1.B.2.c. does not control grinding machines as follows:
1. Cylindrical external, internal, and external-internal grinding machines having all the following characteristics: a. Limited to cylindrical grinding; b. A maximum workpiece outside diameter or length of 150 mm; c. Not more than two axes that can be coordinated simultaneously for "contouring control"; and d. No contouring c-axis;	1. Cylindrical external, internal, and external-internal grinding machines having all the following characteristics: ~~a. Limited to cylindrical grinding;~~ ~~b~~**a.** ~~A maximum workpiece outside diameter or length of 150 mm~~; **Limited to a maximum workpiece capacity of 150 mm outside diameter or length; and** ~~c~~**b.** ~~Not more than two axes that can be coordinated simultaneously for "contouring control"; and~~ **<u>Axes limited to x, z and c.</u>** ~~d. No contouring c-axis;~~
2. Jig grinders with axes limited to x,y,c, and a, where c-axis is used to maintain the grinding wheel normal to the work surface, and the a-axis is configured to grind barrel cams;	2. ~~Jig grinders with axes limited to x,y,c, and a, where c-axis is used to maintain the grinding wheel normal to the work surface, and the a-axis is configured to grind barrel cams;~~ **<u>Jig grinders that do not have a z-axis or a w-axis with an overall positioning accuracy less (better) than 4 microns. Positioning accuracy is according to ISO 230/2 (1988).</u>**
3. Tool or cutter grinding machines with "software" specially designed for the manufacturing of tools or cutters;	~~3. Tool or cutter grinding machines with "software" specially designed for the manufacturing of tools or cutters;~~
4. Crankshaft or camshaft grinding machines.	~~4. Crankshaft or camshaft grinding machines.~~
d. Non-wire type Electrical Discharge Machines (EDM)...	d. Non-wire type Electrical Discharge Machines (EDM)...
<u>Note</u>: Stated "positioning accuracy" levels derived under the following procedures from measurements made according to ISO 230/2 (1988) or national equivalents may be used for each machine tool model if provided to, and accepted by, national authorities instead of individual machine tests.	<u>Note**s**</u>: **<u>1.</u>** Stated "positioning accuracy" levels derived under the following procedures from measurements made according to ISO 230/2 (1988) or national equivalents may be used for each machine tool model if provided to, and accepted by, national authorities instead of individual machine tests.
Stated "positioning accuracy" are to be derived as follows: 1. Select five machines of a model to be evaluated; 2. Measure the linear axis accuracies according to ISO 230/2 (1988); 3. Determine the accuracy values (A) ...; 4. Determine the average accuracy value of each axis. This average value becomes the stated "positioning accuracy" of each axis for the model (Âx, Ây...); 5. Since Item 1.B.2. refers to each linear axis, there will be as many stated "positioning accuracy" values as there are linear axes; 6. If any axis of a machine tool not controlled by Items 1.B.2.a., 1.B.2.b., or 1.B.2.c. has a stated "positioning accuracy" of 6 µm or better (less) for grinding machines, and 8 µm or better (less) for milling and turning machines, both according to ISO 230/2 (1988), then the builder should be required to reaffirm the accuracy level once every eighteen months.	Stated "positioning accuracy" are to be derived as follows: ~~1.~~**<u>a.</u>** Select five machines of a model to be evaluated; ~~2.~~**<u>b.</u>** Measure the linear axis accuracies...; ~~3.~~**<u>c.</u>** Determine the accuracy values (A) ...; ~~4.~~**<u>d.</u>** Determine the average accuracy value...; ~~5.~~**<u>e.</u>** Since Item 1.B.2. refers to each linear axis, there will be as many stated "positioning accuracy" values as there are linear axes; ~~6.~~**<u>f.</u>** If any axis of a machine tool not controlled by Items 1.B.2.a., 1.B.2.b., or 1.B.2.c. has a stated "positioning accuracy" of 6 µm or better (less) for grinding machines, and 8 µm or better (less) for milling and turning machines, both according to ISO 230/2 (1988), then the builder should be required to reaffirm the accuracy level once every eighteen months.
	<u>2. Item 1.B.2. does not control special purpose machine tools limited to the manufacture of any of the following parts:</u> **<u>a. Gears</u>** **<u>b. Crankshafts or cam shafts</u>** **<u>c. Tools or cutters</u>** **<u>d. Extruder worms</u>**
<u>Technical Notes</u>: 1. Axis nomenclature shall be in accordance with International Standard ISO 841... *2. Not counted in the total number of contouring rotary axes are secondary parallel contouring rotary axes the center line of which is parallel to the primary rotary axis.* *3. Rotary axes do not ...*	*<u>Technical Notes</u>: 1. Axis nomenclature shall be in accordance with International Standard ISO 841...* *2. Not counted in the total number of contouring <u>rotary</u> axes are secondary parallel contouring <u>rotary</u> axes ~~the center line of which is parallel to the primary rotary axis~~.* ***<u>(e.g., the w-axis on horizontal boring mills or a secondary rotary axis the centerline of which is parallel to the primary rotary axis).</u>*** *3. Rotary axes do not ...*

	4. For the purposes of 1.B.2. the number of axes which can be coordinated simultaneously for "contouring control" is the number of axes along or around which, during processing of the workpiece, simultaneous and interrelated motions are performed between the workpiece and a tool. This does not include any additional axes along or around which other relative motions within the machine are performed, such as: ***a. Wheel-dressing systems in grinding machines;*** ***b Parallel rotary axes designed for mounting of separate workpieces;*** ***c. Co-linear rotary axes designed for manipulating the same workpiece*** ***by holding it in a chuck from different ends.*** ***5. A machine tool having at least 2 of the 3 turning, milling or grinding capabilities (e.g., a turning machine with milling capability) must be evaluated against each applicable entry, 1.B.2.a., 1.B.2.b. and 1.B.2.c.*** ***6. Items 1.B.2.b.3 and 1.B.2.c.3 include machines based on a parallel linear kinematic design (e.g., hexapods) that have 5 or more axes none of which are rotary axes.***
1.B.3. Dimensional inspection machines, instruments, or systems, as follows... b. Linear displacement measuring instruments... 3. Measuring systems having both of the following characteristics... c. Angular displacement measuring instruments having an "angular position deviation" equal to or better (less) than 0.00025°; Note: Item 1.B.3.c. does not control optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.	1.B.3. Dimensional inspection machines, instruments, or systems, as follows... b. Linear displacement measuring instruments... 3. Measuring systems having both of the following characteristics... c. Angular displacement measuring instruments having an "angular position deviation" equal to or better (less) than 0.00025°; Note: Item 1.B.3.c. does not control optical instruments, such as autocollimators, using collimated light **(e.g., laser light)** to detect angular displacement of a mirror.

Guidelines for Nuclear Transfers

[Nuclear Suppliers Group, Reproduced from INFCIRC/254/Rev.9/Part1, November 2007]

[….](eds.)

Communications Received from the Permanent Mission of Brazil Regarding Certain Member States' Guidelines for the Export of Nuclear Material, Equipment and Technology

GUIDELINES FOR NUCLEAR TRANSFERS

1. The following fundamental principles for safeguards and export controls should apply to nuclear transfers for peaceful purposes to any non-nuclear-weapon State and, in the case of controls on retransfer, to transfers to any State. In this connection, suppliers have defined an export trigger list.

Prohibition on nuclear explosives

2. Suppliers should authorize transfer of items or related technology identified in the trigger list only upon formal governmental assurances from recipients explicitly excluding uses which would result in any nuclear explosive device.

Physical protection

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

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

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

Safeguards

4. (a) Suppliers should transfer trigger list items or related technology to a non-nuclear weapon State only when the receiving State has brought into force an agreement with the IAEA requiring the application of safeguards on all source and special fissionable material in its current and future peaceful activities. Suppliers should authorize such transfers only upon formal governmental assurances from the recipient that:

–if the above-mentioned agreement should be terminated the recipient will bring into force an agreement with the IAEA based on existing IAEA model safeguards agreements requiring the application of safeguards on all trigger list items or related technology transferred by the supplier or processed, or produced or used in connection with such transfers; and

–if the IAEA decides that the application of IAEA safeguards is no longer possible, the supplier and recipient should elaborate appropriate verification measures. If the recipient does not accept these measures, it should allow at the request of the supplier the restitution of transferred and derived trigger list items.

(b) Transfers covered by paragraph 4 (a) to a non-nuclear-weapon State without such a safeguards agreement should be authorized only in exceptional cases when they are deemed essential for the safe operation of existing facilities and if safeguards are applied to those facilities. Suppliers should inform and, if appropriate, consult in the event that they intend to authorize or to deny such transfers.

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

(d) Under agreements to which the policy referred to in paragraph 4 (a) does not apply (see paragraphs 4 (b) and (c)) suppliers should transfer trigger list items or related technology only when covered by IAEA safeguards with duration and coverage provisions in conformity with IAEA doc. GOV/1621. However, suppliers undertake to strive for the earliest possible implementation of the policy referred to in paragraph 4 (a) under such agreements.

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

5. Suppliers will jointly reconsider their common safeguards requirements, whenever appropriate.

Special controls on sensitive exports

6. Suppliers should exercise restraint in the transfer of sensitive facilities, technology and material usable for nuclear weapons or other nuclear explosive devices. If enrichment or reprocessing facilities, equipment or technology are to be transferred, suppliers should encourage recipients to accept, as an alternative to national plants, supplier involvement and/or other appropriate multinational participation in resulting facilities. Suppliers should also promote international (including IAEA) activities concerned with multinational regional fuel cycle centres.

