الهيئة الاتحادية للرقابة النووية
FANR
Federal Authority for Nuclear Regulation

United Arab Emirates

Regulatory Guide

Implementation of the Obligations and Requirements of the Additional Protocol to the UAE Comprehensive Safeguards Agreement

(FANR-RG-015)

Version 0

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Basic Principle of Regulatory Guides

Regulatory guides are issued to describe methods and/or criteria acceptable to the Authority for meeting and implementing specific regulations. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods of complying with the regulations different from the guidance set forth in this regulatory guide will be acceptable if they provide a comparable degree of assurance that the requirements of the regulations are met.

Definitions

Article (1)

For the purposes of this regulatory guide, the following terms shall have the meanings set forth below. Other capitalised terms used but not defined herein shall have the meaning ascribed to them in FANR Regulation for the System of Accounting for and Control of Nuclear Material and Application of Additional Protocol (FANR-REG-10) and the Law.

Amended Report	A report submitted to the Authority which amends the information in an Initial Report or an Annual Update Report.
Annual Update Report	A report submitted annually to the Authority by the Licensee concerning Reportable Activities of the Site or Location.
Complementary Access	Access provided by the State to IAEA inspectors in accordance with the provisions of the Additional Protocol. The purpose of Complementary Access is to verify correctness and completeness of State Declarations. A detailed description of Complementary Access can be found in Articles 4 to 10 of the Additional Protocol.
Declaration	Information submitted to the IAEA by a State about its nuclear programme and related activities
Impure Source Material	Source Material that has not reached the composition and purity suitable for fuel fabrication or for being isotopically enriched, as per Article 2.a.(vi) of the Additional Protocol.
Initial Report	A report, based on the information required under Article 3.a of the Additional Protocol, submitted to the Authority describing Reportable Activities and specifying the Site or Location where the said activities are conducted.
Location	In the context of the Additional Protocol, “Location” usually means any geographical point or area which has been declared by the Authority as being subject to the reporting and access requirements of the IAEA or designated as a “Location” by the IAEA.
Reportable Activities	Those activities that should be reported to the Authority in accordance with FANR-REG-10 and the requirements of the Additional Protocol.
Site	As defined in Article 18.b of the Additional Protocol.

Requirements

Article (2)

The Additional Protocol (see Reference 1 in Article (17) of this guidance) is an international agreement between the IAEA and the UAE that was approved by the IAEA Board of Governors in March 2009, signed by the United Arab Emirates in April 2009, and entered into force in December 2010. The Additional Protocol places further requirements on the State, over and above those of the Safeguards Agreement (see Reference 2 in Article (17) of this guidance), to strengthen the IAEA safeguards system.

Chapter 7 of the Law (see Reference 3 in Article (17) of this guidance) requires the establishment of a system that complies with and ensures the fulfilment of the obligations undertaken by the State in the Safeguards Agreement and any protocols additional to that agreement.

FANR-REG-10 (see Reference 4 in Article (17) of this guidance) provides the basis for meeting the obligations and commitments made under the Safeguards Agreement and the Additional Protocol.

Purpose and Scope

Article (3)

This regulatory guide outlines methods that are acceptable to the Authority for meeting the obligations and commitments under the Additional Protocol. This document also provides acceptance criteria that will be used by the Authority to evaluate the adequacy of the Operator's procedures for reporting to the Authority, and to facilitate the conduct of IAEA verification activities during Complementary Access.

Acceptable methods for meeting the obligations and commitments under the Safeguards Agreement are outlined in FANR-RG-013 "Implementation of the System of Accounting for and Control of Nuclear Material at Locations outside Facilities" and FANR-RG-014, "Implementation of the System of Accounting for and Control of Nuclear Material at Nuclear Facilities".

The Additional Protocol applies to all persons and entities licensed by the Authority to possess Nuclear Material; persons and entities that conduct Nuclear Fuel cycle-related research as specified in FANR-REG-10, Articles (18)-(23); Operators and owners of uranium mines; Operators and owners of uranium and thorium concentration plants; producers, importers and exporters of Nuclear Material as defined in FANR-REG-10; and importers and exporters of certain specified nuclear-related equipment and non-Nuclear Material designed and used in the Nuclear Sector.

Objectives and Obligations

Article (4)

The specific objective of this regulatory guide is to provide guidance for fulfilling the obligations and commitments of FANR-REG-10 relating to the Additional Protocol. Under the Additional Protocol, the State is obligated to make Declarations to the IAEA on nuclear activities conducted in the UAE and to provide the IAEA with sufficient access to Sites and Locations where Reportable Activities are conducted, as well as to resolve questions relating to the accuracy and completeness of the Declarations. Licensees and other persons or entities conducting Nuclear Fuel cycle-related activities are required to provide the Authority with certain information. This includes, but is not limited to, information on all Nuclear Material; information on the places where activities involving Nuclear Material are conducted; information on equipment and non-Nuclear Material designed and used in the Nuclear Sector, and information on the places where specified Nuclear Fuel cycle-related activities are conducted, even if they do not involve the use of Nuclear Material. Under the Additional Protocol, Operators of Nuclear Facilities and other persons or entities that conduct Nuclear Fuel cycle-related activities are also required to allow IAEA inspectors, accompanied by a representative of the Authority, to conduct verification of the places where Nuclear Material is located and where the activities are being conducted.

The reporting and access requirements are in the Additional Protocol, and are in addition to the reporting and access requirements of the Safeguards Agreement. The Additional Protocol requires that information be reported by the State on all nuclear-related activities and material that are not subject to the Safeguards Agreement. Under the Additional Protocol, the IAEA is granted expanded rights, including increased access to information and physical sites, beyond that which is available to the IAEA under the Safeguards Agreement. The Safeguards Agreement provides assurance related to declared activities and declared Nuclear Material. The Additional Protocol was designed to enhance nuclear non-proliferation by enabling the IAEA to verify completeness as well as correctness of Declarations by the State.

System Elements

Under the Additional Protocol, the State is obligated to provide the IAEA with Declarations on nuclear activities that are undertaken in the State (or any place outside the State where these activities are funded, specifically authorised or controlled by, or carried out by or on behalf of the State) and to provide the IAEA with sufficient access to information in order to resolve questions relating to the accuracy and completeness of the Declarations. In order to ensure compliance with the Additional Protocol, organisations and entities in the State performing specified activities will be required to report information to the Authority concerning the following:

- Nuclear Fuel Cycle-Related R&D Activities not involving Nuclear Material.
- Buildings on the Sites and the activities conducted there.
- Manufacture or Construction of specified Nuclear Fuel cycle-related equipment and non-Nuclear Material (as listed in Annex B to this guidance).
- Uranium mines and plants where uranium and thorium are concentrated.
- Possession, import, and export of “impure” uranium and thorium.
- Nuclear Material on which IAEA safeguards has been exempted.
- Intermediate or high-level waste containing Nuclear Material on which IAEA safeguards have been terminated (see Reference 2).
- Import and export of specified Nuclear Fuel cycle-related equipment and non-Nuclear Material (as listed in Annex C to this guidance).
- Future plans - general plan for succeeding ten-year period relevant to the development of the Nuclear Fuel cycle-related activities (including planned Nuclear Fuel Cycle-Related R&D Activities) when approved by the appropriate authorities in the State.

Under the Additional Protocol, the State is also obligated to provide IAEA inspectors physical access to Locations. Once approved by the IAEA Board of Governors, and following consultations with the State and Authority, the State is obligated under the Additional Protocol to provide access beyond the Locations included by the State in a Declaration for collection of environmental samples.

These system elements are discussed in more detail in Articles (5) to (15) of this guidance.

Reporting under the Additional Protocol

Article (5)

Additional Protocol Reports and Information

FANR-REG-10 requires persons or entities conducting specified Nuclear Fuel cycle-related activities to submit reports to the Authority providing information concerning the activities. The requirements derive from the commitments made under Articles 2 and 3 of the Additional Protocol. A list of the specified Nuclear Fuel cycle-related activities subject to reporting under the Additional Protocol was provided in Article (4) of this guidance under the paragraph relating to "System Elements". This Article (5) outlines the information requirements and the general forms that are to be used to report the required information to the Authority. The number and type of forms to be used, which are dependent upon the specific Reportable Activity being undertaken, are outlined in Articles (6) to (15) of this guidance and arranged by Reportable Activity. Copies of the forms themselves are provided in Annex A to this guidance.

General Requirements

In general, persons or entities conducting specified Nuclear Fuel cycle-related activities are required to submit an Initial Report to the Authority describing the activities and specifying the Location where the activities are being undertaken. The Initial Report should be updated periodically. If no changes have occurred since the previous report, this should also be reported.

- **Initial Report:** If you have never submitted a report to the Authority for a Reportable Activity for which a report is required, you should submit an Initial Report consisting of the forms listed for the type of Reportable Activity being undertaken. If you started a new Reportable Activity during the previous calendar year and your Site or Location has not previously been reported to the Authority, you should submit an Initial Report.
    - Persons or entities starting a new Reportable Activity at a Site or Location for which no previous report has been submitted to the Authority should submit an Initial Report at least 60 days before the Reportable Activity commences.
- **Annual Update Report:** If you previously submitted an Initial Report to the Authority for your Location, you should submit an Annual Update Report or a report indicating that there has been no change. If you started a new Reportable Activity during the previous calendar year and your Location has been reported to the Authority previously, you may include the new Reportable Activity in your Annual Update Report. If you have ceased to undertake a Reportable Activity that you reported during the previous calendar year for your Site/Location, you should include this information in your Annual Update Report.
    - Annual Update Reports should be submitted every year by 31 January.
- **Amended Report:** Changes to previously submitted information should be submitted in an Amended Report. Changes include additions or corrections to information regarding Reportable Activities, and corrections or changes to company information, e.g. corrections to address, changes in contact information, etc. If incorrect information is identified as the result of verification activity by the Authority or the IAEA, an Amended Report should be submitted. The forms to be used for the Amended Report are the same as the forms for the Initial Report or Annual Update Report.
    - Amended Reports should be submitted within 30 calendar days after a change in information occurs, an error is identified, or notification is received from the Authority that a change is required.

