[7590-01-P]

NUCLEAR REGULATORY COMMISSION

10 CFR Part 110

RIN 3150-AJ33

[NRC-2014-0007]

Export Controls and Physical Security Standards

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is amending its regulations pertaining to the export and import of nuclear materials and equipment. This rulemaking is necessary to conform the export controls of the United States to the international export control guidelines of the Nuclear Suppliers Group (NSG), of which the United States is a member, and to incorporate by reference the current version of the International Atomic Energy Agency's (IAEA) document, "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5), January 2011." Also, this final rule makes certain editorial revisions, and corrects typographical errors.

DATES: The final rule is effective **[INSERT DATE THAT IS 30 DAYS AFTER THE DATE OF PUBLICATION IN THE *FEDERAL REGISTER*]**, except that the changes to § 110.44(a) and (b)(1) and appendix M to 10 CFR part 110 are effective December 31, 2014. The incorporation by reference of the material in this document is approved as of December 31, 2014.

ADDRESSES: Please refer to Docket ID NRC-2014-0007 when contacting the NRC about the availability of information for this final rule. You can access publicly-available information related to this final rule by any of the following methods:

- **Federal Rulemaking Web Site:** Go to http://www.regulations.gov and search for Docket ID NRC-2014-0007. Address questions about NRC dockets to Carol Gallagher; telephone: 301-287-3422; e-mail: Carol.Gallagher@nrc.gov. For technical questions, contact the individual listed in the FOR FURTHER INFORMATION CONTACT section of this final rule.

- **NRC's Agencywide Documents Access and Management System (ADAMS):** You may obtain publicly available documents online in the ADAMS Public Documents collection at http://www.nrc.gov/reading-rm/adams.html. To begin the search, select "ADAMS Public Documents" and then select "Begin Web-based ADAMS Search." For problems with ADAMS, please contact the NRC's Public Document Room (PDR) reference staff at 1-800-397-4209, 301-415-4737, or by e-mail to pdr.resource@nrc.gov. The ADAMS accession number for each document referenced in this document (if that document is available in ADAMS) is provided the first time that a document is referenced.

- **NRC's PDR:** You may examine and purchase copies of public documents at the NRC's PDR, Room O1-F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.

FOR FURTHER INFORMATION CONTACT: Brooke G. Smith, Office of International Programs, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone: 301-415-2347, e-mail: Brooke.Smith@nrc.gov.

SUPPLEMENTARY INFORMATION:

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I. Background.

The NSG is a group of like-minded States that seeks to contribute to the nonproliferation of nuclear weapons through the implementation of guidelines for nuclear exports and nuclear-related exports. As a participating government in the NSG, the United States has committed to controlling for export items on the NSG control lists. Participating governments are charged with implementing the changes adopted to the list as soon as possible after approval.

This final rule conforms the NRC's export and import regulations in 10 CFR part 110, "Export and Import of Nuclear Equipment and Material," and appendices A, B, C, D, E, F, G, H, I, J, K, N, and O, which contain illustrative lists of items under the NRC's export licensing authority, to current nuclear nonproliferation policies of the Executive Branch. These revisions are necessary to implement changes made to the NSG Guidelines, "Guidelines for Nuclear Transfers (INFCIRC/254/Revision 12/Part 1), June 2013," as adopted by the governments participating in the NSG at the June 2012 and 2013 Plenary Meetings. In addition, this rule amends § 110.30, "Members of the Nuclear Suppliers Group," to add Mexico and Serbia as member countries of the NSG that are eligible to receive radioactive materials under certain general licenses for export. The NSG Guidelines can be found at: www.nuclearsuppliersgroup.org.

In January 2011, the IAEA published the document titled, "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)." This rule also amends § 110.44 and appendix M to 10 CFR part 110 to incorporate by reference the update and recommendations contained in Revision 5 of this IAEA document.

The NRC staff has determined that these changes are consistent with current U.S. policy, and will pose no unreasonable risk to the public health and safety or to the common defense and security of the United States.

Because this rule involves a foreign affairs function of the United States, the notice and comment provisions of the Administrative Procedure Act do not apply (5 U.S.C. 553(a)(1)). In addition, solicitation of public comments would delay the U.S. conformance with its international obligations, and would be contrary to the public interest (5 U.S.C. 553(b)). The final rule is effective **[INSERT DATE THAT IS 30 DAYS AFTER THE DATE OF PUBLICATION IN THE *FEDERAL REGISTER*]**, except that the changes to § 110.44(a) and (b)(1) and appendix M to 10 CFR part 110 are effective December 31, 2014.

II. Section by Section Analysis.

Section 110.2, Definitions.

Paragraph (2)(ii) of the definition of "Utilization facility" is amended to make conforming changes consistent with the changes to appendix A to 10 CFR part 110.

***S*ection 110.26, General license for the export of nuclear reactor components.**

This rule amends § 110.26 to make conforming changes to paragraph (a) consistent with the changes to appendix A to 10 CFR part 110.

Section 110.30, Members of the Nuclear Suppliers Group.

This rule amends § 110.30 to update the list of NSG members by adding Mexico and Serbia.

Section 110.42, Export licensing criteria.

This rule amends § 110.42 to make conforming changes to Footnote 1 consistent with the changes to appendix A to 10 CFR part 110.

Section 110.44, Physical security standards.

Paragraphs (a) and (b)(1) of § 110.44 are amended to incorporate by reference the most recent revision to INFCIRC/225/Revision 5, "The Physical Protection of Nuclear Material and Nuclear Facilities." The effective date for these changes is delayed until December 31, 2014, to provide adequate time for countries to meet the recommendations in Revision 5. "The Physical Protection of Nuclear Material and Nuclear Facilities," INFCIRC/225/Revision 4 (corrected), July 1999, will continue to be used as the physical protection standard in recipient countries until the effective date for INFCIRC/225/Revision 5, as incorporated by reference in 10 CFR part 110.

Appendices A, B, C, D, E, F, G, H, I, J, K, N and O to Part 110.

These appendices are amended to reflect the updated guidelines of the NSG consistent with the IAEA document, "Guidelines for Nuclear Transfers, (INFCIRC/254/Revision 12/Part 1)."

The appendices in 10 CFR part 110 are illustrative only and are not meant to be inclusive lists of facilities and equipment under the NRC's export licensing jurisdiction.

Appendix M to Part 110-Categorization of Nuclear Material.