Special controls on export of enrichment facilities, equipment and technology

7. For a transfer of an enrichment facility, or technology therefor, the recipient nation should agree that neither the transferred facility, nor any facility based on such technology, will be designed or operated for the production of greater than 20% enriched uranium without the consent of the supplier nation, of which the IAEA should be advised.

Controls on supplied or derived material usable for nuclear weapons or other nuclear explosive devices

8. Suppliers should, in order to advance the objectives of these guidelines and to provide opportunities further to reduce the risks of proliferation, include, whenever appropriate and practicable, in agreements on supply of nuclear materials or of facilities which produce material usable for nuclear weapons or other nuclear explosive devices, provisions calling for mutual agreement between the supplier and the recipient on arrangements for reprocessing, storage, alteration, use, transfer or retransfer of any material usable for nuclear weapons or other nuclear explosive devices involved.

Controls on retransfer

9. (a) Suppliers should transfer trigger list items or related technology 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 transferred by the supplier, or with the help of equipment or technology originally transferred by the supplier; the recipient of the retransfer or transfer will have provided the same assurances as those required by the supplier for the original transfer.

(b) In addition the supplier's consent should be required for:

(1) any retransfer of trigger list items or related technology and any transfer referred to under paragraph 9(a) (2) from any State which does not require full scope safeguards, in accordance with paragraph 4(a) of these Guidelines, as a condition f supply;

(2) any retransfer of enrichment, reprocessing or heavy water production facilities, equipment or related technology, and for any transfer of facilities or equipment of the same type derived from items originally transferred by the supplier;

(3) any retransfer of heavy water or material usable for nuclear weapons or other nuclear explosive devices.

(c) To ensure the consent right as defined under paragraph 9(b), government to government assurances will be required for any relevant original transfer.

(d) Suppliers should consider restraint in the transfer of items and related technology identified in the trigger list if there is a risk of retransfers contrary to the assurances given under paragraph 9(a) and (c) as a result of a failure by the recipient to develop and maintain appropriate, effective national export and transshipment controls, as identified by UNSC Resolution 1540.

Non-proliferation Principle

10. Notwithstanding other provisions of these Guidelines, suppliers should authorize transfer of items or related technology identified in the trigger list only when they are satisfied that the transfers would not contribute to the proliferation of nuclear weapons or other nuclear explosive devices or be diverted to acts of nuclear terrorism.

Implementation

11. Suppliers should have in place legal measures to ensure the effective implementation of the Guidelines, including export licensing regulations, enforcement measures, and penalties for violations.

SUPPORTING ACTIVITIES

Physical security

12. Suppliers should promote international co-operation in the areas of physical security through the exchange of physical security information, protection of nuclear materials in transit, and recovery of stolen nuclear materials and equipment. Suppliers should promote broadest adherence to the respective international instruments, inter alia, to the Convention on the Physical Protection of Nuclear Material, as well as implementation of INFCIRC/225, as amended from time to time. Suppliers recognize the importance of these activities and other relevant IAEA activities in preventing the proliferation of nuclear weapons and countering the threat of nuclear terrorism.

Support for effective IAEA safeguards

13. Suppliers should make special efforts in support of effective implementation of IAEA safeguards. Suppliers should also support the Agency's efforts to assist Member States in the improvement of their national systems of accounting and control of nuclear material and to increase the technical effectiveness of safeguards. Similarly, they should make every effort to support the IAEA in increasing further the adequacy of safeguards in the light of technical developments and the rapidly growing number of nuclear facilities, and to support appropriate initiatives aimed at improving the effectiveness of IAEA safeguards.

Trigger list plant design features

14. Suppliers should encourage the designers and makers of trigger list facilities to construct them in such a way as to facilitate the application of safeguards and to enhance physical protection, taking also into consideration the risk of terrorist attacks. Suppliers should promote protection of information on the design of trigger list installations, and stress to recipients the necessity of doing so. Suppliers also recognize the importance of including safety and non-proliferation features in designing and construction of trigger list facilities.

Export Controls

15. Suppliers should, where appropriate, stress to recipients the need to subject transferred trigger list items and related technology and trigger list items derived from facilities originally transferred by the supplier or with the help of equipment or technology originally transferred by the supplier to export controls as outlined in UNSC Resolution 1540. Suppliers are encouraged to offer assistance to recipients to fulfil their respective obligations under UNSC Resolution 1540 where appropriate and feasible.

Consultations

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

(b) Suppliers should consult, as each deems appropriate, with other governments concerned on specific sensitive cases, to ensure that any transfer does not contribute to risks of conflict or instability.

(c) Without prejudice to sub-paragraphs (d) to (f) below:

–In the event that one or more suppliers believe that there has been a violation of supplier/recipient understanding resulting from these Guidelines, particularly in the case of an explosion of a nuclear device, or illegal termination or violation of IAEA safeguards by a recipient, suppliers should consult promptly through diplomatic channels in order to determine and assess the reality and extent of the alleged violation. Suppliers are also encouraged to consult where nuclear material or nuclear fuel cycles activity undeclared to the IAEA or a nuclear explosive activity is revealed.

–Pending the early outcome of such consultations, suppliers will not act in a manner that could prejudice any measure that may be adopted by other suppliers concerning their current contacts with that recipient. Each supplier should also consider suspending transfers of Trigger List items while consultations under 16(c) are ongoing, pending supplier agreement on an appropriate response.

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

(d) If a recipient is reported by the IAEA to be in breach of its obligation to comply with its safeguards agreement, suppliers should consider the suspension of the transfer of Trigger List items to that State whilst it is under investigation by the IAEA. For the purposes of this paragraph, “breach” refers only to serious breaches of proliferation concern;

(e) Suppliers support the suspension of transfers of Trigger List items to States that violate their nuclear non-proliferation and safeguards obligations, recognising that the responsibility and authority for such decisions rests with national governments or the United Nations Security Council. In particular, this is applicable in situations where the IAEA Board of Governors takes any of the following actions:

–finds, under Article XII.C of the Statute, that there has been non-compliance in the recipient, or requires a recipient to take specific actions to bring itself into compliance with its safeguards obligations;

–Decides that the Agency is not able to verify that there has been no diversion of nuclear material required to be safeguarded, including situations where actions taken by a recipient have made the IAEA unable to carry out its safeguards mission in that State.

An extraordinary Plenary meeting will take place within one month of the Board of Governors' action, at which suppliers will review the situation, compare national policies and decide on an appropriate response.

(f) The provisions of subparagraph (e) above do not apply to transfers under paragraph 4 (b) of the Guidelines.

17. Unanimous consent is required for any changes in these Guidelines, including any which might result from the reconsideration mentioned in paragraph 5.

ANNEX A

TRIGGER LIST REFERRED TO IN GUIDELINES

GENERAL NOTES

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

2. With reference to Paragraph 9(b)(2) of the Guidelines, *same type* should be understood as when the design, construction or operating processes are based on the same or similar physical or chemical processes as those identified in the Trigger List.

3. Suppliers recognize the close relationship for certain isotope separation processes between plants, equipment and technology for uranium enrichment and that for the separation of stable isotopes for research, medical and other non-nuclear industrial purposes. In that regard, suppliers should carefully review their legal measures, including export licensing regulations and information/technology classification and security practices, for stable isotope separation activities to ensure the implementation of appropriate protection measures as warranted. Suppliers recognize that, in particular cases, appropriate protection

measures for stable isotope separation activities will be essentially the same as those for uranium enrichment. (See Introductory Note in Section 5 of the Trigger List.) In accordance with Paragraph 16(a) of the Guidelines, suppliers shall consult with other suppliers as appropriate, in order to promote uniform policies and procedures in the transfer and protection of stable isotope separation plants, equipment and technology.

TECHNOLOGY CONTROLS

The transfer of "technology" directly associated with any item in the List will be subject to as great a degree of scrutiny and control as will the item itself, to the extent permitted by national legislation.

Controls on "technology" transfer do not apply to information "in the public domain" or to "basic scientific research".

In addition to controls on "technology" transfer for nuclear non-proliferation reasons, suppliers should promote protection of this technology for the design, construction, and operation of trigger list facilities in consideration of the risk of terrorist attacks, and should stress to recipients the necessity of doing so.

DEFINITIONS

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

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

"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 technology that has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove 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: instruction, skills,
training, working knowledge, consulting services.

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

"technical data" - "Technical data" may take forms such as blueprints, plans, diagrams, models, formulae, engineering designs and specifications, manuals and instructions written or recorded on other media or devices such as disk, tape, read-only memories.

"use" - Operation, installation (including on-site installation), maintenance (checking), repair, overhaul and refurbishing.

MATERIAL AND EQUIPMENT

1. Source and special fissionable material

As defined in Article XX of the Statute of the International Atomic Energy Agency:

1.1. "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.

1.2. "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.

However, for the purposes of the Guidelines, items specified in subparagraph (a) below, and exports of source or special fissionable material to a given recipient country, within a period of 12 months, 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 component in instruments; and Source material which the Government is satisfied is to be used only in nonnuclear 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.

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 regarded as insignificant for practical purposes):

2.1. Nuclear reactors and especially designed or prepared equipment and components therefor (see 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 especially designed or prepared therefor (see Annex B, section 3.);

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

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

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

2.7. Plants for the conversion of uranium and plutonium for use in the fabrication of fuel elements and the separation of uranium isotopes as defined in sections 4 and 5 respectively, and equipment especially designed or prepared therefor (See Annex B, section 7.).