- Exceptions – other report due dates:
  - Processing of intermediate or high-level waste containing Nuclear Material on which IAEA safeguards have been terminated should be reported 210 days before the Processing begins.
  - Exports of specified Nuclear Fuel cycle-related equipment and non-Nuclear Material should be reported quarterly within the 20 days after the end of each quarter, i.e. by 20 April for the first calendar quarter (January-March), by 20 July for the second calendar quarter (April-June), by 20 October for the third quarter (July-September), and by 20 January for the final calendar quarter (October-December).
  - If confirmation of the import of specified Nuclear Fuel cycle-related equipment and non-Nuclear Material is requested by the Authority (for itself or on behalf of the IAEA), the information should be submitted within 30 calendar days.

Correct and complete information is important. Under the Additional Protocol, the IAEA has the right to physically verify the correctness and completeness of the information contained in the Declaration by exercising its right to Complementary Access. The right of the IAEA to Complementary Access is further outlined in Article (16) of this guidance. If the Authority or the IAEA identifies an inconsistency or inaccuracy in the Declaration, the information should be corrected and re-submitted as an Amended Report. If the IAEA makes a specific request for additional information about activities conducted outside a Site/Location which the IAEA considers might be functionally related to activities of the Site/Location, and the request is approved by the Authority, the additional information should be submitted to the Authority.

Quantities should be reported to three decimal places.

General Forms

Some forms are used for all or most Reportable Activities.

- **Form No. 1** - General Information. All reports include Form No. 1. The name and contact information should be provided for a Person that the Authority may contact for clarification of information provided in the report or for additional information; that Person should be familiar with the content of the reports, but need not be the Person who prepares the forms or certifies the report. Form No. 1 should be signed and dated by an officer or manager of the organization with the authority to certify for the organisation that the information reported in the form and all other attached forms is true and complete.
- **Form No. 2 –** Site/Location Information and Contact Information. Most reports include Form No. 2. A reporting code (based on Site Code or LOF Code) will be assigned by the Authority for each reporting Site or Location and should be used on forms for that Site or Location. The telephone number provided for the owner or Operator should be a number that is answered by a Person at all times during normal working hours; this number will be used to notify the owner or Operator immediately upon receipt of an IAEA request for Complementary Access. The names and contact information should be provided for a Person and an alternate Person that the Authority may contact if the IAEA requests Complementary Access to this Site or Location. The telephone numbers provided for the Person and alternate Person should be numbers that are answered by a Person at all times during normal working hours. These individuals should have sufficient authority to facilitate IAEA Complementary Access. If the Reportable Activities are carried out on a Site, a map of the Site should be attached to Form No. 2. Buildings where Reportable Activities are carried out should be identified on the Site map. Installations or buildings providing services essential to the nuclear activities of the Site should be included. The scale of the map and geographical orientation to the North should be indicated. Since the IAEA will use the map for making comparisons with information collected using satellite imagery, the map should be accurate and complete.

- **Form No. 3** – Building Information. If the Reportable Activities are carried out on a Site, the Site should report information concerning each building on the Site. The information provided in respect of the current uses of the building should be full and descriptive in nature covering, for example, laboratories, reactors, warehouses, cafeterias, etc. A description of the previous uses at the Site should be included and will be of particular relevance when previous uses involved Nuclear Material.

Articles (6) to (14) of this guidance outline the information requirements and forms to be used for reporting specific Reportable Activities.

Nuclear Fuel Cycle-Related R&D Activities

Article (6)

Requirement and Forms

FANR-REG-10 requires any Person, organisation or entity conducting Nuclear Fuel Cycle-Related R&D Activities to submit reports to the Authority with a general description of the research and development (R&D) and information specifying the Location of the activities.

If the R&D activities are conducted on a Site, the following report form also applies (to R&D activities with and without State involvement):

- Form No. 3 – Building Information

For R&D activities with State involvement, reporting is required if the R&D activity is related to any of the following processes or systems:

- Conversion of Nuclear Material
- Nuclear Fuel fabrication
- Reactors
- Critical facilities
- Processing of intermediate or high-level waste containing plutonium, high enriched uranium or uranium-233 (but excluding repackaging or conditioning for Storage or Disposal that does not involve the separation of elements. Note: Enrichment is prohibited by State law)

For R&D with no State involvement, reporting is required if the R&D is related to the following processes or systems:

- Processing of intermediate or high-level waste containing plutonium, high enriched uranium or uranium-233 (but excluding repackaging or conditioning for Storage or Disposal that does not involve the separation of elements. Note: Enrichment is prohibited by State law)

If the R&D activities are funded, specifically authorised, licensed, funded, controlled by, or carried out on the behalf of the State, the following report forms apply:

- Form No. 1 – General Information
- Form No. 2 – Site/ Location Information and Contact Information
- Form No. 4 – R&D (Not Involving Nuclear Material) With State Involvement

If the R&D activities are <u>not</u> funded, specifically authorised, licensed, or controlled by, or carried out on the behalf of the State, the following report forms apply:

- Form No. 1 – General Information
- Form No. 2 – Site/Location Information and Contact Information

- Form No. 5 – R&D (Not Involving Nuclear Material) With No State Involvement

Explanations and Clarifications

"State involvement" is intended to cover any Nuclear Fuel Cycle-Related R&D Activity in respect of which the State is involved either in pursuit of its own interests or on behalf of any other entity. Examples of State involvement would be ownership, funding, administrative control, licensing, etc. State involvement is included as a criterion because different requirements are outlined in the Additional Protocol for reporting research based upon whether there is any State involvement or not.

"Nuclear Fuel Cycle-Related R&D Activities" is to be taken in the broad sense and to include R&D to improve the performance of an existing process or system and components of a multi-component R&D project. Reportable R&D activities include technology development, Safety-related studies, and computer modelling that extend knowledge resulting from theoretical or basic scientific research into a Nuclear Fuel cycle-related application. Reportable R&D activities do not include theoretical or basic scientific research; R&D on health and environmental effects, improved Maintenance, or non-nuclear applications such as industrial radioisotopes, medical, hydrological and agricultural applications. R&D is considered to be "theoretical or basic scientific research" if it addresses some basic or fundamental aspect of a process and is developed from established principles, but does not have a direct application to the development of the specified processes or systems.

Buildings on the Sites of Nuclear Facilities and the Activities Conducted There

Article (7)

Requirement and Forms

FANR-REG-10 requires Licensees to submit information to the Authority concerning the Site, buildings on the Site, and all activities conducted in the buildings. If requested by the Authority, Licensees are required to submit information concerning R&D activities conducted by the Licensee outside of the Site, which the Authority considers functionally related to activities of the Site. Licensees should use the following report forms:

- Form No. 1 – General Information
- Form No. 2 – Site/Location Information and Contact Information
- Form No. 3 – Building Information

Licensees are also required to inform the Authority before beginning any Reportable Activity that may be subject to the Additional Protocol or any modifications made to the Facility or Site.

Explanations and Clarifications

A primary objective of strengthened safeguards is to provide assurance that no undeclared Nuclear Material or Reportable Activities are co-located with Nuclear Facilities and LOFs in order to use human resources, technology, equipment and services in place to support elements of the declared programme. Information provided by this Article (7) and Complementary Access will be the basis for actions to obtain credible assurance regarding the absence of undeclared Nuclear Material and Reportable Activities on Sites. It will be used for planning Complementary Access to the Sites of Facilities and LOFs and for evaluation of consistency with the results of access activities and other information available to the IAEA.

Refer to Article (5) of this guidance for clarification in respect of these forms.

Nuclear Fuel Cycle-Related Equipment and Non-Nuclear Material

Article (8)

Requirement and Forms

FANR-REG-10 requires reporting of activities related to the manufacture, assembly, or Construction of the following Nuclear Fuel cycle-related equipment and non-Nuclear Material:

- Centrifuge rotor tubes or the assembly of gas centrifuges
- Diffusion barriers
- Laser-based systems
- Electromagnetic isotope separators
- Columns or extraction equipment
- Aerodynamic separation nozzles or vortex tubes
- Uranium plasma generation systems
- Zirconium tubes
- Heavy water or deuterium
- Nuclear grade graphite
- Flasks for irradiated fuel
- Reactor control rods
- Criticality safe tanks and vessels
- Irradiated fuel element chopping machines
- Hot cells

The following report forms are to be used for this Reportable Activity:

- Form No. 1 – General Information
- Form No. 2 – Site/Location Information and Contact Information
- Form No. 6 – Nuclear-Related Manufacturing, Assembly, or Construction Activities

Explanations and Clarifications

The purpose of this Article (8) is to obtain sufficient information to provide a basis for assurances that manufacturing activities in the limited but very important areas covered by Annex B are consistent with a State's declared programme and that these activities are used only to support the declared programme. This information will provide the IAEA with an overview of the infrastructure directly supporting the State’s Nuclear Fuel cycle-related activities and contribute to the transparency of the State’s nuclear and nuclear-related activities. A brief description of the Reportable Activity and its products will be sufficient for the IAEA to determine their relationship to the State's Nuclear Fuel cycle-related activities and programme.

If several manufacturing, assembly or Construction activities are conducted at this Site/Location, a separate Form No. 6 should be submitted for each Reportable Activity. Detailed information concerning the listed manufacturing, assembly, or Construction activities is provided in Annex B and Annex C to this guidance.

Mines and Concentration Plants

Article (9)

Requirement and Forms

FANR-REG-10 requires reporting of activities involving uranium mining and concentration of uranium or thorium e.g. in-situ leach mines and activities involving ore Processing. The following report forms are to be used:

- Form No. 1 – General Information
- Form No. 2 – Site/Location Information and Contact Information
- Form No. 7 – Uranium and Thorium Concentration Plants and Uranium Mines

Explanations and Clarifications

The purpose of this Article (9) is to contribute to the completeness of the Authority/IAEA's knowledge of all of the State's holdings of Nuclear Material. This includes the capacity to produce Source Material, both in operating or closed-down mines. The information, together with information on inventories, imports and exports of Nuclear Material, would be used to assess the consistency of these holdings with the State's declared nuclear programme.

If several mining or concentration operations are conducted at this Site/Location, a separate Form No. 7 should be submitted for each Reportable Activity.