Appendix M is amended to update the Categorization of Nuclear Material table to be consistent with IAEA publication, INFCIRC/225/Revision 5. The changes to appendix M of 10 CFR part 110 are effective December 31, 2014**.**

III. Regulatory Flexibility Certification.

As required by the Regulatory Flexibility Act of 1980 (5 U.S.C. 605(b)), the Commission certifies that this final rule will not have a significant economic impact on a substantial number of small entities. This rule affects only companies exporting nuclear equipment and material to and from the United States and they do not fall within the scope of the definition of "small entities" set forth in the Regulatory Flexibility Act (5 U.S.C. 601(3)), or the Size Standards established by the NRC (10 CFR 2.810).

IV. Regulatory Analysis.

This rulemaking is necessary to reflect the nuclear nonproliferation policy of the Executive Branch including U.S. Government commitments to controlling export items on the NSG control lists and the IAEA publication, INFCIRC/225/Revision 5. This final rule is expected to have no changes in the information collection burden or cost to the public.

V. Backfit Analysis and Issue Finality.

The NRC has determined that a backfit analysis is not required for this rule because these amendments do not include any provisions that would impose backfits as defined in 10 CFR Chapter I.

VI. Plain Writing.

The Plain Writing Act of 2010 (Pub. L. 111-274) requires Federal agencies to write documents in a clear, concise, and well-organized manner. The NRC has written this document to be consistent with the Plain Writing Act as well as the Presidential Memorandum, "Plain Language in Government Writing," published June 10, 1998 (63 FR 31883).

VII. Environmental Impact: Categorical Exclusion.

The NRC has determined that this final rule is the type of action described in categorical exclusion 10 CFR 51.22(c)(1). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for the rule.

VIII. Paperwork Reduction Act Statement.

This final rule does not contain new or amended information collection requirements subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). Existing requirements were approved by the Office of Management and Budget (OMB) under approval number 3150-0036.

Public Protection Notification.

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

IX. Congressional Review Act.

Under the Congressional Review Act of 1996, the NRC has determined that this action is not a major rule and has verified this determination with the Office of Information and Regulatory Affairs of OMB.

X. Voluntary Consensus Standards.

The National Technology Transfer and Advancement Act of 1995 (Pub. L. 104-113) requires that Federal Agencies use technical standards that are developed or adopted by voluntary consensus standards bodies unless using such a standard is inconsistent with applicable law or otherwise impractical. This final rule does not constitute the establishment of a standard for which the use of a voluntary consensus standard would be applicable.

List of Subjects in 10 CFR Part 110

Administrative practice and procedure, Classified information, Criminal penalties, Export, Import, Incorporation by reference, Intergovernmental relations, Nuclear materials, Nuclear power plants and reactors, Reporting and recordkeeping requirements, Scientific equipment.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and 5 U.S.C. 552 and 553, the NRC is adopting the following amendments to 10 CFR part 110.

PART 110 -- EXPORT AND IMPORT OF NUCLEAR EQUIPMENT AND MATERIAL

1. The authority citation for part 110 continues to read as follows:

AUTHORITY: Atomic Energy Act secs. 51, 53, 54, 57, 63, 64, 65, 81, 82, 103, 104, 109, 111, 126, 127, 128, 129, 161, 181, 182, 183, 187, 189, 223, 234 (42 U.S.C. 2071, 2073, 2074, 2077, 2092–2095, 2111, 2112, 2133, 2134, 2139, 2139a, 2141, 2154–2158, 2201, 2231–2233, 2237, 2239, 2273, 2282); Energy Reorganization Act sec. 201 (42 U.S.C. 5841; Solar, Wind, Waste, and Geothermal Power Act of 1990 sec. 5 (42 U.S.C.2243); Government Paperwork Elimination Act sec. 1704, 112 Stat. 2750 (44 U.S.C. 3504 note); Energy Policy Act of 2005, 119 Stat. 594.

Sections 110.1(b)(2) and 110.1(b)(3) also issued under 22 U.S.C. 2403. Section 110.11 also issued under Atomic Energy Act secs. 54(c), 57(d), 122 (42 U.S.C. 2074, 2152). Section 110.50(b)(3) also issued under Atomic Energy Act sec. 123 (42 U.S.C. 2153). Section 110.51 also issued under Atomic Energy Act sec. 184 (42 U.S.C. 2234). Section 110.52 also issued under Atomic Energy Act sec. 186, (42 U.S.C. 2236). Sections 110.80–110.113 also issued under 5 U.S.C. 552, 554. Sections 110.130–110.135 also issued under 5 U.S.C. 553. Sections 110.2 and 110.42(a)(9) also issued under Intelligence Authorization Act sec. 903 (42 U.S.C. 2151 *et seq.*).

2. In § 110.2, revise paragraph (2)(ii) of the definition of “Utilization facility” to read as follows:

§ 110.2 Definitions.

*   *   *   *   *

Utilization facility means:

*   *   *   *   *

(2) * * *

(ii) Reactor primary coolant pump or circulator;

*   *   *   *   *

3. In § 110.26, revise the introductory text of paragraph (a) to read as follows:

§ 110.26 General license for the export of nuclear reactor components.

(a) A general license is issued to any person to export to a destination listed in paragraph (b) of this section any nuclear reactor component of U.S. origin described in paragraphs (5) through (11) of appendix A to this part if—

*   *   *   *   *

§ 110.30 [Amended]

4. Amend § 110.30 by adding the words “Mexico” and “Serbia” in alphabetical order.

5. In § 110.42, revise footnote 1 to read as follows:

§ 110.42 Export licensing criteria.

* * * * *

[1] Export of nuclear reactors, reactor pressure vessels, reactor primary coolant pumps and circulators, "on-line" reactor fuel charging and discharging machines, and complete reactor control rod systems, as specified in paragraphs (1) through (4) of appendix A to this part, are subject to the export licensing criteria in § 110.42(a). Exports of nuclear reactor components, as specified in paragraphs (5) through (11) of appendix A to this part, when exported separately from the items described in paragraphs (1) through (4) of appendix A to this part, are subject to the export licensing criteria in § 110.42(b).

6. In § 110.44, revise paragraphs (a) and (b)(1) to read as follows:

§ 110.44 Physical security standards.