ANNEX B

CLARIFICATION OF ITEMS ON THE TRIGGER LIST

(as designated in Section 2 of MATERIAL AND EQUIPMENT of Annex A)

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

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 Guidelines. Those individual items within this functionally defined boundary which will be exported only in accordance with the procedures of the Guidelines are listed in paragraphs 1.2. to 1.10. The Government reserves to itself the right to apply the procedures of the Guidelines to other items within the functionally defined boundary.

1.2. Nuclear reactor vessels

Metal vessels, or major shop-fabricated parts therefor, especially designed or prepared to contain the core of a nuclear reactor as defined in paragraph 1.1. above, as well as relevant reactor internals as defined in paragraph 1.8. below.

EXPLANATORY NOTE

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

1.3. Nuclear reactor fuel charging and discharging machines

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

EXPLANATORY NOTE

The items noted above are capable of on-load operation or at employing technically sophisticated positioning or alignment features to allow complex off-load fueling operations such as those in which direct viewing of or access to the fuel is not normally available.

1.4. Nuclear reactor control rods and equipment

Especially designed or prepared rods, support or suspension structures therefor, rod

drive mechanisms or rod guide tubes to control the fission process in a nuclear reactor

as defined in paragraph 1.1. above.

1.5. Nuclear reactor pressure tubes

Tubes which are especially designed or prepared to contain fuel elements and the primary coolant in a reactor as defined in paragraph 1.1. above at an operating pressure in excess of 50 atmospheres.

1.6. Zirconium tubes

Zirconium metal and alloys in the form of tubes or assemblies of tubes, and in quantities exceeding 500 kg for any one recipient country in 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 the primary coolant for nuclear reactors as 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 primary coolant, canned-driven pumps, and pumps with inertial mass systems. This definition encompasses pumps certified to Section III, Division I, Subsection NB (Class 1 components) of the American Society of Mechanical Engineers (ASME) Code, or equivalent standards.

1.8. Nuclear reactor internals

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

EXPLANATORY NOTE

"Nuclear reactor internals" are major structures within a reactor vessel which have one or more functions such as supporting the core, maintaining fuel alignment, directing primary coolant flow, providing radiation shields for the reactor vessel, and guiding in-core instrumentation.

1.9. Heat exchangers

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

EXPLANATORY NOTE

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

1.10. Neutron detection and measuring instruments

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

EXPLANATORY NOTE

The scope of this entry encompasses in-core and ex-core instrumentation which measure flux levels in a large range, typically from 104 neutrons per cm2 per second to 1010 neutrons per cm2 per second or more. Ex-core refers to those instruments outside the core of a reactor as defined in paragraph 1.1. above, but located within the biological shielding.

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/cm3 for use in a nuclear reactor as defined in paragraph 1.1 above, in quantities exceeding 30 metric tons for any one recipient country in any period of 12 months.

EXPLANATORY NOTE

For the purpose of export control, the Government will determine whether or not the exports of graphite meeting the above 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 x concentration of element Z (in ppm);
CF is the conversion factor: (σ_Z x A_B) divided by (σ_B x A_z);

σ_B and σ_Z are the thermal neutron capture cross sections (in barns) for naturally occurring boron and element Z respectively; and A_B and A_z are the atomic masses of naturally occurring boron and element Z respectively.

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 (e.g. by geometry), radiation exposure (e.g. by shielding), and toxicity 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 procedures of the Guidelines. The Government reserves to itself the right to apply the procedures of the Guidelines to other items within the functionally defined boundary as listed below. 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 (e.g. small diameter, annular or slab tanks) especially designed or prepared for use in a reprocessing plant as identified above, intended for dissolution of irradiated nuclear fuel and which are capable of withstanding hot, highly corrosive liquid, and which can be remotely loaded and maintained.

3.3. Solvent extractors and solvent extraction equipment

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.

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

INTRODUCTORY NOTE

Nuclear fuel elements are manufactured from one or more of the source or special fissionable materials mentioned in MATERIAL AND EQUIPMENT of this annex. For oxide fuels, the most common type of fuel, equipment for pressing pellets, sintering, grinding and grading will be present. Mixed oxide fuels are handled in glove boxes (or equivalent containment) until they are sealed in the cladding. In all cases, the fuel is hermetically sealed inside a suitable cladding which is designed to be the primary envelope encasing the fuel so as to provide suitable performance and safety during reactor operation. Also, in all cases, precise control of processes, procedures and equipment to extremely high standards is necessary in 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 equipment especially designed or prepared" for the fabrication of fuel elements include equipment which:

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

(b) seals the nuclear material within the cladding;

(c) checks the integrity of the cladding or the seal; or

(d) checks the finish treatment of the sealed fuel.

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

1) fully automatic pellet inspection stations especially designed or prepared for checking final dimensions and surface defects of the fuel pellets;

2) automatic welding machines especially designed or prepared for welding end caps onto the fuel pins (or rods);

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

Item 3 typically includes equipment for: a) x-ray examination of pin (or rod) end cap welds, b) helium leak detection from pressurized pins (or rods), and c) gamma-ray scanning of the pins (or rods) to check for correct loading of the fuel pellets inside.

5. Plants for the separation of isotopes of natural uranium, depleted uranium or special fissionable material and equipment, other than analytical instruments, especially designed or prepared therefor

INTRODUCTORY NOTE

Plants, equipment and technology for the separation of uranium isotopes have, in many instances, a close relationship to plants, equipment and technology for the separation of stable isotopes. In particular cases, the controls under Section 5 also apply to plants and equipment that are intended for the separation of stable isotopes. These controls of plants and equipment for the separation of stable isotopes are complimentary to controls on plants and equipment especially designed or prepared for the processing, use or production of special fissionable material covered by the Trigger List. These complementary Section 5 controls for stable isotope uses do not apply to the electromagnetic isotope separation process, which is addressed under Part 2 of the Guidelines. Processes for which the controls in Section 5 equally apply whether the intended use is uranium isotope separation or stable isotope separation are: gas centrifuge, gaseous diffusion, the plasma separation process, and acrodynamic processes. For some processes, the relationship to uranium isotope separation depends on the element (stable isotope) being separated. These processes are: laser-based processes (e.g. molecular laser isotope separation and atomic vapor laser isotope separation), chemical exchange, and ion exchange. Suppliers must therefore evaluate these processes on a case-by-case basis to apply Section 5 controls for stable isotope uses accordingly. 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 (3in) 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 UF6 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 or more of the high strength to density ratio materials described in the EXPLANATORY NOTE to this Section. If interconnected, the cylinders are joined together by flexible bellows or rings as described in section 5.1.1.(c) following. The rotor is fitted with an internal baffle(s) and end caps, as described in section 5.1.1.(d) and (e) following, if in final form. However the complete assembly may be delivered only partly assembled.

(b) Rotor tubes:

Especially designed or prepared thin-walled cylinders with thickness of 12 mm (0.5 in) or less, a diameter of between 75 mm (3 in) and 400 mm (16 in), and manufactured from one or more of the high strength to density ratio materials described in the EXPLANATORY NOTE to this Section.

(c) Rings or Bellows:

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

(d) Baffles:

Disc-shaped components of between 75 mm (3 in) and 400 mm (16 in) diameter especially designed or prepared to be mounted inside the centrifuge rotor tube, in order to isolate the take-off chamber from the main separation chamber and, in some cases, to assist the UF6 gas circulation within the main separation chamber of the rotor tube, and manufactured from one of the high strength to density ratio materials described in the EXPLANATORY NOTE to this Section.

(e) Top caps/Bottom caps:

Disc-shaped components of between 75 mm (3 in) and 400 mm (16 in) diameter especially designed or prepared to fit to the ends of the rotor tube, and so contain the UF6 within the rotor tube, and in some cases to support, retain or contain as an integrated part an element of the upper bearing (top cap) or to carry the rotating elements of the motor and lower bearing (bottom cap), and manufactured from one of the high strength to density ratio materials described in the EXPLANATORY NOTE to this Section.

EXPLANATORY NOTE

The materials used for centrifuge rotating components are:

(a) Maraging steel capable of an ultimate tensile strength of 2.05 X 109 N/m2 (300,000 psi) or more;

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

(c) Filamentary materials suitable for use in composite structures and having a specific modulus of 3.18 X 106 m or greater and a specific ultimate tensile strength of 7.62 X 104 m or greater ('Specific Modulus' is the Young's Modulus in N/m2 divided by the specific weight in N/m3; 'Specific Ultimate Tensile Strength' is the ultimate tensile 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 annular magnet suspended within a housing containing a damping medium. The housing will be manufactured from a UF6-

resistant material (see EXPLANATORY NOTE to Section 5.2.). The magnet couples with a pole piece or a second magnet fitted to the top cap described in Section 5.1.1.(e). The magnet may be ring-shaped with a relation between outer and inner diameter smaller or equal to 1.6:1. The magnet may be in a form having an initial permeability of 0.15 H/m (120,000 in CGS units) or more, or a remanence of 98.5% or more, or an energy product of greater than 80 kJ/m3 (107 gauss-oersteds). In addition to the usual material properties, it is a prerequisite that the deviation of the magnetic axes from the geometrical axes is limited to very small tolerances (lower than 0.1 mm or 0.004 in) or that homogeneity of the material of the magnet is specially called for.

(b) Bearings/Dampers:

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

(c) Molecular pumps:

Especially designed or prepared cylinders having internally machined or extruded helical grooves and internally machined bores. Typical dimensions are as follows: 75 mm (3 in) to 400 mm (16 in) internal diameter, 10 mm (0.4 in) or more wall thickness, with the length equal to or greater than the diameter. The grooves are typically rectangular in cross-section and 2 mm (0.08 in) or more in depth.