Impure Source Material

Article (10)

Requirement and Forms

FANR-REG-10 requires that information be reported on imports, exports and possession of ‘‘impure’’ Source Material. “Impure” Source Material, for the purposes of the Additional Protocol, refers to uranium or thorium that has not been processed to the composition or purity that is suitable for fuel fabrication or for being isotopically enriched; i.e. it is not in the form of purified chemical products such as UF_6, U metal, or U_3O_8. The following forms are to be used for reports concerning Impure Source Material:

- Form No. 1 – General Information
- Form No. 2 – Site/Location Information and Contact Information
- Form No. 8 – Holdings, Export, and Import of Impure Source Material

Explanations and Clarifications

The purpose of this Article (10) is to complement the information already provided through Nuclear Material accounting reports pursuant to Articles 58-64 and 66 of the Safeguards Agreement, and thereby provide the IAEA with as complete a picture as practical of all Nuclear Material within the State relevant to actual or potential nuclear activities within the State. The information may be used to confirm the consistency between the State's declared nuclear programme and its holdings of Nuclear Material. The information on exports and imports of Nuclear Material for non-nuclear purposes, in conjunction with the information on exports and imports for other than non-nuclear purposes reported pursuant to Articles 33(a) and (b) of the Safeguards Agreement, provides the IAEA with as complete a picture as is practical of the State's international transfers of Nuclear Material. It may be used to confirm the consistency of the exports and imports of Nuclear Material with the State's declared holdings and with imports and exports declared by other States.

A separate set of forms (Forms numbers 1, 2 and 8) for each uranium mine, each uranium concentration plant, and each thorium concentration plant at a Location should be submitted. (A concentration plant is a place where uranium and/or thorium are chemically concentrated from ore or by-product materials into a form for further Processing).

Description of Intended Use" means a brief description of the end-use of the impure source material, whether nuclear or non-nuclear (e.g. ceramics, paint, electronic components, conversion for uranium Enrichment, etc.).

A separate entry should be made for each export and a separate entry should be made for each import. The information on exports and imports may be used by the IAEA to confirm the consistency of the exports and imports of this Nuclear Material with declared holdings and with imports and exports declared by other States. If an export is shipped to an interim destination before shipment to its final destination, the interim destination should be reported along with the final destination (importing State).

The chemical composition is that of the Source Material, e.g., U_3O_8, or ThO_2.

Do not include Nuclear Material in this report once it is in its non-nuclear end-use form.

Note that import, export, re-export, transit or trans-shipment of Impure Source Material (and other items) is subject to licensing by the Authority (contact Fanr.sglicensing@fanr.gov.ae for more information).

Nuclear Material Exempted from Safeguards

Article (11)

Requirement and Forms

FANR-REG-10 requires reports on holdings of Nuclear Material exempted from Safeguards. The following report forms are used:

Form No. 1 – General Information

Form No. 2 – Site/Location Information and Contact Information

Form No. 9 – Holdings of IAEA Safeguards-Exempted Nuclear Material

Explanations and Clarifications

The purpose of this Article (11) is to complement the information already provided through Nuclear Material accounting reports pursuant to paragraphs 58-64 and 66 of the Safeguards Agreement, and thereby provide the IAEA with as complete a picture as practical of all Nuclear Material within the State relevant to actual or potential nuclear activities within the State. The information may be used to confirm the consistency between the State's declared nuclear programme and its holdings of Nuclear Material.

Articles 35(b) and 36 of the Safeguards Agreement, allow for some Nuclear Material to be exempted from Safeguards under specified conditions. Holdings of Nuclear Material at a Site/Location, which were exempted pursuant to the Safeguards Agreement, should be reported under the Additional Protocol. If you have holdings of more than one type of Nuclear Material that have been exempted from Safeguards, a separate form should be submitted to report holdings of each of the Nuclear Materials (e.g. thorium, plutonium, uranium) held at the Location/Site.

Form No. 9 requires reporting of quantities of holdings of Nuclear Material. The entry should be the element weight in kilograms for natural and depleted uranium and thorium and in grams for plutonium, uranium-233 and enriched uranium.

Nuclear Material Waste Terminated from IAEA Safeguards

Article (12)

Requirement and Forms

FANR-REG-10 determines that the Design, Construction, development and Operation of Facilities for Enrichment or Reprocessing are prohibited in the State as set forth in Article (2)(2) of the Law.

Explanations and Clarifications

Following the fact that the Reprocessing activities are prohibited by Article (2)(2) of the Law, any entity involved in Reprocessing activities is not permitted to further process the intermediate or high level waste containing plutonium, high enriched uranium or uranium-233 in the State.

Export/Import of Nuclear Fuel Cycle-Related Equipment and Non-Nuclear Material

Article (13)

Requirement and Forms

FANR-REG-10 requires reports concerning exports and imports of the following equipment and non-Nuclear Material:

- Reactors and non-Nuclear Material for reactors
- Plants for the reprocessing of irradiated fuel elements, and equipment especially designed or prepared for said plants
- Plants for fabrication of fuel elements
- Plants for the separation of isotopes of uranium and equipment (other than analytical instruments) especially designed or prepared for said plants
- Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared for said plants
- Plants for the conversion of uranium and equipment especially designed or prepared for said plants

The following report forms are to be used for reporting exports of such equipment and material:

- Form No. 1 – General Information
- Form No. 2 – Site/Location Information and Contact Information
- Form No. 10 – Export of Specified Equipment and Non-Nuclear Material

The following report forms are used for reporting imports of such equipment and material:

- Form No. 1 – General Information
- Form No. 2 – Site/Location Information and Contact Information
- Form No. 11 – Confirmation of Import of Equipment or Non-Nuclear Material

Explanations and Clarifications

Detailed information concerning a list of equipment and non-Nuclear Material is provided in Annex C to this guidance.

The purpose of this Article (13) is to obtain information on the State's international transfers in the areas covered by Annex C. The information will contribute substantially to the transparency of the State's nuclear and nuclear-related activities and to the IAEA's understanding of these activities. The information on international transfers of equipment and non-Nuclear Material covered by Annex C may be compared for consistency with the declared nuclear programmes of other States. This will provide indications of where transfers are occurring or where an infrastructure exists that could support nuclear activities that are not part of declared nuclear programmes.

Each export of specified equipment and non-Nuclear Material should be reported on a separate form. Imports should be confirmed upon request by the Authority (for itself or on behalf of the IAEA), and each confirmed import should be reported on a separate form. Export reports should be accumulated and submitted to the Authority quarterly (on 15 April, 15 July, 15 October, and 15 January). Import reports should be submitted as and when requested.

For exports, the date shipped should be a single entry indicating the date the item was actually shipped. For imports, the date received should be a single entry indicating the date the item was actually received. If the items have not been received (but a shipment is expected), this should be noted with the entry "not received" in place of the date. Item identification information should clearly identify the items that were imported or exported.

Note that import, export, re-export, transit or trans-shipment of nuclear-related items and import, export and re-export of dual-use items are subject to licensing by the Authority. See FANR-REG-09 for more information, or contact Fanr.sglicensing@fanr.gov.ae.

Future Plans

Article (14)

Requirement and Forms

FANR-REG-10 requires any Person, organisation, or entity planning to start Nuclear Fuel cycle-related activities (e.g. R&D or Construction of a new Facility) to submit reports to the Authority with a general plan for the succeeding ten-year period relevant to the development of the Nuclear Fuel cycle-related activities (including planned Nuclear Fuel Cycle-Related R&D Activities) once approved by the appropriate authorities in the State. The following report forms are to be used for reporting of requested information:

- Form No. 1 – General Information
- Form No. 12 – Future Plans

Explanations and Clarifications

The submitted information should include all general Government and private sector plans approved by the appropriate authorities for the succeeding ten-year period. Reports under this Article (14) are not to be understood as a substitute for early provision of Design information.

The future plans for development of the Nuclear Fuel cycle-related activities should include a brief statement of the development plans, including the intended results, any target completion dates or overall schedule for the development, and the Locations involved. For developments leading to a new Nuclear Facility, once development has reached the point that reporting requirements are as stipulated under the early provision of Design Information, it should not be included in subsequent reports. Similarly, when other development plans reach the point of implementation and thus become reportable under another article of the Additional Protocol, the corresponding entries under this Article (14) should indicate this and not be included in subsequent reports.

The future plans for Nuclear Fuel Cycle-Related R&D Activities should include a general description of each R&D plan, its overall objectives, any target date or overall schedule for the R&D and the Locations involved.

Request for Amplification or Clarification

Article (15)

Requirement and Forms

If a request is made by the Authority (for itself or on behalf of the IAEA) for additional explanatory information in respect of any of the Reportable Activities, Licensees should respond with:

- Form No. 13 - Response to Request for Supplemental Information
- All other forms that are appropriate to the Reportable Activity, as listed above.

These forms should be completed and submitted within 30 calendar days after receipt of the request from the Authority.

The Authority may also request (for itself or on behalf of the IAEA) information about a location on an adjoining address outside your Location, which the IAEA suspects might be functionally related to the Nuclear Fuel cycle-related activities of your Location.

Complementary Access (CA)

Article (16)

In accordance with FANR-REG-10, Persons and entities conducting specified activities are required to allow IAEA inspectors, accompanied by a representative of the Authority, to conduct verification. The requirement derives from the commitments made under Articles 4 to 10 of the Additional Protocol. A list of the places, Sites, Locations, and activities subject to verification under the Additional Protocol is provided in Article (4) of this guidance. The Additional Protocol provides for IAEA inspectors to have Complementary Access to assure the absence of undeclared Nuclear Material and Reportable Activities or to resolve questions or inconsistencies in the information a State has provided about its nuclear activities.

The IAEA is required under the Additional Protocol to provide advance notice of any proposed Complementary Access activity that it intends to undertake. Contact is made through the Authority, and the Authority notifies the Site/Facility/Location of the intended Complementary Access activity. The advance notice provided by the IAEA shall, in most cases, be provided to the Authority at least 24 hours in advance of the intended Complementary Access activity being undertaken. Advance notice will be shorter for Complementary Access to any place on a Site that is sought in conjunction with Design information verification or ad hoc or routine Inspections (conducted under the Safeguards Agreement) at that Site, in which case at a minimum, at least two hours' advance notice will be provided - unless the circumstances are exceptional. FANR-REG-10 requires Persons or entities conducting Reportable Activities, upon notification by the Authority, to allow IAEA inspectors access to facilities and material. Access should be provided within 24 hours of receipt of the request for Complementary Access by the Authority or within 2 hours of receipt by the Authority of the request for Complementary Access during Design Information Verification or ad hoc or routine Inspections (conducted under the Safeguards Agreement).

Persons or entities conducting Reportable Activities should establish a programme for facilitating and assisting with Complementary Access activities. The contact information that is required in Form No. 2, which is described in Article (5) of this guidance, should be kept current.

