

84.01

84.01 - Nuclear reactors; fuel elements (cartridges), non-irradiated, for nuclear reactors; machinery and apparatus for isotopic separation.

8401.10 - Nuclear reactors

8401.20 - Machinery and apparatus for isotopic separation, and parts thereof

8401.30 - Fuel elements (cartridges), non-irradiated

8401.40 - Parts of nuclear reactors

(I) NUCLEAR REACTORS

The term nuclear reactor covers, in general, all the apparatus and appliances inside the area screened off by the biological shield including, where appropriate, the shield itself. It also includes any other apparatus and appliances **outside** that area, **provided** they form an **integral** part of those contained **inside** the screen.

A nuclear reactor generally comprises :

(A) **The core**, consisting of :

- (1) **The fuel (fissile or fertile)**. This may be dissolved or dispersed in the moderator (homogeneous reactor) or concentrated in fuel elements (cartridges) (heterogeneous reactors).
- (2) **The moderator** and, where appropriate, the neutron reflector (e.g., beryllium, graphite, water, heavy water, certain hydrocarbons such as diphenyl or terphenyls).
- (3) **The coolant**. This serves to remove the heat generated by the reactor (carbon dioxide, helium, water, heavy water, molten sodium or bismuth, a molten sodium-potassium mixture, molten salts, certain hydrocarbons, etc., are frequently used for this purpose). The moderator, however, also often acts as a coolant.
- (4) **The control rods**, of materials with a high neutron absorption capacity (e.g., boron, cadmium, hafnium) or of alloys or compounds of such materials.

(B) **The mechanical structure** (for example, the reactor vessel; the fuel element (cartridges) loading grid; the piping and tubing for the conveyance of the coolant; the valves; the control rod operating mechanism, etc.).

(C) **The measuring, checking and automatic-control instruments** (e.g., neutron sources, ionisation chambers, thermocouples, telecameras, pressure or flow meters).

(D) **The thermal and biological shields** (of steel, concrete, lead, etc.).

Certain other machinery, apparatus and appliances may also be used in nuclear plant and may even be located inside the area screened off by the biological shield. These are **not** regarded as having thereby acquired the essential character of parts of a nuclear reactor and must therefore be classified in their own appropriate headings (see **exclusions** (c) to (ij) below).

The nature, characteristic features and manner of assembly of the component parts of nuclear reactors may, however, differ considerably. The various types of reactors are generally distinguished by reference to :

- (1) The energy of the neutrons propagating the chain reaction (e.g., thermal (or slow), intermediate or fast reactors).
- (2) The distribution of the fissile material in the core of the reactor (e.g., homogeneous reactors or heterogeneous reactors).
- (3) The intended use (e.g., research reactors, isotope producing reactors, material testing reactors, reactors for the conversion of fertile materials into fissile material (converters or breeders), propulsion reactors, thermal or electrical energy producing reactors).
- (4) The nature of the materials used or the principle of operation (e.g., natural uranium, enriched uranium, uranium-thorium, sodium-graphite, gaseous-graphite, pressurised water, pressurised heavy water, boiling water, swimming pool, organic moderator type reactors).

In general, the size of a reactor is so calculated as to be at least “critical”, so that any outward loss of neutrons shall never be sufficient to interrupt the chain reaction. However, for research purposes, “subcritical” reactors, which require additional sources of neutrons, may sometimes be used. These reactors are also included in this heading.

Separately presented parts of nuclear reactors are, in general, classified in accordance with the provisions of Note 2 to Section XVI.

Control rods and the corresponding mechanisms, the neutron sources fitted to initiate the fission reaction of the reactor, the vessel, the grid for insertion of the fuel elements (cartridges) and the pressurisers for pressurised water reactors are, therefore, classified in this heading as parts of nuclear reactors.

The following goods are, however, **not** regarded as parts of nuclear reactors :

- (a) Blocks of graphite (**heading 38.01 or 68.15**), beryllium (**heading 81.12**), or beryllium oxide (**heading 69.14**).
- (b) Metal tubes and pipes, in special forms, or merely shaped but not otherwise worked, presented unassembled, whether or not identifiable as for the construction of nuclear reactors (**Section XV**).
- (c) Steam and other vapour generating boilers (**heading 84.02**).
- (d) Heat exchangers (**heading 84.04 or 84.19**).
- (e) Steam turbines and other vapour turbines (**heading 84.06**).
- (f) Pumps (**heading 84.13 or 84.14**).
- (g) Blowers (**heading 84.14**).
- (h) Apparatus for extracting minerals from water (generally **heading 84.19 or 84.21**).
- (ij) Handling machinery for changing or extracting the fuel elements and travelling cranes (generally **heading 84.26**).
- (k) Mechanical remote control manipulators for radioactive products (**heading 84.28**).

(II) MACHINERY AND APPARATUS FOR ISOTOPIC SEPARATION

This group covers all mechanical, thermal or electrical apparatus and devices specially designed for the enrichment of a chemical element or of a compound of that element in one of its isotopes, or for the complete separation of the constituent isotopes.