(d) Motor stators:

Especially designed or prepared ring-shaped stators for high speed multiphase AC hysteresis (or reluctance) motors for synchronous operation within a vacuum in the frequency range of 600 – 2000 Hz and a power range of 50 - 1000 VA. The stators consist of multi-phase windings on a laminated low loss iron core comprised of thin layers typically 2.0 mm (0.08 in) thick or less.

(e) Centrifuge housing/recipients:

Components especially designed or prepared to contain the rotor tube assembly of a gas centrifuge. The housing consists of a rigid cylinder of wall thickness up to 30 mm (1.2 in) with precision machined ends to locate the bearings and with one or more flanges for mounting. The machined ends are parallel to each other and perpendicular to the cylinder's longitudinal axis to within 0.05 degrees or less. The housing may also be a honeycomb type structure to accommodate several rotor tubes. The housings are made of or protected by materials resistant to corrosion by UF6.

(f) Scoops:

Especially designed or prepared tubes of up to 12 mm (0.5 in) internal diameter for the extraction of UF6 gas from within the rotor tube by a Pitot tube action (that is, with an aperture facing into the circumferential gas flow within the rotor tube, for example by bending the end of a radially disposed tube) and capable of being fixed to the central gas extraction system. The tubes are made of or protected by materials resistant to corrosion by UF6.

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

INTRODUCTORY NOTE

The auxiliary systems, equipment and components for a gas centrifuge enrichment plant are the systems of plant needed to feed UF6 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' UF6 from the centrifuges, together with the equipment required to drive the centrifuges or to control the plant. Normally UF6 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' UF6 gaseous streams flowing from the centrifuges are also passed by way of cascade header pipework to cold traps (operating at about 203 K (-70ºC)) 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 UF6 to the centrifuge cascades at up to 100 kPa (15 psi) and at a rate of 1 kg/h or more;

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

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

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

5.2.2. Machine header piping systems

Especially designed or prepared piping systems and header systems for handling UF6 within the centrifuge cascades. The piping network is normally of the 'triple' header system with each centrifuge connected to each of the headers. There is thus a substantial amount of repetition in its form. It is wholly made of UF6-resistant materials (see EXPLANATORY NOTE to this section) and is fabricated to very high vacuum and cleanliness standards.

5.2.3 Special shut-off and control valves

Especially designed or prepared bellows-sealed valves, manual or automated, shut-off or control, made of or protected by materials resistant to corrosion by UF6, with a diameter of 10 to 160 mm, for use in main or auxiliary systems of gas centrifuge enrichment plants.

5.2.4. UF6 mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking 'on-line' samples of feed, product or tails, from UF6 gas streams and having all of the following characteristics:

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

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

3. Electron bombardment ionization sources;

4. Having a collector system suitable for isotopic analysis.

5.2.5. Frequency changers

Frequency changers (also known as converters or invertors) especially designed or prepared to supply motor stators as defined under 5.1.2.(d), or parts, components and sub-assemblies of such frequency changers having all of the following characteristics:

1. A multiphase output of 600 to 2000 Hz;

2. High stability (with frequency control better than 0.1%);

3. Low harmonic distortion (less than 2%); and

4. An efficiency of greater than 80%.

EXPLANATORY NOTE

The items listed above either come into direct contact with the UF6 process gas or directly control the centrifuges and the passage of the gas from centrifuge to centrifuge and cascade to cascade. Materials resistant to corrosion by UF6 include stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel.

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

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 (UF6), all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF6. 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 (0.2 in) or less, and for tubular forms, a diameter of 25 mm (1 in) or less, made of metallic, polymer or ceramic materials resistant to corrosion by UF6, and

(b) especially prepared compounds or powders for the manufacture of such filters. Such compounds and powders include nickel or alloys containing 60% or more nickel, aluminium oxide, or UF6-resistant fully fluorinated hydrocarbon polymers having a purity of 99.9% or more, a particle size less than 10 microns, and a high degree of particle size uniformity, which are especially prepared for the manufacture of gaseous diffusion barriers.

5.3.2. Diffuser housings

Especially designed or prepared hermetically sealed cylindrical vessels greater than 300 mm (12 in) in diameter and greater than 900 mm (35 in) in length, or rectangular vessels of comparable dimensions, which have an inlet connection and two outlet connections all of which are greater than 50 mm (2 in) in diameter, for containing the gaseous diffusion barrier, made of or lined with UF6-resistant materials and designed for horizontal or vertical installation.

5.3.3. Compressors and gas blowers

Especially designed or prepared axial, centrifugal, or positive displacement compressors, or gas blowers with a suction volume capacity of 1 m3/min or more of UF6, and with a discharge pressure of up to several hundred kPa (100 psi), designed for long-term operation in the UF6 environment with or without an electrical motor of appropriate power, as well as separate assemblies of such compressors and gas blowers. These compressors and gas blowers have a pressure ratio between 2:1 and 6:1 and are made of, or lined with, materials resistant to UF6.

5.3.4. Rotary shaft seals

Especially designed or prepared vacuum seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor or the gas blower rotor with the driver motor so as to ensure a reliable seal against in-leaking of air into the inner chamber of the compressor or gas blower which is filled with UF6. Such seals are normally designed for a buffer gas in-leakage rate of less than 1000 cm3/min (60 in3/min).

5.3.5. Heat exchangers for cooling UF6

Especially designed or prepared heat exchangers made of or lined with UF6-resistant materials (except stainless steel) or with copper or any combination of those metals, and intended for a leakage pressure change rate of less than 10 Pa (0.0015 psi) per hour under a pressure difference of 100 kPa (15 psi).

5.4. Especially designed or prepared auxiliary systems, equipment and components for use in gaseous diffusion enrichment

INTRODUCTORY NOTE

The auxiliary systems, equipment and components for gaseous diffusion enrichment plants are the systems of plant needed to feed UF6 to the gaseous diffusion assembly, to link the individual assemblies to each other to form cascades (or stages) to allow for progressively higher enrichments and to extract the "product" and "tails" UF6 from the diffusion cascades. Because of the high inertial properties of diffusion cascades, any interruption in their operation, and especially their shut-down, leads to serious consequences. Therefore, a strict and constant maintenance of vacuum in all technological systems, automatic protection from accidents, and precise automated regulation of the gas flow is of importance in a gaseous diffusion plant. All this leads to a need to equip the plant with a large number of special measuring, regulating and controlling systems. Normally UF6 is evaporated from cylinders placed within autoclaves and is distributed in gaseous form to the entry point by way of cascade header pipework. The "product" and "tails" UF6 gaseous streams flowing from exit points are passed by way of cascade header pipework to either cold traps or to compression stations where the UF6 gas is liquefied prior to onward transfer into suitable containers for transportation or storage. Because a gaseous diffusion enrichment plant consists of a large number of gaseous diffusion assemblies arranged in cascades, there are many kilometers of cascade header pipework, incorporating thousands of welds with substantial amounts of repetition of layout. The equipment, components and piping systems are fabricated to very high vacuum and cleanliness standards.

5.4.1. Feed systems/product and tails withdrawal systems

Especially designed or prepared process systems, capable of operating at pressures of 300 kPa (45 psi) or less, including: Feed autoclaves (or systems), used for passing UF6 to the gaseous diffusion cascades; Desublimers (or cold traps) used to remove UF6 from diffusion cascades; Liquefaction stations where UF6 gas from the cascade is compressed and cooled to form liquid UF6; "Product" or "tails" stations used for transferring UF6 into containers.

5.4.2. Header piping systems

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

5.4.3. Vacuum systems

(a) Especially designed or prepared large vacuum manifolds, vacuum headers and vacuum pumps having a suction capacity of 5 m3/min (175 ft3/min) or more.

(b) Vacuum pumps especially designed for service in UF6-bearing atmospheres made of, or lined with, aluminium, nickel, or alloys bearing more than 60% nickel. These pumps may be either rotary or positive, may have displacement and fluorocarbon seals, and may have special working fluids present.

5.4.4. Special shut-off and control valves

Especially designed or prepared manual or automated shut-off and control bellows valves made of UF6-resistant materials with a diameter of 40 to 1500 mm (1.5 to 59 in) for installation in main and auxiliary systems of gaseous diffusion enrichment plants.

5.4.5. UF6

mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking "on-line" samples of feed, product or tails, from UF6 gas streams and having all of the following characteristics:

1. Unit resolution for atomic mass unit greater than 320;
2. Ion sources constructed of or lined with nichrome or monel or nickel plated;
3. Electron bombardment ionization sources;
4. Collector system suitable for isotopic analysis.

EXPLANATORY NOTE

The items listed above either come into direct contact with the UF6 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, UF6-resistant materials. For the purposes of the sections relating to gaseous diffusion items the materials resistant to corrosion by UF6 include stainless steel, aluminium, aluminium alloys, aluminium oxide, nickel or alloys containing 60%

or more nickel and UF6-resistant fully fluorinated hydrocarbon polymers.

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

INTRODUCTORY NOTE

In aerodynamic enrichment processes, a mixture of gaseous UF6 and light gas (hydrogen or helium) is compressed and then passed through separating elements wherein isotopic separation is accomplished by the generation of high centrifugal forces over a curved-wall geometry. Two processes of this type have been successfully developed: the separation nozzle process and the vortex tube process. For both processes the main components of a separation stage include cylindrical vessels housing the special separation elements (nozzles or vortex tubes), gas compressors and heat exchangers to remove the heat of compression. An aerodynamic plant requires a number of these stages, so that quantities can provide an important indication of end use. Since aerodynamic processes use UF6, all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of materials that remain stable in contact with UF6.