The activities carried out during Complementary Access could include visual observation, examination of records, sample collection, environmental sampling (i.e. collection of samples from air, water, vegetation, or soil, or swipes from surfaces), use of radiation detection and measurement devices, application of seals and other identifying and tamper-indicating devices, and other objective measures. In general, the objective of the verification activities under the Additional Protocol is to verify the correctness and completeness of information declared in reports and to provide assurance of the absence of any undeclared Nuclear Material and Reportable Activities at the Site or Location being inspected.

Upon request by the Authority, arrangements can be made with the IAEA for "managed access" (procedures to protect sensitive or classified information or, to meet safety or physical protection requirements, while allowing the IAEA to accomplish the purpose of a request for Complementary Access). The IAEA should agree to managed access, but the managed access should not interfere with the IAEA objective of providing assurance of the absence of any undeclared Nuclear Material and Reportable Activities at the Site or Location being inspected.

References

Article (17)

1. Protocol Additional to the Agreement between the United Arab Emirates and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons", IAEA INFCIRC/622/Add.1 (19 January 2011)
2. "Agreement between the United Arab Emirates and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons," IAEA INFCIRC/622 (23 December 2003)
3. UAE Federal Law by Decree No. 6 of 2009, "Concerning the Peaceful Uses of Nuclear Energy"
4. FANR regulation, FANR-REG-10, "Regulation for the System of Accounting for and Control of Nuclear Material and Application of Additional Protocol"

The following documents are not specifically cited in this guidance but provide additional information that may be helpful in establishing a programme for fulfilling the commitments of the Additional Protocol:

1. "Guidelines and Format for Preparation and Submission of Declarations Pursuant to Articles 2 and 3 of the Model Protocol Additional to Safeguards Agreements," IAEA Services Series 11 (Vienna, May 2004)
2. "Nuclear Material Accounting Handbook," IAEA Services Series 15 (Vienna, May 2008).
3. "Guidance for States Implementing Comprehensive Safeguards Agreements and Additional Protocols", IAEA Services Series 21 (Vienna, December 2014).

ANNEX A

Additional Protocol report forms:

Form No. 1 – General Information

Form No. 2 – Site/Location Information and Contact Information

Form No. 3 – Building Information

Form No. 4 – R&D (Not Involving Nuclear Material) With State Involvement

Form No. 5 – R&D (Not Involving Nuclear Material) With No State Involvement

Form No. 6 – Nuclear-Related Manufacturing, Assembly, or Construction Activities

Form No. 7 – Uranium and Thorium Concentration Plants and Uranium Mines

Form No. 8 – Holdings, Export, and Import of Impure Source Material

Form No. 9 – Holdings of IAEA Safeguards-Exempted Nuclear Material

Form No. 10 – Export of Specified Equipment and Non-Nuclear Material

Form No. 11 – Confirmation of Import of Equipment or Non-Nuclear Material

Form No. 12 – Future Plans

Form No. 13 – Response to Request for Supplemental Information

These forms are available in editable Microsoft Word format from either the FANR website or will be provided by FANR after a request to fanr.sglicensing@fanr.gov.ae.

ADDITIONAL PROTOCOL REPORT		
Form No. 1 – General Information		
Expand cells when filling in report information and attach additional forms as necessary.		
1. 1.	REPORTING YEAR	(YYYY):
1.2.	NAME OF COMPANY OR ORGANISATION	
1.3.	POSTAL ADDRESS	
1.4.	PERSON TO CONTACT ABOUT THIS REPORT	Name: Telephone Number: Fax Number: E-mail Address:
1.5.	TYPE OF REPORT (check one box only)	☐ Initial Report ☐ Annual Update Report ☐ Amended Report Year of report to be amended (YYYY): ☐ Type of report (See name of the Form: Supplemental Information Report
1.6.	NUMBER OF EACH FORM ATTACHED TO FORM NO. 1	Form No. 2 ________ Form No. 7 ________ Form No. 12 ________ Form No. 3 ________ Form No. 8 ________ Form No. 13 ________ Form No. 4 ________ Form No. 9 ________ Form No. 5 ________ Form No. 10 _______ Form No. 6 ________ Form No. 11 ________
1.7.	NO CHANGE	☐ Check this box to certify that all of the information for the reporting year listed in 1.1 is exactly the same as the information you submitted in the immediately prior Initial Report Annual Update Report, or Amended Report for this Reportable Activity, Site, or Location. If you can certify that the information is unchanged, this is the only form you should submit for this Reportable Activity for this year.
CERTIFICATION		
1.8.	I certify that I have reviewed the information in this document and its attachments and that, to the best of my knowledge, the information submitted is true and complete. Name of Responsible Official (typed or printed): Title of Responsible Official (typed or printed):	
	Signature of Responsible Official:	Date Signed: DD-MONTH IN WORDS-YYYY

ADDITIONAL PROTOCOL REPORT		
Form No. 2 – Site/Location Information and Contact Information		
Submit a separate form for each Site or Location where Reportable Activities are conducted. ["Site" and "Location" and "Reportable Activities" are defined in Article (1) of FANR-RG-015. This form consists of two pages].		
2.1.	NAME OF SITE/LOCATION WHERE REPORTABLE ACTIVITIES TAKE PLACE	
2.2.	REPORTING CODE	
2.3.	STATUS OF INFORMATION REPORTED	☐ New information reported ☐ Information reported previously about the Reportable Activity has changed ☐ Information reported previously about the Reportable Activity has <u>not</u> changed
2.4.	NAME OF OWNER OR OPERATOR	Name: Telephone Number (24-hour): Fax Number (24-hour):
2.5.	ADDRESS OF PHYSICAL SITE/LOCATION WHERE REPORTABLE ACTIVITIES TAKE PLACE	
2.6	GEOGRAPHIC COORDINATES OF SITE/LOCATION	Latitude: Longitude:
Designate a Person to contact and at least one alternate Person in the case of requests by the Authority for IAEA Complementary Access to this Site/Location. The Authority should be able to contact the primary or alternate Person named immediately upon notification by the IAEA.		
2.7.	PERSON TO CONTACT FOR ACCESS	Name: Primary Telephone Number: Alternate Telephone Number: Fax Number: E-mail Address:
2.8.	ALTERNATE PERSON TO CONTACT FOR ACCESS	Name: Primary Telephone Number: Alternate Telephone Number: Fax Number: E-mail Address:
If the Reportable Activities are conducted on a Site, attach a Site map, drawn to scale.		
2.9.	ARE THE REPORTABLE ACTIVITIES CONDUCTED ON A SITE?	☐ YES ☐ NO

ADDITIONAL PROTOCOL REPORT		
Form No. 2 – Site/Location Information and Contact Information		
2.10.	SITE MAP	Is a Site map attached? ☐ YES ☐ NO

ADDITIONAL PROTOCOL REPORT		
Form No. 3 – Building Information		
Submit a separate form for each building on your Site where Reportable Activities are conducted. ["Site" and "Reportable Activities" are defined in Article (1) of FANR-RG-015.]		
3.1.	REPORTING CODE	
3.2.	BUILDING NAME OR NUMBER	[Identification name or number of building as it appears on the Site map attached to Form No. 2 – Site/Location Information and Contact Information]
3.3.	REPORTING STATUS OF BUILDING	☐ New building ☐ Building with changes ☐ Building with no changes ☐ Building no longer exists
Size of building (including basements and sub-basements) and area		
3.4.	FLOORS IN BUILDING	Total Number:
3.5.	AREA OF EACH FLOOR (IN SQUARE METERS)	[List each floor individually, starting from the bottom of the building, with its area.]
Use of building		
3.6.	CURRENT USE	[Describe the use of the building and, if not apparent from the stated use, the main contents of the building.]
3.7.	PREVIOUS USE	[Describe all previous nuclear-related uses of the building, if any.]

ADDITIONAL PROTOCOL REPORT		
Form No. 4 – R&D (Not Involving Nuclear Material) With State Involvement		
Submit a separate form for each Nuclear Fuel Cycle-Related R&D Activity carried out on your Site/Location that does not involve Nuclear Material and that is carried out, authorised, controlled, Licensed, or funded by the UAE. [This form consists of two pages.]		
4.1.	REPORTING CODE	
4.2.	NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY NUMBER (OR OTHER IDENTIFIER)	
4.3.	NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY TITLE	
4.4.	REPORTING STATUS OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	☐ New Reportable Activity ☐ Reportable Activity with changes ☐ Reportable Activity with no changes ☐ Reportable Activity has ceased
4.5.	PLACE WHERE NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY IS CONDUCTED	[List building name(s) or number(s) and any additional information that defines more precisely where the Nuclear Fuel Cycle-Related R&D activity is carried out, e.g. room number(s).]
4.6.	TIME LINE OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	Date when the Reportable Activity started: DD-MONTH IN WORDS-YYYY Estimated Reportable Activity end date: DD-MONTH IN WORDS-YYYY
4.7.	PROCESS OR SYSTEM TO WHICH NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY IS RELATED	☐ Conversion of Nuclear Material ☐ Nuclear Fuel Manufacture ☐ Reactors ☐ Critical Facilities ☐ Processing of intermediate or high-level waste containing plutonium, high enriched uranium or uranium-233.
4.8.	LEVEL OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	(Check the one box that best describes the stage of development of the technology in the Nuclear Fuel Cycle-Related R&D Activity) ☐ Theoretical Analysis ☐ Demonstration ☐ Experiment ☐ Feasibility Study ☐ Conceptual Design ☐ Prototype ☐ Proof of Concept
4.9.	DESCRIPTION OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	[Provide a general description of the Nuclear Fuel Cycle-Related R&D Activity.]

ADDITIONAL PROTOCOL REPORT		
Form No. 4 – R&D (Not Involving Nuclear Material) With State Involvement		
4.10.	NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY OBJECTIVE	[Provide a brief description of the objective of the Nuclear Fuel Cycle-Related R&D Activity and the intended application of the R&D results.]
Information concerning the principal State Government Agency Involved in the Nuclear Fuel Cycle-Related R&D Activity.		
4.11.	DEPARTMENT/AGENCY	Name: Address:
4.12.	CONTACT PERSON AT DEPARTMENT/AGENCY	Name of Contact Person: Telephone Number of Contact Person: Fax Number of Contact Person:
4.13.	NATURE OF INVOLVEMENT	[Describe the nature of the involvement of the State Government agency, e.g. funding]
Provide the names and locations of all other sponsors and/or collaborators, both foreign and domestic, Government and non-Government, for this Nuclear Fuel Cycle-Related R&D Activity. [Space is provided for up to three. Add additional cells, if necessary.]		
4.14.	Organisation Name: Address: Country:	
4.15	Organisation Name: Address: Country:	
4.16	Organisation Name: Address: Country:	

ADDITIONAL PROTOCOL REPORT

Form No. 5 – R&D (Not Involving Nuclear Material) With No State Involvement

Submit a separate form for each Nuclear Fuel Cycle-Related R&D Activity carried out on your Site/Location that does <u>not</u> involve Nuclear Material and that is that is <u>not</u> funded, controlled, or specifically authorized by the State. [This form consists of two pages.]