(a) Physical security measures in recipient countries must provide protection at least comparable to the recommendations in the current version of IAEA publication, ''Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities" (INFCIRC/225/Revision 5), January 2011, which is incorporated by reference in this part. This incorporation by reference was approved by the Director of the Office of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Notice of any changes made to the material incorporated by reference will be published in the *Federal Register*. Copies of INFCIRC/225/Revision 5 may be obtained from the Marketing and Sales Unit, Publishing Section, IAEA, Vienna International Centre, PO Box 100, 1400 Vienna Austria; Fax: 43 1 2600 29302; telephone: 43 1 2600 22417; e-mail: sales.publications@iaea.org; Web site: http://www.iaea.org/books. You may inspect a copy at the NRC Library, 11545 Rockville Pike, Rockville, Maryland 20852–2738, telephone: 301-415-4737 or 1-800-397-4209, between

8:30 a.m. and 4:15 p.m.; or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal-register/cfr/ibr-locations.html*.

(b) * * *

(1) Receipt by the appropriate U.S. Executive Branch Agency of written assurances from the relevant recipient country government that physical security measures providing protection at least comparable to the recommendations set forth in INFCIRC/225/Revision 5.

*   *   *   *   *

7. Revise appendix A to part 110 to read as follows:

Appendix A to Part 110—Illustrative List of Nuclear Reactor Equipment under NRC Export Licensing Authority

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.

(1) Reactor pressure vessels, i.e., metal vessels, as complete units or major shop-fabricated parts, especially designed or prepared to contain the core of a nuclear reactor and capable of withstanding the operating pressure of the primary coolant.

(2) On-line (e.g., CANDU) reactor fuel charging and discharging machines, i.e., manipulative equipment especially designed for inserting or removing fuel in an operating nuclear reactor.

(3) Complete reactor control rod system, i.e., rods especially designed or prepared for the control of the reaction rate in a nuclear reactor, including the neutron absorbing part and the support or suspension structures therefor.

(4) Reactor primary coolant pumps or circulators, i.e., pumps or circulators especially designed or prepared for circulating the primary coolant in a nuclear reactor.

(5) Reactor pressure tubes, i.e., tubes especially designed or prepared to contain both fuel elements and the primary coolant in a nuclear reactor.

(6) Zirconium tubes, i.e., zirconium metal and alloys in the form of tubes or assemblies of tubes especially designed or prepared for use as fuel cladding in a nuclear reactor.

(7) Reactor internals, e.g., core support structures, control and rod guide tubes, fuel channels, calandria tubes, thermal shields, baffles, core grid plates, and diffuser plates especially designed or prepared for use in a nuclear reactor.

(8) Reactor control rod drive mechanisms, including detection and measuring equipment to determine neutron flux levels within the core of a nuclear reactor.

(9) Heat exchangers, e.g., steam generators especially designed or prepared for the primary, or intermediate, coolant circuit of a nuclear reactor or heat exchangers especially designed or prepared for use in the primary coolant circuit of a nuclear reactor.

(10) External thermal shields especially designed or prepared for use in a nuclear reactor for reduction of heat loss and also for containment vessel protection.

(11) Any other components especially designed or prepared for use in a nuclear reactor or in any of the components described in this appendix.

8. Revise appendix B to part 110 to read as follows:

Appendix B to Part 110—Illustrative List of Gas Centrifuge Enrichment Plant Components under NRC's Export Licensing Authority

1. *Assemblies and components especially designed or prepared for use in gas centrifuges.*

NOTE: The gas centrifuge normally consists of a thin-walled cylinder(s) of between 75 mm and 650 mm diameter contained in a vacuum environment and spun at high peripheral speed (of the order of 300 m/per second and more) with the central axis vertical. In order to achieve high speed, the materials of construction for the rotating 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 uranium hexafluoride (UF_6) gas and featuring at least three separate channels of which two 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.

1.1 *Rotating Components.*

(a) Complete Rotor Assemblies: Thin-walled cylinders, or a number of interconnected thin-walled cylinders, manufactured from one of the high strength-to-density ratio materials described in the footnote to this section.

If interconnected, the cylinders are joined together by flexible bellows or rings as described in § 1.1(c) of this appendix. The rotor is fitted with an internal baffle(s) and end caps, as described in § 1.1(d) and (e) of this appendix, 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 or less, a diameter of between 75 mm and 650 mm, and manufactured from one of the high strength-to-density ratio materials described in the footnote 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 in a short cylinder of wall thickness 3 mm or less, a diameter of between 75 mm and 650 mm, having a convolute, and manufactured from one of the high strength-to-density ratio materials described in the footnote to this section.

(d) Baffles: Disc shaped components of between 75 mm and 650 mm 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 footnote to this section.

(e) Top Caps/Bottom Caps: Disc shaped components of between 75 mm and 650 mm 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 footnote to this section.

Footnote

The materials used for centrifuge rotating components include the following:

(a) Maraging steel capable of an ultimate tensile strength of 1.95 GPa or more.

(b) Aluminum alloys capable of an ultimate tensile strength of 0.46 GPa or more.

(c) Filamentary materials suitable for use in composite structures and having a specific modulus of 3.18×10^6 m or greater and a specific ultimate tensile strength of 7.62×10^4 m or greater.

("Specific Modulus" is the Young's modulus in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 23 $\pm$ 20 °C and a relative humidity of 50 $\pm$ 5 percent. "Specific tensile strength" is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 23 $\pm$ 20 °C and a relative humidity of 50 $\pm$ 5 percent.)

1.2 Static Components.

(a) Magnetic Suspension Bearings: 1. 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 footnote to § 2 of this appendix). The magnet couples with a pole piece or a second magnet fitted to the top cap described in § 1.1(e) of this appendix. The magnet may be ring-shaped with a relation between outer and inner diameter smaller or equal to 1.6:1. The magnet may be in a form having an initial permeability of 0.15 Henry/meter or more, or a remanence of 98.5 percent or more, or an energy product of greater than 80,000 joules/m^3. 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 0.1mm) or that homogeneity of the material of the magnet is specially called for.

2. Active magnetic bearings especially designed or prepared for use with gas centrifuges. These bearings usually have the following characteristics:

(i) Designed to keep centred a rotor spinning at 600 Hz or more; and

(ii) Associated to a reliable electrical power supply and/or to an uninterruptible power supply (UPS) unit in order to function for more than 1 hour.