EXPLANATORY NOTE

The items listed in this section either come into direct contact with the UF6 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 protected by UF6-resistant materials. For the purposes of the section relating to aerodynamic enrichment items, the materials resistant to corrosion by UF6 include copper, stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel and UF6-resistant fully fluorinated hydrocarbon polymers.

5.5.1. Separation nozzles

Especially designed or prepared separation nozzles and assemblies thereof. The separation nozzles consist of slit-shaped, curved channels having a radius of curvature less than 1 mm (typically 0.1 to 0.05 mm), resistant to corrosion by UF6 and having a knife-edge within the nozzle that separates the gas flowing through the nozzle into two fractions.

5.5.2. Vortex tubes

Especially designed or prepared vortex tubes and assemblies thereof. The vortex tubes are cylindrical or tapered, made of or protected by materials resistant to corrosion by UF6, having a diameter of between 0.5 cm and 4 cm, a length to diameter ratio of 20:1 or less and with one or more tangential inlets. The tubes may be equipped with nozzletype appendages at either or both ends.

EXPLANATORY NOTE

The feed gas enters the vortex tube tangentially at one end or through swirl vanes or at numerous tangential positions along the periphery of the tube.

5.5.3. Compressors and gas blowers

Especially designed or prepared axial, centrifugal or positive displacement compressors or gas blowers made of or protected by materials resistant to corrosion by UF6 and with a suction volume capacity of 2 m3/min or more of UF6/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 exhaust connections, for sealing the shaft connecting the compressor rotor or the gas blower rotor with the driver motor so as to ensure a reliable seal against out-leakage of process gas or in-leakage of air or seal gas into the inner chamber of the compressor or gas blower which is filled with a UF6/carrier gas mixture.

5.5.5. Heat exchangers for gas cooling

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

5.5.6. Separation element housings

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

EXPLANATORY NOTE

These housings may be cylindrical vessels greater than 300 mm in diameter and greater than 900 mm in length, or may be rectangular vessels of comparable dimensions, and may be designed for horizontal or vertical installation.

5.5.7. Feed systems/product and tails withdrawal systems

Especially designed or prepared process systems or equipment for enrichment plants made of or protected by materials resistant to corrosion by UF6, including:

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

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

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

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

5.5.8. Header piping systems

Especially designed or prepared header piping systems, made of or protected by materials resistant to corrosion by UF6, for handling UF6 within the aerodynamic cascades. This piping network is normally of the 'double' header design with each stage or group of stages connected to each of the headers.

5.5.9. Vacuum systems and pumps

(a) Especially designed or prepared vacuum systems having a suction capacity of 5 m3/min or more, consisting of vacuum manifolds, vacuum headers and vacuum pumps, and designed for service in UF6-bearing atmospheres,

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

5.5.10. Special shut-off and control valves

Especially designed or prepared manual or automated shut-off and control bellows valves made of or protected by materials resistant to corrosion by UF6 with a diameter of 40 to 1500 mm for installation in main and auxiliary systems of aerodynamic enrichment plants.

5.5.11. UF6 mass spectrometers/Ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking 'on-line' samples of feed, 'product' or 'tails', from UF6 gas streams and having all of the following characteristics:

1. Unit resolution for mass greater than 320;

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

3. Electron bombardment ionization sources;

4. Collector system suitable for isotopic analysis.

5.5.12. UF6/carrier gas separation systems

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

EXPLANATORY NOTE

These systems are designed to reduce the UF6 content in the carrier gas to 1 ppm or less and may incorporate equipment such as:

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

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

(c) Separation nozzle or vortex tube units for the separation of UF6 from carrier gas, or

(d) UF6 cold traps capable of temperatures of -20°C or less.

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

INTRODUCTORY NOTE

The slight difference in mass between the isotopes of uranium causes small changes in chemical reaction equilibria that can be used as a basis for separation of the isotopes. Two processes have been successfully developed: liquid-liquid chemical exchange and solid-liquid ion exchange. In the liquid-liquid chemical exchange process, immiscible liquid phases (aqueous and organic) are countercurrently contacted to give the cascading effect of thousands of separation stages. The aqueous phase consists of uranium chloride in hydrochloric acid solution; the organic phase consists of an extractant containing uranium chloride in an organic solvent. The contactors employed in the separation cascade can be liquid-liquid exchange columns (such as pulsed columns with sieve plates) or liquid centrifugal contactors. Chemical conversions (oxidation and reduction) are required at both ends of the separation cascade in order to provide for the reflux requirements at each end. A major design concern is to avoid contamination of the process streams with certain metal ions. Plastic, plastic-lined (including use of fluorocarbon 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 on a special, very fast-acting, ion-exchange resin or adsorbent. A solution of uranium in hydrochloric acid and other chemical agents is passed through cylindrical enrichment columns containing packed beds of the adsorbent. For a continuous process, a reflux system is necessary to release the uranium from the adsorbent back into the liquid flow so that 'product' and 'tails' can be collected. This is accomplished with the use of suitable reduction/oxidation chemical agents that are fully regenerated in separate external circuits and that may be partially regenerated within the isotopic separation columns themselves. The presence of hot concentrated hydrochloric acid solutions in the process requires that the equipment be made of or protected by special corrosion-resistant materials.

5.6.1. Liquid-liquid exchange columns (Chemical exchange)

Countercurrent liquid-liquid exchange columns having mechanical power input (i.e., pulsed columns with sieve plates, reciprocating plate columns, and columns with internal turbine mixers), especially designed or prepared for uranium enrichment using the chemical exchange process. For corrosion resistance to concentrated hydrochloric acid solutions, these columns and their internals are made of or protected by suitable plastic materials (such as fluorocarbon polymers) or glass. The stage residence time of the columns is designed to be short (30 seconds or less).

5.6.2. Liquid-liquid centrifugal contactors (Chemical exchange)

Liquid-liquid centrifugal contactors especially designed or prepared for uranium enrichment using the chemical exchange process. Such contactors use rotation to achieve dispersion of the organic and aqueous streams and then centrifugal force to separate the phases. For corrosion resistance to concentrated hydrochloric acid solutions, the contactors are made of or are lined with suitable plastic materials (such as fluorocarbon polymers) or are lined with glass. The stage residence time of the centrifugal contactors is designed to be short (30 seconds or less).

5.6.3. Uranium reduction systems and equipment (Chemical exchange)

(a) Especially designed or prepared electrochemical reduction cells to reduce uranium from one valence state to another for uranium enrichment using the chemical exchange process. The cell materials in contact with process solutions must be corrosion resistant to concentrated hydrochloric acid solutions.

EXPLANATORY NOTE

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

(b) Especially designed or prepared systems at the product end of the cascade for taking the U+4 out of the organic stream, adjusting the acid concentration and feeding to the electrochemical reduction cells.

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 adjustment and control, and pumps or other transfer devices for feeding to the electrochemical reduction cells. A major design concern is to avoid contamination of the aqueous stream with certain metal ions. Consequently, for those parts in contact with the process stream, the system is constructed of equipment made of or protected by suitable materials (such as glass, fluorocarbon polymers, polyphenyl sulfate, polyether sulfone, and resinimpregnated graphite).

5.6.4. Feed preparation systems (Chemical exchange)

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

EXPLANATORY NOTE

These systems consist of dissolution, solvent extraction and/or ion exchange equipment for purification and electrolytic cells for reducing the uranium U+6 or U+4 to U+3. These systems produce uranium chloride solutions having only a few parts per million of metallic impurities such as chromium, iron, vanadium, molybdenum and other bivalent or higher multi-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 isotope 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 separation equipment and extracting the resultant U+4 into the stripped organic stream returning from the product end of the cascade,

(b) Equipment that separates water from hydrochloric acid so that the water and the concentrated hydrochloric acid 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 prepared for uranium enrichment using the ion exchange process, including porous macroreticular resins, and/or pellicular structures in which the active chemical exchange groups are limited to a coating on the surface of an inactive porous support structure, and other composite structures in any suitable form including particles or fibers. These ion exchange resins/adsorbents have diameters of 0.2 mm or less and must be chemically resistant to concentrated hydrochloric acid solutions as well as physically strong enough so as not to degrade in the exchange columns. The resins/adsorbents are especially designed to achieve very fast uranium isotope exchange kinetics (exchange rate half-time of less than 10 seconds) and are capable of operating at a temperature in the range of 100°C to 200°C.

5.6.7. Ion exchange columns (Ion exchange)

Cylindrical columns greater than 1000 mm in diameter for containing and supporting packed beds of ion exchange resin/adsorbent, especially designed or prepared for uranium enrichment using the ion exchange process. These columns are made of or protected by materials (such as titanium or fluorocarbon plastics) resistant to corrosion by concentrated hydrochloric acid solutions and are capable of operating at a temperature in the range of 100℃ to 200℃ and pressures above 0.7 MPa (102 psi).

5.6.8. Ion exchange reflux systems (Ion exchange)

(a) Especially designed or prepared chemical or electrochemical reduction systems for regeneration of the chemical reducing agent(s) used in ion exchange uranium enrichment cascades.

(b) Especially designed or prepared chemical or electrochemical oxidation systems for regeneration of the chemical oxidizing agent(s) used in ion exchange uranium enrichment cascades.

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 regenerate Fe+3 by oxidizing Fe+2.