5.1.	REPORTING CODE	
5.2.	NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY NUMBER (OR OTHER IDENTIFIER)	
5.3.	NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY TITLE	
5.4.	REPORTING STATUS OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	☐ New Reportable Activity ☐ Reportable Activity with changes ☐ Reportable Activity with no changes ☐ Reportable Activity has ceased
5.5.	PLACE WHERE NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY IS CONDUCTED	[List building name(s) or number(s) and any additional information that defines more precisely where the Nuclear Fuel Cycle-Related R&D Activity is carried out, e.g. room number(s)]
5.6.	TIME LINE OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	Date when the Reportable Activity started: DD-MONTH IN WORDS-YYYY Estimated Reportable Activity end date: DD-MONTH IN WORDS-YYYY
5.7.	PROCESS OR SYSTEM TO WHICH NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY IS RELATED	☐ Processing of intermediate or high-level waste containing plutonium, high enriched uranium or uranium-233.
5.8.	LEVEL OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	(Check the one box that best describes the stage of development of the technology in the Nuclear Fuel Cycle-Related R&D Activity) ☐ Theoretical Analysis ☐ Demonstration ☐ Experiment ☐ Feasibility Study ☐ Conceptual Design ☐ Prototype ☐ Proof of Concept
5.9.	DESCRIPTION OF NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY	[Provide a general description of the Nuclear Fuel Cycle-Related R&D Activity]
5.10.	NUCLEAR FUEL CYCLE-RELATED R&D ACTIVITY OBJECTIVE	[Provide a brief description of the objective of the Nuclear Fuel Cycle-Related R&D Activity and the intended application of the R&D results]

ADDITIONAL PROTOCOL REPORT	
Form No. 5 – R&D (Not Involving Nuclear Material) With No State Involvement	
Provide the names and locations of all sponsors and/or collaborators, both foreign and domestic, Government and non-Government, for this Nuclear Fuel Cycle-Related R&D Activity.	
5.14.	Organisation Name: Address: Country:
5.15	Organisation Name: Address: Country:
5.16	Organisation Name: Address: Country:

ADDITIONAL PROTOCOL REPORT		
Form No. 6 – Nuclear-Related Manufacturing, Assembly, or Construction Activities		
Submit a separate form for each nuclear-related manufacturing, assembly, or Construction Activity at your Location.		
6.1.	REPORTING CODE	
6.2.	REPORTABLE ACTIVITY	☐ (i) Manufacture of centrifuge rotor tubes or the assembly of gas centrifuges ☐ (ii) Manufacture of diffusion barriers ☐ (iii) Manufacture or assembly of laser-based systems ☐ (iv) Manufacture or assembly of electromagnetic isotope separators ☐ (v) Manufacture or assembly of columns or extraction equipment ☐ (vi) Manufacture of aerodynamic separation nozzles or vortex tubes ☐ (vii) Manufacture or assembly of uranium plasma generation systems ☐ (viii) Manufacture of zirconium tubes ☐ (ix) Manufacture or upgrading of heavy water or deuterium ☐ (x) Manufacture of nuclear grade graphite ☐ (xi) Manufacture of flasks for irradiated fuel ☐ (xii) Manufacture of reactor control rods ☐ (xiii) Manufacture of criticality safe tanks and vessels ☐ (xiv) Manufacture of irradiated fuel element chopping machines ☐ (xv) Construction of hot cells
6.3.	REPORTING STATUS OF REPORTABLE ACTIVITY	☐ New Reportable Activity ☐ Reportable Activity with changes ☐ Reportable Activity with no changes ☐ Reportable Activity has ceased
6.4.	PLACE WHERE REPORTABLE ACTIVITY IS CONDUCTED	[List building name(s) or number(s) and any additional information that defines more precisely where the Reportable Activity is carried out, e.g. room number(s). If a Site map is attached, the number should be the same as the number used on the Site map]
6.5.	ACTUAL PRODUCTION	Approximate annual production for the past calendar year: [Production may be expressed in terms of items or kilograms] ☐ Items ☐ Kilograms

ADDITIONAL PROTOCOL REPORT

Form No. 7 – Uranium Mines and Uranium and Thorium Concentration Plants

Submit a separate form for each uranium mine, uranium concentration plant, or thorium concentration plant.

7.1.	REPORTING CODE		
7.2.	REPORTING STATUS OF REPORTABLE ACTIVITY	☐ New Reportable Activity ☐ Reportable Activity with changes ☐ Reportable Activity with no changes ☐ Reportable Activity has ceased	
7.3.	CONTACT PERSON AT SITE/ LOCATION	Name: Telephone Number: Fax Number:	
7.4.	ADDRESS OF PHYSICAL SITE/LOCATION		
7.5.	GEOGRAPHIC COORDINATES OF SITE/LOCATION	Latitude: Longitude:	
7.6.	PLACE WHERE REPORTABLE ACTIVITY IS CONDUCTED	[List building name(s) or number(s) and any additional information that defines more precisely where the Reportable Activity is carried out, e.g. room number(s). If the building is on a Site and a Site map is attached, the number should be the same as the number used on the Site map]	
7.7	TYPE OF OPERATION	☐ Open-Pit or Surface Mine ☐ Underground Mine ☐ Conventional Mill ☐ Phosphate By-Product Plant ☐ In-Situ Leach Mine ☐ Ore Concentration Plant ☐ Other Concentration Plant	
7.8	OPERATIONAL STATUS	☐ Operating ☐ Temporarily closed-down but capable of operating ☐ Closed-down, not capable of operating	
7.9	ANNUAL PRODUCTION CAPACITY	Uranium (element in metric tons)	Thorium (element in metric tons)
7.10	PAST CALENDAR YEAR ACTUAL PRODUCTION	Uranium (element in metric tons)	Thorium (element in metric tons)

ADDITIONAL PROTOCOL REPORT

Form No. 8 – Holdings, Export, and Import of Impure Source Material

Submit the following information for each Site/Location at which one or more one metric tons of uranium and/or thorium is present. [This form consists of two pages.]

8.1.	REPORTING CODE	
8.2.	REPORTING STATUS OF REPORTABLE ACTIVITY	☐ New Reportable Activity ☐ Reportable Activity with changes ☐ Reportable Activity with no changes ☐ Reportable Activity has ceased

Information concerning holdings of uranium and thorium

		uranium	**thorium**
8.3.	QUANTITY	(in metric tons)	
8.4.	CHEMICAL FORM AND COMPOSITION		
8.5.	USE OR INTENDED USE	☐ Nuclear ☐ Non-Nuclear	☐ Nuclear ☐ Non-Nuclear
8.6.	INTENDED USE		
8.7.	PHYSICAL LOCATION	[List building name(s) or number(s) and any additional information that defines more precisely where the material is located. If the building is on a Site and a Site map is attached, the number should be the same as the number used on the Site map.]	

Submit the following information for each export of one or more one metric tons of impure uranium or thorium for specifically non-nuclear purposes. [If there were more than two exports, insert additional cells.]

8.8.a	QUANTITY	(in metric tons)
8.9.a	CHEMICAL FORM AND COMPOSITION	
8.10.a	DATE EXPORTED	DD-MONTH IN WORDS-YYYY
8.11.a	IMPORTING State	
8.12.a	DESCRIPTION OF INTENDED USE	

ADDITIONAL PROTOCOL REPORT		
Form No. 8 – Holdings, Export, and Import of Impure Source Material		
Additional export(s) of Impure Source Material.		
8.8.b	QUANTITY	(in metric tons)
8.9.b	CHEMICAL FORM AND COMPOSITION	
8.10.b	DATE EXPORTED	DD-MONTH IN WORDS-YYYY
8.11.b	IMPORTING State	
8.12.b	DESCRIPTION OF INTENDED USE	
Submit the following information for each import of one or more one metric tons of impure uranium or thorium for specifically non-nuclear purposes. [If there were more than two imports, insert additional cells.]		
8.13.a	QUANTITY	(in metric tons)
8.14.a	CHEMICAL FORM AND COMPOSITION	
8.15.a	DATE IMPORTED	DD-MONTH IN WORDS-YYYY
8.16.a	EXPORTING State	
8.17.a	DESCRIPTION OF INTENDED USE	
Additional import(s) of Impure Source Material.		
8.13.b	QUANTITY	(in metric tons)
8.14.b	CHEMICAL FORM AND COMPOSITION	
8.15.b	DATE IMPORTED	(YYYY/MM/DD)
8.16.b	EXPORTING State	
8.17.b	DESCRIPTION OF INTENDED USE	

ADDITIONAL PROTOCOL REPORT

Form No. 9 – Holdings of IAEA Safeguards-Exempted Nuclear Material

Submit a separate form to report information about holdings or change in location of each type of Nuclear Material at your Site/Location, which was exempted from IAEA Safeguards pursuant to Article 35(b) or Article 36 of INFCIRC-622.

9.1.	REPORTING CODE	
9.2.	REPORTING STATUS OF REPORTABLE ACTIVITY	☐ New Reportable Activity ☐ Reportable Activity with changes ☐ Reportable Activity with no changes ☐ Reportable Activity has ceased

Information about quantity, use, and Location.