(b) Bearings/Dampers: Especially designed or prepared bearings comprising a pivot/cup assembly mounted on a damper. The pivot is normally a hardened steel shaft polished into a hemisphere at one end with a means of attachment to the bottom cap described in § 1.1(e) of this appendix at the other. The shaft may, however, have a hydrodynamic bearing attached. The cup is pellet-shaped with 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 to 650 mm internal diameter, 10 mm or more wall thickness, with a length equal to or greater than the diameter. The grooves are typically rectangular in cross-section and 2 mm or more in depth.

(d) Motor Stators: Especially designed or prepared ring shaped stators for high speed multi-phase alternating current (AC) hysteresis (or reluctance) motors for synchronous operation within a vacuum at a frequency of 600 Hz or greater and a power of 40 volts amps or greater. The stators may consist of multi-phase windings on a laminated low loss iron core comprised of thin layers typically 2.0 mm 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 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.

(f) Scoops: Especially designed or prepared tubes 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.

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

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

Some of the items listed below 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 copper, copper alloys, stainless steel, aluminum, aluminum oxide, aluminum alloys, nickel or alloys containing 60 percent or more nickel, and fluorinated hydrocarbon polymers.

(a) 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:

1. Feed autoclaves, ovens, or systems used for passing UF_6 to the enrichment process.

2. Desublimers, cold traps, or pumps used to remove UF_6 from the enrichment process for subsequent transfer upon heating.

3. 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.

4. “Product” and “tails” stations used for transferring UF_6 into containers.

(b) Machine Header Piping Systems: Especially designed or prepared piping systems and header systems for handling UF_6 within the centrifuge cascades.

This piping network is normally of the “triple” header system with each centrifuge connected to each of the headers. There is therefore a substantial amount of repetition in its form. It is wholly made of or protected by UF_6 resistant materials (see Note to this section) and is fabricated to very high vacuum and cleanliness standards.

(c) Special shut-off and control valves:

1. Shut-off valves especially designed or prepared to act on the feed, “product” or “tails” UF_6 gaseous streams of an individual gas centrifuge.

2. Bellows-sealed valves, manual or automated, shut-off or control, made of or protected by materials resistant to corrosion by UF_6, with an inside diameter of 10 to 160 mm, especially designed or prepared for use in main or auxiliary systems of gas centrifuge enrichment plants. Typical especially designed or prepared valves include bellow-sealed valves, fast acting closure-types, fast acting valves, and others.

(d) UF_6 Mass Spectrometers/Ion Sources: Especially designed or prepared mass spectrometers capable of taking on-line samples from UF_6 gas streams and having all of the following:

1. Capable of measuring ions of 320 atomic mass units or greater and having a resolution of better than 1 part in 320.

2. Ion sources constructed of or protected by nickel, nickel-copper alloys with a nickel content of 60 percent or more by weight, or nickel-chrome alloys.

3. Electron bombardment ionization sources.

4. Having a collector system suitable for isotope analysis.

(e) Frequency Changers: Frequency changers (also known as converters or inverters) especially designed or prepared to supply motor stators as defined under § 1.2(d) of this appendix, or parts, components, and subassemblies of such frequency changers having all of the following characteristics:

1. A multiphase output of 600 Hz or greater; and

2. High stability (with frequency control better than 0.2 percent).

(f) Any other components especially designed or prepared for use in a gas centrifuge enrichment plant or in any of the components described in this appendix.

9. Revise appendix C to part 110 to read as follows:

Appendix C to Part 110—Illustrative List of Gaseous Diffusion Enrichment Plant Assemblies and Components under NRC Export Licensing Authority

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

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 for accidents, and precise automated regulation of the gas flow is of importance in a gaseous diffusion plant. All this leads to a need to equip the plant with a large number of special measuring, regulating, and controlling systems.

Normally UF_6 is evaporated from cylinders placed within autoclaves and is distributed in gaseous form to the entry point by way of cascade header pipework. The "product" and "tails" UF_6 gaseous streams flowing from exit points are passed by way of cascade header pipework to either cold traps or to compression stations where the UF_6 gas is liquified prior to onward transfer into suitable containers for transportation or storage. Because a gaseous diffusion enrichment plant consists of a large number of gaseous diffusion assemblies arranged in cascades, there are many kilometers of cascade header pipework, incorporating thousands of welds with substantial amounts of repetition of layout. The equipment, components, and piping systems are fabricated to very high vacuum and cleanliness standards.

The items listed below 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 this appendix, the materials resistant to corrosion by UF_6 include copper, copper alloys, stainless steel, aluminum, aluminum oxide, aluminum alloys, nickel or alloys containing 60 percent or more nickel and fluorinated hydrocarbon polymers.

1. Assemblies and components especially designed or prepared for use in gaseous diffusion enrichment.

1.1 Gaseous Diffusion Barriers and Barrier Materials.

(a) Especially designed or prepared thin, porous filters, with a pore size of 10-100 nm, a thickness of 5 mm or less, and for tubular forms, a diameter of 25 mm or less, made of metallic, polymer or ceramic materials resistant to corrosion by UF_6 (See Note in § 2 of this appendix).

(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, aluminum oxide, or UF_6-resistant fully fluorinated hydrocarbon polymers having a purity of 99.9 percent by weight or more, a particle size less than 10 μm, and a high degree of particle size uniformity, which are especially prepared for the manufacture of gaseous diffusion barriers.

1.2 Diffuser Housings.

Especially designed or prepared hermetically sealed vessels for containing the gaseous diffusion barrier, made of or protected by UF_6-resistant materials (See Note in § 2 of this appendix).

1.3 Compressors and Gas Blowers.

Especially designed or prepared compressors or gas blowers with a suction volume capacity of 1 m^3 per minute or more of UF_6, and with a discharge pressure of up to 500 kPa, designed for long-term operation in the UF_6 environment, as well as separate assemblies of such compressors and gas blowers. These compressors and gas blowers have a pressure ratio of 10:1 or less and are made of, or protected by, materials resistant to UF_6 (See Note in § 2 of this appendix).

1.4 Rotary Shaft Seals.

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

1.5 Heat Exchangers for Cooling UF_6.

Especially designed or prepared heat exchangers made of or protected by UF_6 resistant materials (see Note to § 2 of this appendix) and intended for a leakage pressure change rate of less than 10 Pa per hour under a pressure difference of 100 kPa.