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

INTRODUCTORY NOTE

Present systems for enrichment processes using lasers fall into two categories: those in which the process medium is atomic uranium vapor and those in which the process medium is the vapor of a uranium compound. Common nomenclature for such processes include: first category - atomic vapor laser isotope separation (AVLIS or SILVA); second category - molecular laser isotope separation (MLIS or MOLIS) and chemical reaction by isotope selective laser activation (CRISLA). The systems, equipment and components for laser enrichment plants embrace: (a) devices to feed uranium-metal vapor (for selective photo-ionization) or devices to feed the vapor of a uranium compound (for photo-dissociation or chemical activation); (b) devices to collect enriched and depleted uranium metal as 'product' and 'tails' in the first category, and devices to collect dissociated or reacted compounds as 'product' and unaffected material as 'tails' in the second category; (c) process laser systems to selectively excite the uranium-235 species; and (d) feed preparation and product conversion equipment. The complexity of the spectroscopy of uranium atoms and compounds may require incorporation of any of a number of available laser technologies.

EXPLANATORY NOTE

Many of the items listed in this section come into direct contact with uranium metal vapor or liquid or with process gas consisting of UF6 or a mixture of UF6 and other gases. All surfaces that come into contact with the uranium or UF6 are wholly made of or protected by corrosion-resistant materials. For the purposes of the section relating to laser-based enrichment items, the materials resistant to corrosion by the vapor or liquid of uranium metal or uranium alloys include yttria-coated graphite and tantalum; and the materials resistant to corrosion by UF6 include copper, stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel and UF6-resistant fully fluorinated hydrocarbon polymers.

5.7.1. Uranium vaporization systems (AVLIS)

Especially designed or prepared uranium vaporization systems which contain highpower strip or scanning electron beam guns with a delivered power on the target of more than 2.5 kW/cm.

5.7.2. Liquid uranium metal handling systems (AVLIS)

Especially designed or prepared liquid metal handling systems for molten uranium or uranium alloys, consisting of crucibles and cooling equipment for the crucibles. EXPLANATORY NOTE

The crucibles and other parts of this system that come into contact with molten uranium or uranium alloys are made of or protected by materials of suitable corrosion and heat resistance. Suitable materials include tantalum, yttria-coated graphite, graphite coated with other rare earth oxides (see INFCIRC/254/Part 2 - (as amended)) or mixtures thereof.

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

Especially designed or prepared 'product' and 'tails' collector assemblies for uranium metal in liquid or solid form.

EXPLANATORY NOTE

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

5.7.4. Separator module housings (AVLIS)

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

EXPLANATORY NOTE

These housings have multiplicity of ports for electrical and water feed-throughs, laser beam windows, vacuum pump connections and instrumentation diagnostics and monitoring. They have provisions for opening and closure to allow refurbishment of internal components.

5.7.5. Supersonic expansion nozzles (MLIS)

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

5.7.6. Uranium pentafluoride product collectors (MLIS)

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

5.7.7. UF6/carrier gas compressors (MLIS)

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

5.7.8. Rotary shaft seals (MLIS)

Especially designed or prepared rotary shaft seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor rotor with the driver motor so as to ensure a reliable seal against out-leakage of process gas or in-leakage of air or seal gas into the inner chamber of the compressor which is filled with a UF6/carrier gas mixture.

5.7.9. Fluorination systems (MLIS)

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

EXPLANATORY NOTE

These systems are designed to fluorinate the collected UF5 powder to UF6 for subsequent collection in product containers or for transfer as feed to MLIS units for additional enrichment. In one approach, the fluorination reaction may be accomplished within the isotope separation system to react and recover directly off the 'product' collectors. In another approach, the UF5 powder may be removed/transferred from the 'product' collectors into a suitable reaction vessel (e.g., fluidized-bed reactor, screw reactor or flame tower) for fluorination. In both approaches, equipment for storage and transfer of fluorine (or other suitable fluorinating agents) and for collection and transfer of UF6 are used.

5.7.10. UF6 mass spectrometers/ion sources (MLIS)

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking 'on-line' samples of feed, 'product' or 'tails', from 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.

5.7.11. Feed systems/product and tails withdrawal systems (MLIS)

Especially designed or prepared process systems or equipment for enrichment plants made of or protected by materials resistant to corrosion by 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 subsequent 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, or

(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 uranium isotopes.

EXPLANATORY NOTE

The lasers and laser components of importance in laser-based enrichment processes include those identified in INFCIRC/254/Part 2 - (as amended). The laser system for the AVLIS process usually consists of two lasers: a copper vapor laser and a dye laser. The laser system for MLIS usually consists of a CO_2 or excimer laser and a multi-pass optical cell with revolving mirrors at both ends. Lasers or laser systems for both processes require a spectrum frequency stabilizer for operation over extended periods of time.

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

INTRODUCTORY NOTE

In the plasma separation process, a plasma of uranium ions passes through an electric field tuned to the 235U ion resonance frequency so that they preferentially absorb energy and increase the diameter of their corkscrew-like orbits. Ions with a large diameter path are trapped to produce a product enriched in 235U. The plasma, which is made by ionizing uranium vapor, is contained in a vacuum chamber with a high strength magnetic field produced by a superconducting magnet. The main technological systems of the process include the uranium plasma generation system, the separator module with superconducting magnet (see INFCIRC/254/Part 2 - (as amended)), and metal 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 producing or accelerating ions and having the following characteristics: greater than 30 GHz frequency and greater than 50 kW mean power output for ion production.

5.8.2. Ion excitation coils

Especially designed or prepared radio frequency ion excitation coils for frequencies of more than 100 kHz and capable of handling more than 40 kW mean power.

5.8.3. Uranium plasma generation systems

Especially designed or prepared systems for the generation of uranium plasma, which may contain high-power strip or scanning electron beam guns with a delivered power on the target of more than 2.5 kW/cm.

5.8.4. Liquid uranium metal handling systems

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

EXPLANATORY NOTE

The crucibles and other parts of this system that come into contact with molten uranium or uranium alloys are made of or protected by materials of suitable corrosion and heat resistance. Suitable materials include tantalum, yttria-coated graphite, graphite coated with other rare earth oxides (see INFCIRC/254/Part 2 - (as amended)) or mixtures thereof.

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

Especially designed or prepared 'product' and 'tails' collector assemblies for uranium metal in solid form. These collector assemblies are made of or protected by materials resistant to the heat and corrosion of uranium metal vapor, such as yttria-coated graphite or tantalum.

5.8.6. Separator module housings

Cylindrical vessels especially designed or prepared for use in plasma separation enrichment plants for containing the uranium plasma source, radio-frequency drive coil and the 'product' and 'tails' collectors.

EXPLANATORY NOTE

These housings have a multiplicity of ports for electrical feed-throughs, diffusion pump connections and instrumentation diagnostics and monitoring. They have provisions for opening and closure to allow for refurbishment of internal 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 electromagnetic enrichment plants.

INTRODUCTORY NOTE

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

5.9.1. Electromagnetic isotope separators

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

(a) Ion sources

Especially designed or prepared single or multiple uranium ion sources consisting of a vapor source, ionizer, and beam accelerator, constructed of suitable materials such as graphite, stainless steel, or copper, and capable of providing a total ion beam current of 50 mA or greater.

(b) Ion collectors

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

(c) Vacuum housings

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

EXPLANATORY NOTE

The housings are specially designed to contain the ion sources, collector plates and water-cooled liners and have provision for diffusion pump connections and opening and closure for removal and reinstallation of these components.

(d) Magnet pole pieces

Especially designed or prepared magnet pole pieces having a diameter greater than 2 m used to maintain a constant magnetic field within an electromagnetic isotope separator and to transfer the magnetic field between adjoining separators.

5.9.2. High voltage power supplies

Especially designed or prepared high-voltage power supplies for ion sources, having all of the following characteristics: capable of continuous operation, output voltage of 20,000 V or greater, output current of 1 A or greater, and voltage regulation of better than 0.01% over a time period of 8 hours.

5.9.3. Magnet power supplies

Especially designed or prepared high-power, direct current magnet power supplies having all of the following characteristics: capable of continuously producing a current output of 500 A or greater at a voltage of 100 V or greater and with a current or voltage regulation better than 0.01% over a period of 8 hours.

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

INTRODUCTORY NOTE

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

The GS process is based upon the exchange of hydrogen and deuterium between water and hydrogen sulphide within a series of towers which are operated with the top section cold and the bottom section hot. Water flows down the towers while the hydrogen sulphide gas circulates from the bottom to the top of the towers. A series of perforated trays are used to promote mixing between the gas and the water. Deuterium migrates to the water at low temperatures and to the hydrogen sulphide at high temperatures. Gas or water, enriched in deuterium, is removed from the first stage towers at the junction of the hot and cold sections and the process is repeated in subsequent stage towers. The product of the last stage, water enriched up to 30% in deuterium, is sent to a distillation unit to produce reactor grade heavy water; i.e., 99.75% deuterium oxide.

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

Many of the key equipment items for heavy water production plants using GS or the ammonia-hydrogen exchange processes are common to several segments of the chemical and petroleum industries. This is particularly so for small plants using the GS process. However, few of the items are available "off-the-shelf". The GS and ammonia-hydrogen processes require the handling of large quantities of flammable, corrosive and toxic fluids at elevated pressures. Accordingly, in establishing the design and operating standards for plants and equipment using these processes, careful attention to the materials selection and specifications is required to ensure long service life with high safety and reliability factors. The choice of scale is primarily a function of economics and need. Thus, most of the equipment items would be prepared according to the requirements of the customer.