9.3.	TYPE OF MATERIAL	(Check one only) ☐ Thorium ☐ Plutonium ☐ Natural or Depleted Uranium ☐ Enriched Uranium Isotope Percent: U-233_______ U-235_______
9.4.	PHYSICAL LOCATION	[List building name(s) or number(s) and any additional information that defines more precisely where the material is located. If the building is on a Site and a Site map is attached, the number should be the same as the number used on the Site map.]
9.5.	QUANTITY ON HAND	(in grams/kilograms)
9.6.	INTENDED USE	☐ Nuclear ☐ Non-Nuclear
9.7.	DESCRIPTION OF INTENDED USE	

ADDITIONAL PROTOCOL REPORT

Form No. 10 – Export of Specified Equipment and Non-Nuclear Material

Submit a separate form for each export of specified equipment and non-Nuclear Material listed in FANR Regulation for Safeguards and Material Control and Accounting (FANR-REG-10)

10.1.	REPORTING CODE	
10.2.	EQUIPMENT OR MATERIAL EXPORTED	(Tick one box only) ☐ Reactors and equipment for reactors ☐ Non-Nuclear Material for reactors ☐ Plants for the Reprocessing of irradiated fuel elements, and equipment especially designed or prepared for Reprocessing plants ☐ Plants for the manufacture of fuel elements ☐ Plants for the separation of isotopes of uranium and equipment, other than analytical instruments, especially designed or prepared for separation plants ☐ Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared for these plants ☐ Plants for the conversion of uranium and equipment especially designed or prepared for conversion plants
Information about the exported item(s).		
10.3.	IDENTITY OF THE EXPORTED ITEM(S)	
10.4	ITEM INFORMATION	[Provide the information that is applicable to this export.] Dimensions: Capacity (Volume): Throughput: Material of Construction: Serial or Model Numbers(s): Name and Address of Manufacturer: Key Specification of Non-Nuclear Material: Additional Identifying Information:
10.5.	QUANTITY EXPORTED	[As applicable] Number of Items: Weight (specify whether tons or kilograms):
10.6.	DATE OF EXPORT	Actual or expected date of export: DD-MONTH IN WORDS-YYYY
10.7.	IMPORTER	Receiving State: Name of Company or Organisation: Address:
10.8.	INTENDED USE IN RECEIVING STATE	

ADDITIONAL PROTOCOL REPORT		
Form No. 10 – Export of Specified Equipment and Non-Nuclear Material		
Form No. 11 – Confirmation of Import of Equipment or Non-Nuclear Material		
Upon specific request by the Authority, submit a separate form for each import of specified equipment and non-Nuclear Material listed in FANR Regulation for Safeguards and Material Control and Accounting (FANR-REG-10)		
11.1.	REPORTING CODE	
11.2.	EQUIPMENT OR MATERIAL IMPORTED	(Tick one box only) ☐ Reactors and equipment for reactors ☐ Non-Nuclear Material for reactors ☐ Plants for the Reprocessing of irradiated fuel elements, and equipment especially designed or prepared for Reprocessing plants ☐ Plants for the fabrication of fuel elements ☐ Plants for the separation of isotopes of uranium and equipment, other than analytical instruments, especially designed or prepared for separation plants ☐ Plants for the production of heavy water, deuterium and deuterium compounds and equipment especially designed or prepared for these plants ☐ Plants for the conversion of uranium and equipment especially designed or prepared for conversion plants
11.3.	PHYSICAL LOCATION OF IMPORTED EQUIPMENT OR MATERIAL	[List building name(s) or number(s) and any additional information that defines more precisely where the material is located. If the building is on a Site and a Site map is attached, the number should be the same as the number used on the Site map.]
11.4.	DATE IMPORT WAS RECEIVED	DD-MONTH IN WORDS-YYYY
Confirmation, as importer, of information provided to the IAEA by the exporting State		
11.5	RESPONSE	[Response to IAEA request for information concerning an import of specified equipment or non-Nuclear Material]

ADDITIONAL PROTOCOL REPORT

Form No. 12 – Future Plans

Submit a separate form for each general plan for the succeeding ten-year period relevant to the development of the Nuclear Fuel cycle-related activities (including planned Nuclear Fuel Cycle-Related R&D Activities) when approved by the appropriate authorities in the State. [This form consists of two pages.]

12.1.	REPORTING CODE	
12.2.	PROJECT NUMBER (OR OTHER IDENTIFIER)	
12.3.	PROJECT TITLE	
12.4.	REPORTING STATUS OF PROJECT	☐ New Reportable Activity ☐ Reportable Activity with changes ☐ Reportable Activity with <u>no</u> changes ☐ Reportable Activity has ceased
12.5.	PLACE WHERE PROJECT WILL BE CONDUCTED	[List building name(s) or number(s) and any additional information that defines more precisely where the planned Reportable Activity will be carried out.
12.6.	TIME LINE OF PROJECT	Date when the project will start: DD-MONTH IN WORDS-YYYY Estimated project end date: DD-MONTH IN WORDS-YYYY
12.7.	PROCESS OR SYSTEM TO WHICH PROJECT WILL BE RELATED	☐ Conversion of Nuclear Material ☐ Nuclear Fuel Fabrication ☐ Reactors ☐ Critical Facilities ☐ Processing of intermediate or high-level waste containing plutonium, high enriched uranium or uranium-233 ☐ Other
12.8.	LEVEL OF PROJECT	(Tick the one box that best describes the stage of development of the technology in the project) ☐ Theoretical Analysis ☐ Conceptual Design ☐ Prototype ☐ Proof of Concept ☐ New Facility ☐ Demonstration ☐ Experiment ☐ Feasibility Study
12.9.	DESCRIPTION OF PROJECT	[Provide a general description of the project/Reportable Activity]
12.10.	PROJECT OBJECTIVE	[Provide a brief description of the objective of the Reportable Activity and the intended application/use]

ADDITIONAL PROTOCOL REPORT		
Form No. 12 – Future Plans		
12.11.	DEPARTMENT/AGENCY/ COMPANY	Name: Address:
12.12.	CONTACT PERSON AT DEPARTMENT/AGENCY/ COMPANY	Name of Contact Person: Telephone Number of Contact Person: Fax Number of Contact Person:
12.13.	NATURE OF INVOLVEMENT	[Describe the nature of the involvement, e.g. funding – State or Private]
Provide the names and locations of all other sponsors and/or collaborators, both foreign and domestic, Government and non-Government, for this Reportable Activity.		
12.14.	Organisation Name: Address: Country:	
12.15	Organisation Name: Address: Country:	
12.16	Organisation Name: Address: Country:	

ADDITIONAL PROTOCOL REPORT		
Form No. 13 – Response to Request for Supplemental Information		
Upon specific request by the Authority, submit this form to provide amplifications or clarifications of information provided in previous reports.		
13.1.	REPORTING CODE	
13.2	INFORMATION RESPONDING TO REQUEST BY THE AUTHORITY	

ANNEX B

List of Nuclear-Related Manufacturing, Assembly, or Construction Activities

1) The manufacture of centrifuge rotor tubes or the assembly of gas centrifuges.

   Centrifuge rotor tubes means thin-walled cylinders as described in 5.1.1(b) of Annex C.

   Gas centrifuges means centrifuges as described in the Introductory Note to 5.1 of Annex C.

2) The manufacture of diffusion barriers.

   Diffusion barriers means thin, porous filters as described in 5.3.1(a) of Annex C.

3) The manufacture or assembly of laser-based systems.

   Laser-based systems means systems incorporating those items as described in 5.7 of Annex C.

4) The manufacture or assembly of electromagnetic isotope separators.

   Electromagnetic isotope separators means those items referred to in 5.9.1 of Annex C containing ion sources as described in 5.9.1(a) of Annex C.

5) The manufacture or assembly of columns or extraction equipment.

   Columns or extraction equipment means those items as described in 5.6.1, 5.6.2, 5.6.3, 5.6.5, 5.6.6, 5.6.7 and 5.6.8 of Annex C.

6) The manufacture of aerodynamic separation nozzles or vortex tubes.

   Aerodynamic separation nozzles or *vortex tubes* means separation nozzles and vortex tubes as described respectively in 5.5.1 and 5.5.2 of Annex C.

7) The manufacture or assembly of uranium plasma generation systems.

   Uranium plasma generation systems means systems for the generation of uranium plasma as described in 5.8.3 of Annex C.

8) The manufacture of zirconium tubes.

   Zirconium tubes means tubes as described in 1.6 of Annex C.

9) The manufacture or upgrading of heavy water or deuterium.

   Heavy water or deuterium means deuterium, heavy water (deuterium oxide) and any other deuterium compound in which the ratio of deuterium to hydrogen atoms exceeds 1:5000.

10) The manufacture of nuclear grade graphite.

    Nuclear grade graphite means graphite having a purity level better than 5 Parts per million boron equivalent and with a density greater than 1.50 g/cm^3.

11) The manufacture of flasks for irradiated fuel.

    A *flask for irradiated fuel* means a vessel for the transportation and/or Storage of irradiated fuel which provides chemical, thermal and radiological protection, and dissipates decay heat during handling, transportation and Storage.

12) The manufacture of reactor control rods.

    Reactor control rods means rods as described in 1.4 of Annex C.

13) The manufacture of criticality safe tanks and vessels.

    Criticality safe tanks and vessels means those items as described in 3.2 and 3.4 of Annex C.

14) The manufacture of irradiated fuel element chopping machines.

Irradiated fuel element chopping machines means equipment as described in 3.1 of Annex C.

15) The Construction of hot cells.

Hot cells means a cell or interconnected cells totalling at least 6 m^3 in volume with shielding equal to or greater than the equivalent of 0.5 m of concrete, with a density of 3.2 g/cm^3 or greater, outfitted with equipment for remote Operations.

ANNEX C

Specified Equipment and Non-Nuclear Material for the Reporting of Exports and Imports

1. Reactors and equipment therefor

1.1 Complete Nuclear Reactors

Nuclear Reactors capable of Operation so as to maintain a controlled self-sustaining fission chain reaction, excluding zero energy reactors, the latter being defined as reactors with a designed maximum rate of production of plutonium not exceeding 100 grams per year.

EXPLANATORY NOTE

A “Nuclear Reactor” basically includes the items within or attached directly to the reactor vessel, the equipment which controls the level of power in the core, and the components which normally contain or come in direct contact with or control the primary coolant of the reactor core. It is not intended to exclude reactors which could reasonably be capable of modification to produce significantly more than 100 grams of plutonium per year. Reactors designed for sustained Operation at significant power levels, regardless of their capacity for plutonium production, are not considered as “zero energy reactors”.

1.2 Reactor pressure vessels

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

EXPLANATORY NOTE

A top plate for a reactor pressure vessel is covered by item 1.2 as a major shop-fabricated part of a pressure vessel. Reactor internals (e.g. support columns and plates for the core and other vessel internals, control rod guide tubes, thermal shields, baffles, core grid plates, diffuser plates, etc.) are normally supplied by the reactor supplier. In some cases, certain internal support components are included in the fabrication of the pressure vessel. These items are sufficiently critical to the Safety and reliability of the Operation of the reactor (and, therefore, to the guarantees and liability of the reactor supplier), so that their supply, outside the basic supply arrangement for the reactor itself, would not be common practice. Therefore, although the separate supply of these unique, especially designed and prepared, critical, large, and expensive items would not necessarily be considered as falling outside the area of concern, such a mode of supply is considered unlikely.