2. Auxiliary systems, equipment, and components especially designed or prepared for use in gaseous diffusion enrichment.

NOTE: The items listed below either come into direct contact with the UF_6 process gas or directly control the flow within the cascade. Materials resistant to corrosion by UF_6 include copper, copper alloys, stainless steel, aluminum, aluminum oxide, aluminum alloys, nickel or alloys containing 60 percent or more nickel, and fluorinated hydrocarbon polymers.

2.1 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:

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

(2) Desublimers, cold traps, or pumps used to remove UF_6 from the enrichment process for subsequent transfer upon heating;

(3) 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;

(4) “Product” or “tails” stations used for transferring UF_6 into containers.

2.2 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.

2.3 Vacuum Systems.

(a) Especially designed or prepared vacuum manifolds, vacuum headers and vacuum pumps having a suction capacity of 5 m^3 per minute or more.

(b) Vacuum pumps especially designed for service in UF_6-bearing atmospheres made of, or protected by, materials resistant to corrosion by UF_6 (See Note to this section). These pumps may be either rotary or positive displacement, may have fluorocarbon seals, and may have special working fluids present.

2.4 Special Shut-Off and Control Valves.

Especially designed or prepared bellows-sealed valves, manual or automated, shut-off or control valves, made of, or protected by, materials resistant to corrosion by UF_6, for installation in main and auxiliary systems of gaseous diffusion enrichment plants.

2.5 UF_6 Mass Spectrometers/Ion Sources.

Especially designed or prepared mass spectrometers capable of taking on-line samples from UF_6 gas streams and having all of the following:

(a) capable of measuring ions of 320 atomic mass units or greater and having a resolution of better than 1 part in 320;

(b) ion sources constructed of or protected by nickel, nickel-copper alloys with a nickel content of 60 percent or more by weight, or nickel-chrome alloys;

(c) electron bombardment ionization sources; and

(d) having a collector system suitable for isotopic analysis.

3. Any other components especially designed or prepared for use in a gaseous diffusion enrichment plant or in any of the components described in this appendix.

10. Revise appendix D to part 110 to read as follows:

Appendix D to Part 110—Illustrative List of Aerodynamic Enrichment Plant Equipment and Components under NRC Export Licensing Authority

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 included 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. Because aerodynamic processes use UF_6, all equipment, pipeline and instrumentation surfaces (that come in contact with the gas) must be made of, or protected by, materials that remain stable in contact with UF_6. All surfaces which come into contact with the process gas are made of, or protected by, UF_6-resistant materials; including copper, copper alloys, stainless steel, aluminum, aluminum oxide, aluminum alloys, nickel or alloys containing 60 percent or more nickel by weight, and fluorinated hydrocarbon polymers. The following items either come into direct contact with the UF_6 process gas or directly control the flow within the cascade:

(1) Separation nozzles and assemblies.

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, 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.

(2) Vortex tubes and assemblies.

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, and with one or more tangential inlets. The tubes may be equipped with nozzle-type appendages at either or both ends.

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.

(3) Compressors and gas blowers.

Especially designed or prepared compressors or gas blowers made of, or protected by, materials resistant to corrosion by the UF_6/carrier gas (hydrogen or helium) mixture.

(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 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) Heat exchangers for gas cooling.

Especially designed or prepared heat exchangers, made of, or protected by, materials resistant to corrosion by UF_6.

(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.

(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:

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

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

(iii) 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

(iv) “Product” or “tails” stations used for transferring UF_6 into containers.

(8) Header piping systems.

Especially designed or prepared header piping systems, made of or protected by materials resistant to corrosion by UF_6, for handling UF_6 within the aerodynamic cascades. The piping network is normally of the “double” header design with each stage or group of stages connected to each of the headers.

(9) Vacuum systems and pumps.

(i) Especially designed or prepared vacuum systems consisting of vacuum manifolds, vacuum headers and vacuum pumps, and designed for service in UF_6-bearing atmospheres.

(ii) Especially designed or prepared vacuum pumps 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.

(10) Special shut-off and control valves.

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

(11) UF_6 mass spectrometers/ion sources.

Especially designed or prepared mass spectrometers capable of taking on-line samples from UF_6 gas streams and having all of the following:

(i) Capable of measuring ions of 320 atomic mass units or greater and having a resolution of better than 1 part in 320;

(ii) Ion sources constructed of or protected by nickel, nickel-copper alloys with a nickel content of 60 percent or more by weight, or nickel-chrome alloys;

(iii) Electron bombardment ionization sources; and

(iv) Collector system suitable for isotopic analysis.

(12) UF_6/carrier gas separation systems.

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

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:

(i) Cryogenic heat exchangers and cryoseparators capable of temperatures of 153 K (-120 °C) or less;

(ii) Cryogenic refrigeration units capable of temperatures of 153 K (-120 °C) or less;

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

(iv) UF6 cold traps capable of freezing out UF_6.

(13) Any other components especially designed or prepared for use in an aerodynamic enrichment plant or in any of the components described in this appendix.

11. Revise appendix E to part 110 to read as follows:

Appendix E to Part 110—Illustrative List of Chemical Exchange or Ion Exchange Enrichment Plant Equipment and Components under NRC Export Licensing Authority

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.

A. 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.

(1) Liquid-liquid exchange columns.

Countercurrent liquid-liquid exchange columns having mechanical power input 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 normally made of, or protected by, suitable plastic materials (such as fluorinated hydrocarbon polymers) or glass. The stage residence time of the columns is normally designed to be 30 seconds or less.

(2) Liquid-liquid centrifugal contactors.

Especially designed or prepared for uranium enrichment using the chemical exchange process. These contactors use rotation to achieve dispersion of the organic and aqueous streams and then centrifugal force to separate the phases. For corrosion resistance to concentrated hydrochloric acid solutions, the contactors are normally made of, or protected by, suitable plastic materials (such as fluorinated hydrocarbon polymers) or glass. The stage residence time of the centrifugal contactors is designed to be short (30 seconds or less).

(3) Uranium reduction systems and equipment.

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

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

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. For those parts in contact with the process stream, the system is constructed of equipment made of, or protected by, materials such as glass, fluorocarbon polymers, polyphenyl sulfate, polyether sulfone, and resin-impregnated graphite.

(ii) 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.

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. For those parts in contact with the process stream, the system is constructed of equipment made of, or protected by, materials such as glass, fluorocarbon polymers, polyphenyl sulfate, polyether sulfone, and resin-impregnated graphite.

(4) Feed preparation systems.