Finally, it should be noted that, in both the GS and the ammonia-hydrogen exchange processes, items of equipment which individually are not especially designed or prepared for heavy water production can be assembled into systems which are especially designed or prepared for producing heavy water. The catalyst production system used in the ammonia-hydrogen exchange process and water distillation systems used for the final concentration of heavy water to reactor-grade in either process are examples of such systems.

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

6.1. Water - Hydrogen Sulphide Exchange Towers

Exchange towers fabricated from fine carbon steel (such as ASTM A516) with diameters of 6 m (20 ft) to 9 m (30 ft), capable of operating at pressures greater than or equal to 2 MPa (300 psi) and with a corrosion allowance of 6 mm or greater, especially designed or prepared for heavy water production utilizing the waterhydrogen sulphide exchange process.

6.2. Blowers and Compressors

Single stage, low head (i.e., 0.2 MPa or 30 psi) centrifugal blowers or compressors for hydrogen-sulphide gas circulation (i.e., gas containing more than 70% H_2S) especially designed or prepared for heavy water production utilizing the water-hydrogen sulphide exchange process. These blowers or compressors have a throughput capacity greater than or equal to 56 m3/second (120,000 SCFM) while operating at pressures greater than or equal to 1.8 MPa (260 psi) suction and have seals designed for wet H_2S service.

6.3. Ammonia-Hydrogen Exchange Towers

Ammonia-hydrogen exchange towers greater than or equal to 35 m (114.3 ft) in height with diameters of 1.5 m (4.9 ft) to 2.5 m (8.2 ft) capable of operating at pressures greater than 15 MPa (2225 psi) especially designed or prepared for heavy water production utilizing the ammonia-hydrogen exchange process. These towers also have at least one flanged, axial opening of the same diameter as the cylindrical part through which the tower internals can be inserted or withdrawn.

6.4. Tower Internals and Stage Pumps

Tower internals and stage pumps especially designed or prepared for towers for heavy water production utilizing the ammonia-hydrogen exchange process. Tower internals include especially designed stage contactors which promote intimate gas/liquid contact. Stage pumps include especially designed submersible pumps for circulation of liquid ammonia within a contacting stage internal to the stage towers.

6.5. Ammonia Crackers

Ammonia crackers with operating pressures greater than or equal to 3 MPa (450 psi) especially designed or prepared for heavy water production utilizing the ammoniahydrogen exchange process.

6.6. Infrared Absorption Analyzers

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

6.7. Catalytic Burners

Catalytic burners for the conversion of enriched deuterium gas into heavy water especially designed or prepared for heavy water production utilizing the ammoniahydrogen exchange process.

6.8. Complete heavy water upgrade systems or columns therefor

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

EXPLANATORY NOTE

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

7. Plants for the conversion of uranium and plutonium for use in the fabrication of fuel elements and the separation of uranium isotopes as defined in sections 4 and 5 respectively, and equipment especially designed or prepared therefore

EXPORTS

The export of the whole set of major items within this boundary will take place only in accordance with the procedures of the Guidelines**.** All of the plants, systems, and specially designed or prepared equipment within this boundary can be used for the processing, production, or use of special fissionable material.

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

INTRODUCTORY NOTE

Uranium conversion plants and systems may perform one or more transformations from one uranium chemical species to another, including: conversion of uranium ore concentrates to UO3, conversion of UO3 to UO2, conversion of uranium oxides to UF4, UF6, or UCl4, conversion of UF4 to UF6, conversion of UF6 to UF4, conversion of UF4 to uranium metal, and conversion of uranium fluorides to UO2. Many of the key equipment items for uranium conversion plants are common to several segments of the chemical process industry. For example, the types of equipment employed in these processes may include: furnaces, rotary kilns, fluidized bed reactors, flame tower reactors, liquid centrifuges, distillation columns and liquid-liquid extraction columns. However, few of the items are available "off-the-shelf"; most would be prepared according to the requirements and specifications of the customer. In some instances, special design and construction considerations are required to address the corrosive properties of some of the chemicals handled (HF, F2, ClF3, and uranium fluorides) as well as nuclear criticality concerns. Finally, it should be noted that, in all of the uranium conversion processes, items of equipment which individually are not especially designed or prepared for uranium conversion can be assembled into systems which are especially designed or prepared for use in uranium conversion.

7.1.1. Especially designed or prepared systems for the conversion of uranium ore concentrates to UO3

EXPLANATORY NOTE

Conversion of uranium ore concentrates to UO3 can be performed by first dissolving the ore in nitric acid and extracting purified uranyl nitrate using a solvent such as tributyl phosphate. Next, the uranyl nitrate is converted to UO3 either by concentration and denitration or by neutralization with gaseous ammonia to produce ammounium diuranate with subsequent filtering, drying, and calcining.

7.1.2. Especially designed or prepared systems for the conversion of UO3 to UF6

EXPLANATORY NOTE

Conversion of UO3 to UF6 can be performed directly by fluorination. The process requires a source of fluorine gas or chlorine trifluoride.

7.1.3. Especially designed or prepared systems for the conversion of UO3 to UO2

EXPLANATORY NOTE

Conversion of UO3 to UO2 can be performed through reduction of UO3 with cracked ammonia gas or hydrogen.

7.1.4. Especially designed or prepared systems for the conversion of UO2 to UF4

EXPLANATORY NOTE

Conversion of UO2 to UF4 can be performed by reacting UO2 with hydrogen fluoride gas (HF) at 300-500°C.

7.1.5. Especially designed or prepared systems for the conversion of UF4 to UF6

EXPLANATORY NOTE

Conversion of UF4 to UF6 is performed by exothermic reaction with fluorine in a tower reactor. UF6 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.

7.1.6. Especially designed or prepared systems for the conversion of UF4 to U metal

EXPLANATORY NOTE

Conversion of UF4 to U metal is performed by reduction with magnesium (large batches) or calcium (small batches). The reaction is carried out at temperatures above the melting point of uranium (1130 °C).

7.1.7. Especially designed or prepared systems for the conversion of UF6 to UO2

EXPLANATORY NOTE

Conversion of UF6 to UO2 can be performed by one of three processes. In the first, UF6 is reduced and hydrolyzed to UO2 using hydrogen and steam. In the second, UF6 is hydrolyzed by solution in water, ammonia is added to precipitate ammonium diuranate, and the diuranate is reduced to UO2 with hydrogen at 820°C. In the third process, gaseous UF6, CO2, and NH3 are combined in water, precipitating ammonium uranyl carbonate. The ammonium uranyl carbonate is combined with steam and hydrogen at 500-600°C to yield UO2 .

UF6 to UO2 conversion is often performed as the first stage of a fuel fabrication plant.

7.1.8. Especially designed or prepared systems for the conversion of UF6 to UF4

EXPLANATORY NOTE

Conversion of UF6 to UF4 is performed by reduction with hydrogen.

7.1.9. Especially designed or prepared systems for the conversion of UO2 to UCl4

EXPLANATORY NOTE

Conversion of UO2 to UCl4 can be performed by one of two processes. In the first, UO2 is reacted with carbon tetrachloride (CCl4) at approximately 400ºC. In the second, UO2 is reacted at approximately 700ºC in the presence of carbon black (CAS 1333-86-4), carbon monoxide, and chlorine to yield UCl4.

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

INTRODUCTORY NOTE

Plutonium conversion plants and systems perform one or more transformations from one plutonium chemical species to another, including: conversion of plutonium nitrate to PuO2, conversion of PuO2 to PuF4, and conversion of PuF4 to plutonium metal Plutonium conversion plants are usually associated with reprocessing facilities, but may also be associated with plutonium fuel fabrication facilities. Many of the key equipment items for plutonium conversion plants are common to several segments of the chemical process industry. For example, the types of equipment employed in these processes may include: furnaces, rotary kilns, fluidized bed reactors, flame tower reactors, liquid centrifuges, distillation columns and liquid-liquid extraction columns. Hot cells, glove boxes and remote manipulators may also be required. However, few of the items are available "off-the-shelf"; most would be prepared according to the requirements and specifications of the customer. Particular care in designing for the special radiological, toxicity and criticality hazards associated with plutonium is essential. In some instances, special design and construction considerations are required to address the corrosive properties of some of the chemicals handled (e.g. HF). Finally, it should be noted that, for all plutonium conversion processes, items of equipment which individually are not especially designed or prepared for plutonium conversion can be assembled into systems which are especially designed or prepared for use in plutonium conversion.

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

EXPLANATORY NOTE

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. The process systems are particularly adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards. In most reprocessing facilities, this process involves the conversion of plutonium nitrate to plutonium dioxide. Other processes can involve the precipitation of plutonium oxalate or plutonium peroxide.

7.2.2. Especially designed or prepared systems for plutonium metal production

EXPLANATORY NOTE

This process usually 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 (e.g. involving equipment fabricated or lined with a precious metal), metal reduction (e.g. employing ceramic crucibles), slag recovery, product handling, ventilation, waste management and process control. The process systems are particularly adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards. Other processes include the fluorination of plutonium oxalate or plutonium peroxide followed by a reduction to metal.

ANNEX C

CRITERIA FOR LEVELS OF PHYSICAL PROTECTION

1. The purpose of physical protection of nuclear materials is to prevent unauthorized use and handling of these materials. Paragraph 3(a) of the Guidelines document calls for agreement among suppliers on the levels of protection to be ensured in relation to the type of materials, and equipment and facilities containing these materials, taking account of international recommendations.