The most important are those used for the production of heavy water (deuterium oxide) or for the enrichment of uranium in U 235.

The apparatus and devices used for the production of heavy water by enrichment of natural water include :

- (1) Special fractional distillation and rectification apparatus comprising a very large number of plates arranged in clusters and in cascade and utilising the slight difference in boiling point between heavy water and normal water to obtain head fractions which are continually more depleted in heavy water and tail fractions which are continually more enriched.
- (2) Apparatus which, by low-temperature fractional distillation of liquid hydrogen, separates the deuterium, which can then be combusted to obtain heavy water.
- (3) Apparatus for the production of heavy water or deuterium compounds, based on isotopic exchange, sometimes in the presence of catalytic agents, for example by the "dual-temperature" method or by contact of different liquid or gaseous hydrogenous phases.
- (4) Electrolytic cells intended for the production of heavy water by water electrolysis, and apparatus combining electrolysis with isotopic exchange between the hydrogen produced and the originating water itself.

For the enrichment of uranium in U 235, the following apparatus is most often used :

- (1) Special centrifuges called "gas" (uranium hexafluoride) centrifuges, whose cylindrical rotor ("bowl"), of plastic material or steel, rotates at very high speeds.

These centrifuges are treated internally against the corrosive effects of uranium hexafluoride. In practice, a very large number of units is used, arranged in cascade and operating down-current or counter-current.

- (2) Uranium isotope separators (gaseous diffusion type). In this equipment, gaseous uranium hexafluoride is separated into two fractions, with slightly different contents of uranium 235 compared to the starting gas, by diffusion through a porous membrane ("barrier") inside a diffusion chamber (which may be tubular). By repeating the operation many times pure uranium 235 hexafluoride can be obtained.
- (3) "Nozzle" apparatus (Becker process), in which a stream of gas (uranium hexafluoride and helium or hydrogen) is injected at high speed into a highly incurved nozzle. A "paring tube" at the outlet separates the enriched fraction of uranium hexafluoride.

Calutrons for electro-magnetic separation are also classified in this heading.

Subject to the general provisions regarding the classification of parts (see the General Explanatory Note to Section XVI), parts of the machines and apparatus of this group are also covered.

(III) FUEL ELEMENTS (CARTRIDGES) NON-IRRADIATED, FOR NUCLEAR REACTORS

Fuel elements (cartridges), non-irradiated, for nuclear reactors consist of fissile or fertile material contained in a sheath, generally of base metal (e.g., of zirconium, aluminium, magnesium, stainless steel), fitted with special attachments for handling.

Fissile fuel elements may contain natural uranium, either in the metallic state or as compounds (oxides, carbides, nitrides, etc.), uranium enriched in uranium 235 or 233 or in plutonium, either in the metallic state or as compounds, or thorium enriched in plutonium. Fertile fuel elements (for example, with thorium or depleted uranium), when placed at the periphery of the reactor to reflect neutrons, become fissile after absorbing some of the neutrons.

Fuel elements are of different types, for example :

- (1) Combustible metals or alloys thereof in the form of bars or tubes sheathed in base metal. This metallic sheath may be flanged to facilitate heat exchange, and the element may be fitted with a support and a head for convenience of insertion into and extraction from the reactor.
- (2) Dispersions of the fissile fuel in graphite in the form of bars, plates or spheres encased in graphite or consisting of other types of dispersions and cermets. These are flanged or fitted in the same way as the fuel elements (cartridges) described in (1) above.
- (3) An assembly of :
 - (i) A series of sandwiched plates consisting of the fissile or fertile fuel (metal or ceramic compound) coated on the outside with inert metal.
 - (ii) Inert metal tubes filled with pellets of uranium dioxide or carbide.
 - or
 - (iii) Concentric fissile metal tubes sheathed with inert metal.

All these types of fuel elements (cartridges) are fitted with supports which also serve to keep them spaced apart and fixed in place; they often have an outer casing. All the sub-elements constituting these fuel elements (cartridges) are mounted on a common base and attached to a common head.

Presented separately, these sub-elements (e.g., stainless steel sheaths filled with nuclear fuel and sealed) are classified as **parts** of fuel elements (cartridges).

Microspheres of nuclear fuel coated with layers of carbon or silicon carbide, intended for introduction into spherical or prismatic fuel elements, and spent (irradiated) fuel elements (cartridges), fall in **heading 28.44**.

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The heading also **excludes** :

- (a) Furnaces for the separation of irradiated nuclear fuel by pyrometallurgical processes (**heading 84.17** or **85.14**, as the case may be).
- (b) Separators for irradiated fuels or for processing effluents, operating by fractional distillation (**other than those for the production of heavy water**) (**heading 84.19**).
- (c) Air filters specially designed to eliminate radioactive dust (physical or electrostatic types); active-charcoal purifiers for retaining radioactive iodine; ion-exchange apparatus for the separation of radioactive elements, including such apparatus operating by electrodialysis; separators for irradiated fuels or for processing effluents, whether operating by ion-exchange or operating chemically (**heading 84.21**).