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

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

(5) Uranium oxidation systems.

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.

These systems may incorporate equipment such as:

(i) 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; and

(ii) 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.

B. In the solid-liquid ion-exchange process, enrichment is accomplished by uranium adsorption/desorption on a special, 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 in 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.

(1) Fast reacting ion exchange resins/adsorbents.

Especially designed or prepared for uranium enrichment using the ion exchange process, including porous macroreticular resins, and/or pellicular structures in which the active chemical exchange groups are limited to a coating on the surface of an inactive porous support structure, and other composite structures in any suitable form including particles or fibers. These ion exchange resins/adsorbents have diameters of 0.2 mm or less and must be chemically resistant to concentrated hydrochloric acid solutions as well as physically strong enough so as not to degrade in the exchange columns. The resins/adsorbents are especially designed to achieve very fast uranium isotope exchange kinetics (exchange rate half-time of less than 10 seconds) and are capable of operating at a temperature in the range of 373 K (100 °C) to 473 K (200 °C).

(2) Ion exchange columns.

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 373 K (100 °C) to 473 K (200 °C) and pressures above 0.7 MPa.

(3) Ion exchange reflux systems.

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

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}.

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

The ion exchange enrichment 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}.

C. Any other components especially designed or prepared for use in a chemical exchange or ion exchange enrichment plant or in any of the components described in this appendix.

12. Revise appendix F to part 110 to read as follows:

Appendix F to Part 110—Illustrative List of Laser-Based Enrichment Plant Equipment and Components under NRC Export Licensing Authority

NOTE: Present systems for enrichment processes using lasers fall into two categories: the process medium is atomic uranium vapor and the process medium is the vapor of a uranium compound, sometimes mixed with another gas or gases. Common nomenclature for these processes include: first category-atomic vapor laser isotope separation; and second category-molecular laser isotope separation including chemical reaction by isotope selective laser activation. The systems, equipment, and components for laser enrichment plants include: (a) devices to feed uranium-metal vapor for selective photo-ionization or devices to feed the vapor of a uranium compound (for selective photo-dissociation or selective excitation/activation); (b) devices to collect enriched and depleted uranium metal as “product” and “tails” in the first category, and devices to collect enriched and depleted uranium compounds as “product” and “tails” in the second category; (c) process laser systems to selectively excite the uranium-235 species; and (d) feed preparation and product conversion equipment. The complexity of the spectroscopy of uranium atoms and compounds may require incorporation of a number of available laser and laser optics technologies.

All surfaces that come into direct contact with the uranium or UF_6 are wholly made of, or protected by, corrosion-resistant materials. For laser-based enrichment items, the materials resistant to corrosion by the vapor or liquid of uranium metal or uranium alloys include yttria-coated graphite and tantalum; and the materials resistant to corrosion by UF_6 include copper, copper alloys, stainless steel, aluminum, aluminum oxide, aluminum alloys, nickel or alloys containing 60 percent or more nickel by weight, and fluorinated hydrocarbon polymers.
Many of the following items come into direct contact with uranium metal vapor or liquid or with process gas consisting of UF_6 or a mixture of UF_6 and other gases:

(1) Uranium vaporization systems (atomic vapor based methods).

Especially designed or prepared uranium metal vaporization systems for use in laser enrichment.

These systems may contain electron beam guns and are designed to achieve a delivered power (1 kW or greater) on the target sufficient to generate uranium metal vapour at a rate required for the laser enrichment function.

(2) Liquid or vapor uranium metal handling systems and components (atomic vapor based methods).

Especially designed or prepared systems for handling molten uranium, molten uranium alloys, or uranium metal vapor.

The liquid uranium metal handling systems may consist of crucibles and cooling equipment for the crucibles. The crucibles and other system parts that come into contact with molten uranium, molten uranium alloys, or uranium metal vapor are made of, or protected by, materials of suitable corrosion and heat resistance, such as tantalum, yttria-coated graphite, graphite coated with other rare earth oxides, or mixtures thereof.

(3) Uranium metal “product” and “tails” collector assemblies (atomic vapor based methods).

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

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

(4) Separator module housings (atomic vapor based methods).

Especially designed or prepared cylindrical or rectangular vessels for containing the uranium metal vapor source, the electron beam gun, and the “product” and “tails” collectors. These housings have multiplicity of ports for electrical and water feed-throughs, laser beam windows, vacuum pump connections, and instrumentation diagnostics and monitoring with opening and closure provisions to allow refurbishment of internal components.

(5) Supersonic expansion nozzles (molecular based methods).

Especially designed or prepared supersonic expansion nozzles for cooling mixtures of UF_6 and carrier gas to 150 K (-123 ºC) or less which are corrosion resistant to UF_6.

(6) “Product” or “tails” collectors (molecular based methods).

Especially designed or prepared components or devices for collecting uranium product material or uranium tails material following illumination with laser light.

In one example of molecular laser isotope separation, the product collectors serve to collect enriched uranium pentafluoride (UF_5) solid material. The product collectors may consist of filter, impact, or cyclone-type collectors, or combinations thereof, and must be corrosion resistant to the UF_5/ UF_6 environment.

(7) UF_6/carrier gas compressors (molecular based methods).

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

(8) Rotary shaft seals (molecular based methods).

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 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.

(9) Fluorination systems (molecular based methods).

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

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 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 is used for storage and transfer of fluorine (or other suitable fluorinating agents) and for collection and transfer of UF_6.

(10) UF_6 mass spectrometers/ion sources (molecular based methods).

Especially designed or prepared mass spectrometers capable of taking on-line samples from UF_6 gas streams and having all of the following characteristics:

(i) Capable of measuring ions of 320 atomic mass units or greater and having a resolution of better than 1 part in 320;

(ii) Ion sources constructed of or protected by nickel, nickel-copper alloys with a nickel content of 60 percent or more by weight, or nickel-chrome alloys;

(iii) Electron bombardment ionization sources; and

(iv) Collector system suitable for isotopic analysis.

(11) Feed systems/product and tails withdrawal systems (molecular based methods).

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

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

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

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

(iv) “Product” or “tails” stations used to transfer UF_6 into containers.

(12) UF_6/carrier gas separation systems (molecular based methods).

Especially designed or prepared process systems for separating UF_6 from carrier gas.