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

3. The document INFCIRC/225 of the International Atomic Energy Agency entitled "The Physical Protection of Nuclear Material" and similar documents which from time to time are prepared by international groups of experts and updated as appropriate to account for changes in the state of the art and state of knowledge with regard to physical protection of nuclear material are a useful basis for guiding recipient States in designing a system of physical protection measures and procedures.

4. The categorization of nuclear material presented in the attached table or as it may be updated from time to time by mutual agreement of suppliers shall serve as the agreed basis for designating specific levels of physical protection in relation to the type of materials, and equipment and facilities containing these materials, pursuant to paragraph 3(a) and 3(b) of the Guidelines document.

5. The agreed levels of physical protection to be ensured by the competent national authorities in the use, storage and transportation of the materials listed in the attached table shall as a minimum include protection characteristics as follows:

CATEGORY III

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

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

CATEGORY II

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

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

CATEGORY I

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

Use and storage within a highly protected area, i.e., a protected area as defined for Category II above, to which, in addition, access is restricted to person whose trustworthiness has been determined, and which is under surveillance by guards who are in close communication with appropriate response forces. Specific measures taken in this context should have as their objective the detection and prevention of any assault, unauthorized access or unauthorized removal of material.

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

7. Suppliers should request identification by recipients of those agencies or authorities having responsibility for ensuring that levels of protection are adequately met and having responsibility for internally co-ordinating response/recovery operations in the event of unauthorized use or handling of protected materials. Suppliers and recipients should also designate points of contact within their national authorities to co-operate on matters of out-of-country transportation and other matters of mutual concern.

TABLE: CATEGORIZATION OF NUCLEAR MATERIAL

Material	Form	Category		
		I	II	III
1. Plutonium***[a]**]	Unirradiated***[b]**	2 kg or more	Less than 2 kg but more than 500 g	500 g or less***[c]**
2. Uranium-235	Unirradiated***[b]**]			
	- uranium enriched to 20% 235U or more	5 kg or more	Less than 5 kg but more than 1 kg	1 kg or less***[c]**

	] - uranium enriched to 10% 235U but less than 20%	-	10 kg or more	Less than 10 kg*[c]
	- - uranium enriched above natural, but less than 10% ^{235}U* [d]	-	-	10 kg or more
3. Uranium-233	Unirradiated*[b]	2 kg or more	Less than 2 kg but more than 500 g	500 g or less*[c]
4. Irradiated fuel			Depleted or natural uranium, thorium or low-enriched fuel (less than 10% fissile content)* [e][f]	

[a] As identified in the Trigger List.
[b] Material not irradiated in a reactor or material irradiated in a reactor but with a radiation level equal to or less than 100 rads/hour at one metre unshielded.
[c] Less than a radiologically significant quantity should be exempted.
[d] Natural uranium, depleted uranium, and thorium and quantities of uranium enriched to less than 10% not falling in Category III should be protected in accordance with prudent management practice.
[e] Although this level of protection is recommended, it would be open to States, upon evaluation of the specific circumstances, to assign a different category of physical protection.
[f] Other fuel which by virtue of its original fissile material content is classified as Category I or II before irradiation may be reduced one category levels while the radiation level from the fuel exceed 100 rads/hour at tone metre unshielded.

Comparison Table of Changes to the Guidelines for Nuclear Transfers (INFCIRC/254/Part 1)

Old (Revision 8)	New (Revision 9)
	Annex A – General Note
	3. Suppliers recognize the close relationship for certain isotope separation processes between plants, equipment and technology for uranium enrichment and that for the separation of stable isotopes for research, medical and other non-nuclear industrial purposes. In that regard, suppliers should carefully review their legal measures, including export licensing regulations and information/technology classification and security practices, for stable isotope separation activities to ensure the implementation of appropriate protection measures as warranted. Suppliers recognize that, in particular cases, appropriate protection measures for stable isotope separation activities will be essentially the same as those for uranium enrichment. (See Introductory Note in Section 5 of the Trigger List.) In accordance with Paragraph 16(a) of the Guidelines, suppliers shall consult with other suppliers as appropriate, in order to promote uniform policies and procedures in the transfer and protection of stable isotope separation plants, equipment and technology.
Annex A	**Annex A**
2.5. Plants for the separation of isotopes of uranium and equipment, other than analytical instruments, especially designed or prepared therefore (see Annex B, section 5.);	2.5. Plants for the separation of isotopes of **natural** uranium, **depleted uranium or special fissionable material** and equipment, other than analytical instruments, especially designed or prepared therefor (see Annex B, section 5.);
Annex B	**Annex B**
5. Plants for the separation of isotopes of uranium and equipment, other than analytical instruments, especially designed or prepared therefor	5. Plants for the separation of isotopes of **natural** uranium**, depleted uranium or special fissionable material** and equipment, other than analytical instruments, especially designed or prepared therefor
	Annex B, Section 5
	INTRODUCTORY NOTE **Plants, equipment and technology for the separation of uranium isotopes have, in many instances, a close relationship to plants, equipment and technology for the separation of stable isotopes. In particular cases, the controls under Section 5 also apply accordingly to plants and equipment that are intended for the separation of stable isotopes. These controls of plants and equipment for the separation of stable isotopes are complementary to controls on plants and equipment especially designed or prepared for the processing, use or production of special fissionable material covered by the Trigger List. These complementary Section 5 controls for stable isotope uses do not apply to the electromagnetic isotope separation process, which is addressed under Part 2 of the Guidelines.** **Processes for which the controls in Section 5 equally apply whether the intended use is uranium isotope separation or stable isotope separation are: gas centrifuge, gaseous diffusion, the plasma separation process, and aerodynamic processes.** **For some processes, the relationship to uranium isotope separation depends on the element (stable isotope) being separated. These processes are: laser-based processes (e.g., molecular laser isotope separation and atomic vapor laser isotope separation), chemical exchange, and ion exchange. Suppliers must therefore evaluate these processes on a case-by-case basis to apply Section 5 controls for stable isotope uses accordingly.**
	5.2.3 Special shut-off and control valves **Especially designed or prepared bellows-sealed valves, manual or automated, shut-off or control, made of or protected by materials resistant to corrosion by UF6, with a diameter of 10 to 160 mm, for use in main or auxiliary systems of gas centrifuge enrichment plants.**
5.2.3.	5.2.**4.**
5.2.4	5.2.**5**

Communication Received from the Permanent Mission of the United Kingdom Regarding the Export of Nuclear Material and of Certain Categories of Equipment and Other Material

[Reproduced from INFCIRC/209/Rev.2/Mod.1, 10 January 2008]

1. The Director General has received a *note verbale* from the Permanent Mission of the United Kingdom, dated 10 January 2008, in which it requests that the Agency circulate to all Member States a letter of 12 December 2006 from the Chairman of the Zangger Committee, Mr Pavel Klucký, to the Director General, on behalf of the Governments of Argentina, Australia, Austria, Belgium, Bulgaria, Canada, China, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxemburg, the Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland and the United States of America, concerning the export of nuclear material and of certain categories of equipment and other material.

2. In the light of the wish expressed in the above-mentioned *note verbale*, the text of the *note verbale*, as well as the letter and attachments thereto, are hereby reproduced for the information of all Member States.

[Eds. Text of:

Note 002/08 from United Kingdom Mission, Vienna dated 10 January 2008
Letter from Pavel Klucký, Chairman of the Z|angger Committee to Dr Mohamed ElBaradei, Director General, IAEA, Vienna, dated 12 December 2006
Memorandum B

not included]

Procedures in Relation to Exports of Nuclear Materials and Certain Categories of Equipment and Material in Relation to Article III (2) of the NPT

[NPT/CONF.2010/PC.II/WP.37, 8 May 2008]

Working paper submitted by Argentina, Australia, Austria, Belgium, Bulgaria, Canada, China, Croatia, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Republic of Korea, Romania, the Russian Federation, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland and the United States of America as members of the Zangger Committee and Costa Rica, Cyprus, Estonia, Kyrgyzstan, Latvia, Lithuania, Malta and New Zealand as additional co-sponsors

1. Co-sponsors propose to include the following language in the final document of the 2010 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons:

(a) The Preparatory Committee notes that a number of States Party meet regularly in an informal group known as the Zangger Committee, in order to co-ordinate their implementation of Article III, Paragraph 2 of the Treaty related to the supply of nuclear material and equipment. To this end, these States Party have adopted two Memoranda A and B, including a list of items triggering IAEA safeguards, for their exports to non-nuclear-weapon States not party to the Treaty, as set forth in IAEA document INFCIRC/209 as amended. The Zangger Committee's Memoranda also relate to exports to non-nuclear-weapon States Party to the Treaty insofar as the recipient State should recognize the items on the Trigger List as well as the procedures and criteria from Article III, Paragraph 2 of the Treaty as a basis for its own export control decisions, including re-exports.

(b) The Preparatory Committee endorses the importance of the Zangger Committee as guidance for States Party in meeting their obligation under Article III, Paragraph 2 of the Treaty and invites all States to adopt the Memoranda of the Zangger Committee as minimal standards in connection with any nuclear co-operation.

(c) The Preparatory Committee recommends that the list of items triggering IAEA safeguards and the procedures for implementation, in accordance with Article III, Paragraph 2 of the Treaty, be reviewed from time to time to take into account advances in technology, the proliferation sensitivity, and changes in procurement practices.

(d) The Preparatory Committee urges the Zangger Committee to share its experience on export controls, so that states draw on the arrangements of its Memoranda.