1.3 Reactor fuel charging and discharging machines

Manipulative equipment especially designed or prepared for inserting or removing fuel in a Nuclear Reactor as defined in paragraph 1.1 above capable of on-load Operation or employing technically sophisticated positioning or alignment features to allow complex off-load fueling Operations such as those in which direct viewing of or access to the fuel is not normally available.

1.4 Reactor control rods

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

EXPLANATORY NOTE

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

1.5 Reactor pressure tubes

Tubes which are especially designed or prepared to contain fuel elements and the primary coolant in a reactor as defined in paragraph 1.1 above at an operating pressure in excess of 5.1 MPa (740 psi).

1.6 Zirconium tubes

Zirconium metal and alloys in the form of tubes or assemblies of tubes, and in quantities exceeding 500 kg in any period of 12 months, especially designed or prepare 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 NC-1 or equivalent standards.

2. Non-Nuclear Materials for reactors

2.1 Deuterium and heavy water

Deuterium, heavy water (deuterium oxide) and any other deuterium compound in which the ratio of deuterium to hydrogen atoms exceeds 1:5000 for use in a Nuclear Reactor as defined in paragraph 1.1 above in quantities exceeding 200 kg of deuterium atoms for any one recipient country in any period of 12 months.

2.2 Nuclear grade graphite

Graphite having a purity level better than 5 parts per million boron equivalent and with a density greater than 1.50 g/cm^3 for use in a Nuclear Reactor as defined in paragraph 1.1 above in quantities exceeding 3×10^4 kg (30 metric tons) for any one recipient country in any period of 12 months.

NOTE: For the purpose of reporting, the State will determine whether or not the exports of graphite meeting the above specifications are for Nuclear Reactor use.

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). 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 should 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 should 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 percent, or

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

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

3.5 Plutonium nitrate to oxide conversion system

INTRODUCTORY NOTE

In most Reprocessing facilities, this final process involves the conversion of the plutonium nitrate solution to plutonium dioxide. The main functions involved in this process are: Process feed Storage and adjustment, precipitation and solid-liquor separation, calcination, product handling, ventilation, waste management, and process control. Complete systems especially designed or prepared for the conversion of plutonium nitrate to plutonium oxide, in particular adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards.

3.6 Plutonium oxide to metal production system

INTRODUCTORY NOTE

This process, which could be related to a Reprocessing Facility, involves the fluorination of plutonium dioxide, normally with highly corrosive hydrogen fluoride, to produce plutonium fluoride which is subsequently reduced using high purity calcium metal to produce metallic plutonium and a calcium fluoride slag. The main functions involved in this process are: Fluorination (e.g. involving equipment fabricated or lined with a precious metal), metal reduction (e.g. employing ceramic crucibles), slag recover, product handling, ventilation, waste management and process control. Complete systems especially designed or prepared for the production of plutonium metal, in particular adapted so as to avoid criticality and radiation effects and to minimize toxicity hazards.

4. Plants for the fabrication of fuel elements

A “plant for the fabrication of fuel elements” includes the equipment:

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

(b) Which seals the Nuclear Material within the cladding.

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

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

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

INTRODUCTORY NOTE

The gas centrifuge normally consists of a thin-walled cylinder(s) of between 75 mm (3 in.) and 400 mm (16 in.) diameter contained in a vacuum environment and spun at high peripheral speed of the order of 300 m/s or more with its central axis vertical. In order to achieve high speed the materials of Construction for the rotating components have to be of a high strength to density ratio and the rotor assembly, and hence its individual components, have to be manufactured to very close tolerances in order to minimize the unbalance. In contrast to other centrifuges, the gas centrifuge for uranium Enrichment is characterized by having within the rotor chamber a rotating disc-shaped baffle(s) and a stationary tube arrangement for feeding and extracting the UF_6 gas and featuring at least 3 separate channels, of which 2 are connected to scoops extending from the rotor axis towards the periphery of the rotor chamber. Also contained within the vacuum environment are a number of critical items which do not rotate and which although they are especially designed are not difficult to fabricate nor are they fabricated out of unique materials. A centrifuge Facility however requires a large number of these components, so that quantities can provide an important indication of end use.

5.1.1 Rotating components

(a) Complete rotor assemblies:

Thin-walled cylinders, or a number of interconnected thin-walled cylinders, manufactured from one or more of the high strength to density ratio materials described in the EXPLANATORY NOTE to this Section. If interconnected, the cylinders are joined together by flexible bellows or rings as described in section 5.1.1(c) following. The rotor is fitted with an internal baffle(s) and end caps, as described in section 5.1.1(d) and (e) following, if in final form. However the complete assembly may be delivered only partly assembled.

(b) Rotor tubes:

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

(c) Rings or Bellows:

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

(d) Baffles:

Disc-shaped components of between 75 mm (3 in.) and 400 mm (16 in.) diameter especially designed or prepared to be mounted inside the centrifuge rotor tube, in order to isolate the take-off chamber from the main separation chamber and, in some cases, to assist the UF_6 gas circulation within the main separation chamber of the rotor tube, and manufactured from one of the high strength to density ratio materials described in the EXPLANATORY NOTE to this Section.

(e) Top Caps/Bottom Caps:

Disc-shaped components of between 75 mm (3 in.) and 400 mm (16 in.) diameter especially designed or prepared to fit to the ends of the rotor tube, and so contain the UF_6 within the rotor tube, and in some cases to support, retain or contain as an integrated part an element of the upper bearing (top cap) or to carry the rotating elements of the motor and lower bearing (bottom cap), and manufactured from one of the high strength to density ratio materials described in the EXPLANATORY NOTE to this Section.

EXPLANATORY NOTE

The materials used for centrifuge rotating components are:

(a) Maraging steel capable of an ultimate tensile strength of 2.05 x 10^9 N/m^2 (300,000 psi) or more;

(b) Aluminium alloy capable of an ultimate tensile strength of 0.46 x 10^9 N/m^2 (67,000 psi) or more;

(c) Filamentary materials suitable for use in composite structures and having a specific modulus of 12.3 x 10^6 m or greater and a specific ultimate tensile strength of 0.3 x 10^6 m or greater ('Specific Modulus' is the Young's Modulus in N/m^2 divided by the specific weight in N/m^3; 'Specific Ultimate Tensile Strength' is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3).

5.1.2 Static components

(a) Magnetic suspension bearings:

Especially designed or prepared bearing assemblies consisting of an annular magnet suspended within a housing containing a damping medium. The housing will be manufactured from a UF_6-resistant material (see EXPLANATORY NOTE to Section 5.2). The magnet couples with a pole piece or a second magnet fitted to the top cap described in Section 5.1.1(e). The magnet may be ring-shaped with a relation between outer and inner diameter smaller or equal to 1.6:1. The magnet may be in a form having an initial permeability of 0.15H/m (120,000 in CGS units) or more, or a remanence of 98.5% or more, or an energy product of greater than 80kJ/m^3 (10^7 gauss-oersteds). In addition to the usual material properties, it is a prerequisite that the deviation of the magnetic axes from the geometrical axes is limited to very small tolerances (lower than 0.1 mm or 0.004 in.) or that homogeneity of the material of the magnet is specially called for.

(b) Bearings/Dampers:

Especially designed or prepared bearing 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 UF_6.

(f) Scoops:

Especially designed or prepared tubes of up to 12 mm (0.5 in.) internal diameter for the extraction of UF_6 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 UF_6.

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

INTRODUCTORY NOTE

The auxiliary systems, equipment and components for a gas centrifuge Enrichment plant are the systems of plant needed to feed UF_6 to the centrifuges, to link the individual centrifuges to each other to form cascades (or stages) to allow for progressively higher Enrichments and to extract the 'product' and 'tails' UF_6 from the centrifuges, together with the equipment required to drive the centrifuges or to control the plant. Normally UF_6 is evaporated from the solid using heated autoclaves and is distributed in gaseous form to the centrifuges by way of cascade header pipework. The 'product' and 'tails' UF_6 gaseous streams flowing from the centrifuges are also passed by way of cascade header pipework to cold traps (operating at about 203 K(-70NC)) 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 kilometres 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:

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

2. desublimers (or cold traps) used to remove UF_6 from the cascades at up to 3 kPa (0.5 psi) pressure. The desublimers are capable of being chilled to 203 K (-70 degrees C) and heated to 343 K (70 degrees C);

3. ‘product’ and ‘Tails’ stations used for trapping UF_6 into containers.

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

5.2.2 Machine header piping systems

Especially designed or prepared piping systems and header systems for handling UF_6 within the centrifuge cascades. The piping network is normally of the ‘triple’ header system with each centrifuge connected to each of the headers. There is thus a substantial amount of repetition in its form. It is wholly made of UF_6-resistant materials (see EXPLANATORY NOTE to this section) and is fabricated to very high vacuum and cleanliness standards.

5.2.3 UF_6 mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking ‘on-line’ samples of feed, product or tails, from UF_6 gas streams and having all of the following characteristics:

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

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

3. Electron bombardment ionization sources;

4. Having a collector system suitable for isotopic analysis.

5.2.4 Frequency changers

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

1. A multiphase output of 600 to 2000 Hz;

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

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

4. An efficiency of greater than 80%.

EXPLANATORY NOTE

The items listed above either come into direct contact with the UF_6 process gas or directly control the centrifuges and the passage of the gas from centrifuge to centrifuge and cascade to cascade. Materials resistant to corrosion by UF_6 include stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel.

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

INTRODUCTORY NOTE

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

5.3.1 Gaseous diffusion barriers

(a) Especially designed or prepared thin, porous filters, with a pore size of 100 - 1,000 D (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 UF_6, and

(b) Especially prepared compounds or powders for the manufacture of such filters. Such compounds and powders include nickel or alloys containing 60 percent or more nickel, aluminium oxide, or UF_6-resistant fully fluorinated hydrocarbon polymers having a purity of 99.9 percent 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 UF_6-resistant materials and designed for horizontal or vertical installation.

5.3.3 Compressors and gas blowers

Especially designed or prepared axial, centrifugal, or positive displacement compressors, or gas blowers with a suction volume capacity of 1 m^3/min or more of UF_6, and with a discharge pressure of up to several hundred kPa (100 psi), designed for long-term Operation in the UF_6 environment with or without an electrical motor of appropriate power, as well as separate assemblies of such compressors and gas blowers. These compressors and gas blowers have a pressure ratio between 2:1 and 6:1 and are made of, or lined with, materials resistant to UF_6.