These systems may incorporate equipment such as:

(i) Cryogenic heat exchangers or cryoseparators capable of temperatures of 153 K (-120 °C) or less;

(ii) Cryogenic refrigeration units capable of temperatures of 153 K (-120 °C) or less; or

(iii) UF_6 cold traps capable of freezing out UF_6.

(13) Lasers or Laser systems.

Especially designed or prepared for the separation of uranium isotopes.

The laser system typically contains both optical and electronic components for the management of the laser beam (or beams) and the transmission to the isotope separation chamber. The laser system for atomic vapor based methods usually consists of tunable dye lasers pumped by another type of laser (e.g., copper vapor lasers or certain solid-state lasers). The laser system for molecular based methods may consist of CO_2 lasers or excimer lasers and a multi-pass optical cell. Lasers or laser systems for both methods require spectrum frequency stabilization for operation over extended periods of time.

(14) Any other components especially designed or prepared for use in a laser-based enrichment plant or in any of the components described in this appendix.

13. Revise appendix G to part 110 to read as follows:

Appendix G to Part 110—Illustrative List of Plasma Separation Enrichment Plant Equipment and Components under NRC Export Licensing Authority

NOTE: In the plasma separation process, a plasma of uranium ions passes through an electric field tuned to the ^{235}U 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 ^{235}U. The plasma, made by ionizing uranium vapor, is contained in a vacuum chamber with a high-strength magnetic field produced by a superconducting magnet. The main technological systems of the process include the uranium plasma generation system, the separator module with superconducting magnet, and metal removal systems for the collection of “product” and “tails.”

(1) Microwave power sources and antennae.

Especially designed or prepared microwave power sources and antennae for producing or accelerating ions having the following characteristics: greater than 30 GHz frequency and greater than 50 kW mean power output for ion production.

(2) Ion excitation coils.

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

(3) Uranium plasma generation systems.

Especially designed or prepared systems for the generation of uranium plasma for use in plasma separation plants.

(4) Uranium metal “product” and “tails” collector assemblies.

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

(5) Separator module housings.

Especially designed or prepared cylindrical vessels for use in plasma separation enrichment plants for containing the uranium plasma source, radio-frequency drive coil, and the “product” and “tails” collectors.

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.

(6) Any other components especially designed or prepared for use in a plasma separation enrichment plant or in any of the components described in this appendix.

14. In appendix H to part 110, add a new paragraph (4) to read as follows:

Appendix H to Part 110—Illustrative List of Electromagnetic Enrichment Plant Equipment and Components under NRC Export Licensing Authority

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(4) Any other components especially designed or prepared for use in an electromagnetic enrichment plant or in any of the components described in this appendix.

15. Revise appendix I to part 110 to read as follows:

Appendix I to Part 110—Illustrative List of Reprocessing Plant Components under NRC Export Licensing Authority

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 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.

(1) Irradiated fuel element chopping machines.

Remotely operated equipment especially designed or prepared for use in a reprocessing plant and intended to cut, chop, or shear irradiated nuclear fuel assemblies, bundles, or rods. 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.

(2) Dissolvers.

Critically safe tanks (e.g. small diameter, annular, or slab tanks) especially designed or prepared for use in a reprocessing plant, 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.

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.

(3) Solvent extractors and solvent extraction equipment.

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

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.

(4) Chemical holding or storage vessels.

Especially designed or prepared holding or storage vessels for use in a plant for the reprocessing of irradiated fuel. The holding or storage vessels must be resistant to the corrosive effect of nitric acid. The holding or storage vessels are normally fabricated of materials such as low carbon stainless steels, titanium or zirconium, or other high quality materials. Holding or storage vessels may be designed for remote operation and maintenance and may have the following features for control of nuclear criticality:

(i) Walls or internal structures with a boron equivalent of at least 2 percent, or

(ii) A maximum diameter of 175 mm (7 in) for cylindrical vessels, or

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

(5) Neutron measurement systems for process control.

Neutron measurement systems especially designed or prepared for integration and use with automated process control systems in a plant for the reprocessing of irradiated fuel elements. These systems involve the capability of active and passive neutron measurement and discrimination in order to determine the fissile material quantity and composition. The complete system is composed of a neutron generator, a neutron detector, amplifiers, and signal processing electronics.

The scope of this entry does not include neutron detection and measurement instruments that are designed for nuclear material accountancy and safeguarding or any other application not related to integration and use with automated process control systems in a plant for the reprocessing of irradiated fuel elements.

(6) Plutonium nitrate to plutonium oxide conversion systems. 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.

(7) Plutonium metal production systems. 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.

(8) Process control instrumentation specially designed or prepared for monitoring or controlling the processing of material in a reprocessing plant.

(9) Any other components especially designed or prepared for use in a reprocessing plant or in any of the components described in this appendix.

16. In appendix J to part 110, add a new paragraph (c) to read as follows:

Appendix J to Part 110—Illustrative List of Uranium Conversion Plant Equipment and Plutonium Conversion Plant Equipment under NRC Export Licensing Authority

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(c) Any other components especially designed or prepared for use in a uranium conversion plant or plutonium conversion plant or in any of the components described in this appendix.

17. Revise appendix K to part 110 to read as follows:

Appendix K to Part 110—Illustrative List of Equipment and Components under NRC Export Licensing Authority for Use in a Plant for the Production of Heavy Water, Deuterium and Deuterium Compounds

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

A. 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 percent in deuterium, is sent to a distillation unit to produce reactor grade heavy water; i.e., 99.75 percent deuterium oxide.

B. 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 then to an ammonia converter. Inside the towers the gas flows from the bottom to the top while the liquid ammonia flows from the top to the bottom. The deuterium is stripped from the hydrogen in the synthesis gas and concentrated in the ammonia. The ammonia then flows into an ammonia cracker at the bottom of the tower while the gas flows into an ammonia converter at the top. Further enrichment takes place in subsequent stages and reactor-grade heavy water is produced through final distillation. The synthesis gas feed can be provided by an ammonia plant that 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.

C.1. Much of the key equipment for heavy water production plants using either the GS process or the ammonia-hydrogen exchange process are common to several segments of the chemical and petroleum industries; particularly in small plants using the GS process. However, few items are available “off-the-shelf.” Both processes require the handling of large quantities of flammable, corrosive, and toxic fluids at elevated pressures. Therefore, in establishing the design and operating standards for plants and equipment using these processes, careful attention to materials selection and specifications is required to ensure long service life with high safety and reliability factors. The choice is primarily a function of economics and need. Most equipment, therefore, is prepared to customer requirements.

In both processes, equipment which individually is not especially designed or prepared for heavy water production can be assembled into especially designed or prepared systems for producing heavy water. Examples of such systems are the catalyst production system used in the ammonia-hydrogen exchange process and the water distillation systems used for the final concentration of heavy water to reactor-grade in either process.

C.2. Equipment especially designed or prepared for the production of heavy water utilizing either the water-hydrogen sulphide exchange process or the ammonia-hydrogen exchange process:

(i) Water-hydrogen Sulphide Exchange Towers.

Exchange towers with diameters of 1.5 m or greater and capable of operating at pressures greater than or equal to 2 MPa (300 psi) especially designed or prepared for heavy water production utilizing the water-hydrogen sulphide exchange process.

(ii) 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 percent H2S). The blowers or compressors have a throughput capacity greater than or equal to 56 m^3/second (120,000 standard cubic feet per minute) while operating at pressures greater than or equal to 1.8 MPa (260 psi) suction and have seals designed for wet H2S service.

(iii) 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). The towers 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.

(iv) Tower Internals and Stage Pumps Used in the Ammonia-hydrogen Exchange Process.

Tower internals include especially designed stage contactors which promote intimate gas/liquid contact. Stage pumps include especially designed submersible pumps for circulation of liquid ammonia within a contacting stage internal to the stage towers.

(v) Ammonia Crackers Utilizing the Ammonia-hydrogen Exchange Process.

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.

(vi) Ammonia Synthesis Converters or Synthesis Units.

Ammonia synthesis converters or synthesis units especially designed or prepared for heavy water production utilizing the ammonia-hydrogen exchange process.

These converters or units take synthesis gas (nitrogen and hydrogen) from an ammonia/hydrogen high-pressure exchange column (or columns), and the synthesized ammonia is returned to the exchange column (or columns).

(vii) Infrared Absorption Analyzers.

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

(viii) Catalytic Burners Used in the Ammonia-hydrogen Exchange Process.

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.

(ix) Complete Heavy Water Upgrade Systems or Columns.

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

D. Any other components especially designed or prepared for use in a plant for the production of heavy water, deuterium, and deuterium compounds or in any of the components described in this appendix.

18. Revise appendix M to part 110 to read as follows:

Appendix M to Part 110—Categorization of Nuclear Material

Categorization of Nuclear Material

[From IAEA INFCIRC/225/Revision 5]

Material	Form	Category I	Category II	Category III[3]
1. Plutonium[1]	Unirradiated[2]	2 kg or more	Less than 2 kg but more than 500 g	500 g or less but more than 15 g
2. Uranium-235 (^{235}U)	Unirradiated[2] - Uranium enriched to 20 percent ^{235}U or more - Uranium enriched to 10 percent ^{235}U but less than 20 percent ^{235}U - Uranium enriched above natural, but less than	5 kg or more	Less than 5 kg but more than 1 kg 10 kg or more	1 kg or less but more than 15 g Less than 10 kg but more than 1 kg 10 kg or more

	10 percent ^{235}U			
3. Uranium-233 (^{233}U)	Unirradiated[2]	2 kg or more	Less than 2 kg but more than 500 g	500 g or less but more than 15 g
4. Irradiated Fuel (The categorization of irradiated fuel in the table is based on international *transport* considerations. The State may assign a different category for domestic use, storage and *transport* taking all relevant factors into account)			Depleted or natural uranium, thorium or low enriched fuel (less than 10 percent fissile content)[4, 5]	

[1] All plutonium except that with isotopic concentration exceeding 80 percent in plutonium-238.

[2] Material not irradiated in a reactor or material irradiated in a reactor but with a radiation level equal to or less than 1 Gy/h (100 rad/h) at 1 m unshielded.

[3] Quantities not falling in Category III and natural uranium, depleted uranium and thorium should be protected at least in accordance with prudent management practice.

[4] Although this level of protection is recommended, it would be open to States, upon evaluation of the specific circumstances, to assign a different category of physical protection.

[5] Other fuel which by virtue of its original fissile material content is classified as Category I or II before irradiation may be reduced one category level while the radiation level from the fuel exceeds 1 Gy/h (100 rad/h) at one meter unshielded.

19. In appendix N to part 110, add a new paragraph c. to read as follows:

Appendix N to Part 110—Illustrative List of Lithium Isotope Separation Facilities, Plants and Equipment under NRC's Export Licensing Authority

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c. Any other components especially designed or prepared for use in a reprocessing plant or in any of the components described in this appendix.

20. Revise appendix O to part 110 to read as follows:

Appendix O to Part 110—Illustrative List of Fuel Element Fabrication Plant Equipment and Components under NRC's Export Licensing Authority

NOTE: Nuclear fuel elements are manufactured from source or special nuclear material. For oxide fuels, the most common type of fuel equipment for pressing pellets, sintering, grinding and grading will be present. Mixed oxide fuels are handled in glove boxes (or equivalent containment) until they are sealed in the cladding. In all cases, the fuel is hermetically sealed inside a suitable cladding which is designed to be the primary envelope encasing the fuel so as to provide suitable performance and safety during reactor operation. Also, in all cases, precise control of processes, procedures and equipment to extremely high standards is necessary in order to ensure predictable and safe fuel performance.

(a) Items that are considered especially designed or prepared for the fabrication of fuel elements include equipment that:

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

(2) Seals the nuclear material within the cladding;

(3) Checks the integrity of the cladding or the seal;

(4) Checks the finished treatment of the sealed fuel; or

(5) Is used for assembling reactor fuel elements.

(b) This equipment or systems of equipment may include, for example:

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

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

(3) Automatic test and inspection stations especially designed or prepared for checking the integrity of completed fuel pins (or rods). This item typically includes equipment for:

(i) X-ray examination of pin (or rod) end cap welds;

(ii) Helium leak detection from pressurized pins (or rods); and

(iii) Gamma-ray scanning of the pins (or rods) to check for correct loading of the fuel pellets inside.

(4) Systems especially designed or prepared to manufacture nuclear fuel cladding.

(c) Any other components especially designed or prepared for use in a fuel element fabrication plant or in any of the components described in this appendix.

Dated at Rockville, Maryland, this 18th day of June, 2014.

For the Nuclear Regulatory Commission.

Mark A. Satorius,

Executive Director for Operations.

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