5.3.4 Rotary shaft seals

Especially designed or prepared vacuum seals, with seal feed and seal exhaust connections, for sealing the shaft connecting the compressor or the gas blower rotor with the driver motor so as to ensure a reliable seal against in-leaking of the air into the inner chamber of the compressor or gas blower which is filled with UF_6. Such seals are normally designed for a buffer gas in-leakage rate of less than 1000 cm^3/min (60 in^3/min).

5.3.5 Heat exchangers for cooling UF_6

Especially designed or prepared heat exchangers made of or lined with UF_6-resistant materials (except stainless steel) or with copper or any combination of those metals, and intended for a leakage pressure change rate or 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 UF_6 to the gaseous diffusion assembly, to link the individual assemblies to each other to form cascades (or stages) to allow for progressively higher Enrichments and to extract the ‘product’ and ‘tails’ UF_6 from the diffusion cascades. Because of the high inertial properties of diffusion cascades, any interruption in their Operation, and especially their shut-down, leads to serious consequences. Therefore, a strict and constant Maintenance of vacuum in all technological systems, automatic protection from Accidents, and precise automated regulation of the gas flow is of importance in a gaseous diffusion plant. All this leads to a need to equip the plant with a large number of special measuring, regulating and controlling systems. Normally UF_6 is evaporated from cylinders placed within autoclave and is distributed in gaseous form to the entry point by way of cascade header pipework. The ‘product’ and ‘tails’ UF_6 gaseous streams flowing from exit points are passed by way of cascade header pipework to either cold traps or to compression stations where the UF_6 gas is liquefied prior to onward transfer into suitable containers for transportation or Storage. Because a gaseous diffusion Enrichment plant consists of a large number of gaseous diffusion assemblies arranged in cascades, there are many kilometres of cascade header pipework, incorporating thousands of welds with substantial amounts of repetition 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:

1. Feed autoclaves (or systems), used for passing UF_6 to the gaseous diffusion cascades;
2. desublimers (or cold traps) used to remove UF_6 from diffusion cascades;
3. liquefaction stations where UF_6 gas from the cascade is compressed and cooled to form liquid UF_6; and

‘product’ or ‘tails’ stations used for transferring UF_6 into containers.

5.4.2 Header piping systems

Especially designed or prepared piping systems and header systems for handling UF_6 within the gaseous diffusion cascades. This piping network is normally of the “double” header system with each cell connected to each of the headers.

5.4.3 Vacuum systems

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

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

5.4.4 Special shut-off and control valves

Especially designed or prepared manual or automated shut-off and control bellows valves made of UF_6-resistant materials with a diameter of 40 to 1500mm (1.5 to 59 in.) for installation in main and auxiliary systems of gaseous diffusion Enrichment plants.

5.4.5 UF_6 mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers capable of taking "on-line" samples of feed product or tails, from UF_6 gas streams and having all of the following characteristics:

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

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

INTRODUCTORY NOTE

In aerodynamic Enrichment processes, a mixture of gaseous UF_6 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 UF_6, all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) should be made of materials that remain stable in contact with UF_6.

EXPLANATORY NOTE

The items listed in this section either come into direct contact with the UF_6 process gas or directly control the flow within the cascade. All surfaces which come into contact with the process gas are wholly made of or protected by UF_6-resistant materials. For the purposes of the section relating to aerodynamic Enrichment items, the materials resistant to corrosion by UF_6 include copper, stainless steel, aluminium, aluminium alloys, nickel or alloys containing 60% or more nickel and UF_6-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 UF_6 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 UF_6, having a diameter of between 0.5 cm and 4 cm, a length to diameter ratio of 20:1 or less and with one or more tangential inlets. The tubes may be equipped with nozzle-type 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 UF_6 and with a suction volume capacity of 2 m^3/min or more of UF_6/carrier gas (hydrogen or helium) mixture.

5.5.4 Rotary shaft seals

Especially designed or prepared rotary shaft seals, with seal feed and seal exhaust connections for sealing the shaft connecting the compressor rotor or the gas blower rotor with the driver motor so as to ensure a reliable seal against out-leakage of process gas or in-leakage of air or seal gas into the inner chamber of the compressor or gas blower which is filled with a UF_6/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 UF_6.

5.5.6 Separation element housings

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

EXPLANATORY NOTE

These housings may be cylindrical vessels greater than 300 mm in diameter and greater than 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 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; and

(d) ‘product’ or ‘tails’ stations used for transferring UF_6 into containers.

5.5.8 Header piping systems

Especially designed or prepared header piping systems, made of our protected by materials resistant to corrosion by UF_6, for handling UF_6 within the aerodynamic cascades. This piping network is normally of the ‘double’ header Design with each stage or group of stages connected to each of the headers.

5.5.9 Vacuum systems and pumps

(a) Especially designed or prepared vacuum systems having a suction capacity of 5 m^3/min or more, consisting of vacuum manifolds, vacuum headers and vacuum pumps, and designed for service in UF_6-bearing atmospheres.

(b) Vacuum pumps especially designed or prepared for service in UF_6-bearing atmospheres and made of or protected by materials resistant to corrosion by UF_6. These pumps may use fluorocarbon seals and special working fluids.

5.5.10 Special shut-off and control valves

Especially designed or prepared manual or automated shut-off and control bellows valves made of or protected by materials resistant to corrosion by UF_6 with a diameter of 40 to 1500 mm for installation in main and auxiliary systems of aerodynamic Enrichment plants.

5.5.11 UF_6 mass spectrometers/ion sources

Especially designed or prepared magnetic or quadrupole mass spectrometers 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.

5.5.12 UF_6 carrier gas separation systems

Especially designed or prepared process systems for separating UF_6 from carrier gas (hydrogen or helium).

EXPLANATORY NOTE

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

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

(b) cryogenic refrigeration units capable of temperatures of -120 degrees C or less, or

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

(d) UF_6 cold traps capable of temperatures of -20 degrees 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 the 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 should be corrosion resistant to concentrated hydrochloric acid solutions.

EXPLANATORY NOTE

The cell cathodic compartment should 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 resin-impregnated 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 portion 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 fibres. These ion exchange resins/adsorbents have diameters of 0.2 mm or less and should 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 degrees C to 200 degrees 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 degrees C to 200 degrees C and pressures above 0.7 MPa (102 psia).

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 vapour and those in which the process medium is the vapour of a uranium compound. Common nomenclature for such processes include: First category - atomic vapour 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 vapour (for selective photo-ionization) or devices to feed the vapour 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; and (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.

5.7.1 Uranium vaporization systems (AVLIS)

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

5.7.2 Liquid uranium metal handling systems (AVLIS)

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

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 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 vapour 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 vapour 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 UF_6 and carrier gas to 150 K or less and which are corrosion resistant to UF_6.

5.7.6 Uranium pentafluoride product collectors (MLIS)

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

5.7.7 UF_6/carrier gas compressors (MLIS)

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

5.7.8 Rotary shaft seals (MLIS)

Especially designed or prepared rotary shaft seals, with seal feed and seal 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 UF_6/carrier gas mixture.

5.7.9 Fluorination systems (MLIS)

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

EXPLANATORY NOTE

These systems are designed to fluorinate the collected UF_5 powder to UF_6 for subsequent collection in product 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 UF_5 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 UF_6 are used.

5.7.10 UF_6 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; and

(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 degrees C or less, or

(b) cryogenic refrigeration units capable of temperatures of -120 degrees C or less, or

(c) UF_6 cold traps capable of temperatures of -20 degrees 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 laser system for the AVLIS process usually consists of two lasers: a copper vapour 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 U-235 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 U-235. The plasma, which is made by ionizing uranium vapour, 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 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 30GHz frequency and greater than 50kW 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 40kW 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 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 vapour 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 ‘products’ 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 vapour 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 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 form 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 in to 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 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 water-hydrogen sulphide exchange process.

6.2 Blowers and Compressors

Single stage, low head (i.e., 0.2 MPa or 30 psi) centrifugal blowers or compressors for hydrogen-sulphide gas circulation (i.e., gas containing more than 70% 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 m^3/second (120,000 SCFM) while operating at pressures greater than or equal to 1.8 MPa (260 psi) suction and have seals designed for wet H2S service.

6.3 Ammonia-Hydrogen Exchange Towers

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

6.4 Tower Internals and Stage Pumps

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

6.5 Ammonia Crackers

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

6.6 Infrared Absorption Analysers

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

6.7 Catalytic Burners

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

7. 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 UO_3, conversion of UO_3 to UO_2, conversion of uranium oxides to UF_4 or UF_6, conversion of UF_4 to UF_6, conversion of UF_6 to UF_4, conversion of UF_4 to uranium metal, and conversion of uranium fluorides to UO_2. Many of the key equipment items for uranium conversion plants are 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 specification 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, F_2, ClF_3, and uranium fluorides). 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 Especially designed or prepared systems for the conversion of uranium ore concentrates to UO_3

EXPLANATORY NOTE

Conversion of uranium ore concentrates to UO_3 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 UO_3 either by concentration and denitration or by neutralization with gaseous ammonia to produce ammonium diuranate with subsequent filtering, drying, and calcining.

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

EXPLANATORY NOTE

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

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

EXPLANATORY NOTE

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

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

EXPLANATORY NOTE

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

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

EXPLANATORY NOTE

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

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

EXPLANATORY NOTE

Conversion of UF_4 to U metal is performed by reduction with magnesium (large batches) or calcium (small batches). The reaction is carried out at temperatures above the melting point of uranium (1130 degrees C).

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

EXPLANATORY NOTE

Conversion of UF_6 to UO_2 can be performed by one of three processes. In the first, UF_6 is reduced and hydrolysed to UO_2 using hydrogen and steam. In the second, UF_6 is hydrolysed by solution in water, ammonia is added to precipitate ammonium diuranate, and the diuranate is reduced to UO_2 with hydrogen at 820 degrees C. In the third process, gaseous UF_6, CO_2, and NH_3 are combined with water, precipitating ammonium uranyl carbonate. The ammonium uranyl carbonate is combined with steam and hydrogen at 500-600 degrees C to yield UO_2. UF_6 to UO_2 conversion is often performed as the first stage of a fuel fabrication plant.

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

EXPLANATORY NOTE

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