

SECTION G — PHYSICS

G21 NUCLEAR PHYSICS; NUCLEAR ENGINEERING

G21C NUCLEAR REACTORS (fusion reactors, hybrid fission-fusion reactors G21B; nuclear explosives G21J)

Subclass index

REACTORS.....	1/00
REACTOR ELEMENTS	
Fuel; moderator; cooling; containment; shielding.....	3/00, 5/00, 15/00, 13/00, 11/00
Handling fuel and other materials.....	19/00
CONTROL; MONITORING; TESTING.....	7/00, 17/00
EMERGENCY PROTECTION.....	9/00
MANUFACTURE.....	21/00
ADAPTATIONS OF REACTORS FOR EXPERIMENTATION OR IRRADIATION.....	23/00

1/00 Reactors [1, 2006.01]	
1/01 • General details not provided for in groups G21C 3/00-G21C 19/00 [3, 2006.01]	1/32 • Integral reactors, i.e. reactors wherein parts functionally associated with the reactor but not essential to the reaction, e.g. heat exchangers, are disposed inside the enclosure with the core (G21C 1/02-G21C 1/30 take precedence) [3, 2006.01]
1/02 • Fast fission reactors, i.e. reactors not using a moderator [1, 2006.01]	
1/03 • • cooled by a coolant not essentially pressurised, e.g. pool-type reactors [5, 2006.01]	
1/04 • Thermal reactors [1, 2006.01]	3/00 Reactor fuel elements or their assemblies; Selection of substances for use as reactor fuel elements [1, 2006.01]
1/06 • • Heterogeneous reactors, i.e. in which fuel and moderator are separated [1, 2006.01]	3/02 • Fuel elements [1, 2006.01]
1/07 • • • Pebble-bed reactors; Reactors with granular fuel [5, 2006.01]	3/04 • • Constructional details [1, 2006.01]
1/08 • • • moderator being highly pressurised, e.g. boiling-water reactor, integral-superheat reactor, pressurised-water reactor (G21C 1/22 takes precedence) [1, 2006.01]	3/06 • • • Casings; Jackets [1, 2006.01]
1/09 • • • • Pressure regulating arrangements, i.e. pressurisers [5, 2006.01]	3/07 • • • • characterised by their material, e.g. alloys [5, 2006.01]
1/10 • • • • moderator and coolant being different or separated [1, 2006.01]	3/08 • • • • provided with external means to promote heat-transfer, e.g. fins, baffles, corrugations [1, 2006.01]
1/12 • • • • • moderator being solid, e.g. Magnox reactor [1, 2006.01]	3/10 • • • • End closures [1, 2006.01]
1/14 • • • • moderator being substantially not pressurised, e.g. swimming-pool reactor (G21C 1/22 takes precedence) [1, 2006.01]	3/12 • • • • Means forming part of the element for locating it within the reactor core; External spacers for this purpose [1, 2006.01]
1/16 • • • • • moderator and coolant being different or separated, e.g. sodium-graphite reactor [1, 2006.01]	3/14 • • • • Means forming part of the element for inserting it into, or removing it from, the core; Means for coupling adjacent elements [1, 2006.01]
1/18 • • • • • coolant being pressurised [1, 2006.01]	3/16 • • • Details of the construction within the casing [1, 2006.01]
1/20 • • • • • • moderator being liquid, e.g. pressure- tube reactor [1, 2006.01]	3/17 • • • • Means for storage or immobilisation of gases in fuel elements [5, 2006.01]
1/22 • • • using liquid or gaseous fuel [1, 2006.01]	3/18 • • • • Internal spacers or other non-active material within the casing, e.g. compensating for expansion of fuel rods or for compensating excess reactivity (interlayers G21C 3/20) [1, 2006.01]
1/24 • • Homogeneous reactors, i.e. in which fuel and moderator present an effectively homogeneous medium to the neutrons [1, 2006.01]	3/20 • • • • with coating on fuel or on inside of casing; with non-active interlayer between casing and active material [1, 2006.01]
1/26 • • • Single-region reactors [1, 2006.01]	3/22 • • with fissile or breeder material in contact with coolant [1, 2006.01]
1/28 • • • Two-region reactors [1, 2006.01]	3/24 • • with fissile or breeder material in fluid form within a non-active casing [1, 2006.01]
1/30 • Subcritical reactors [1, 2006.01]	

- 3/26 • • with fissile or breeder material in powder form within a non-active casing [1, 2006.01]
- 3/28 • • with fissile or breeder material in solid form within a non-active casing [1, 2006.01]
- 3/30 • Assemblies of a number of fuel elements in the form of a rigid unit [1, 2006.01]
- 3/32 • • Bundles of parallel pin-, rod-, or tube-shaped fuel elements [1, 2006.01]
- 3/322 • • • Means to influence the coolant flow through or around the bundles [5, 2006.01]
- 3/324 • • • Coats or envelopes for the bundles [5, 2006.01]
- 3/326 • • • comprising fuel elements of different composition; Comprising, in addition to the fuel elements, other pin-, rod-, or tube-shaped elements, e.g. control rods, grid support rods, fertile rods, poison rods or dummy rods [5, 2006.01]
- 3/328 • • • • Relative disposition of the elements in the bundle lattice [5, 2006.01]
- 3/33 • • • Supporting or hanging of elements in the bundle (spacer grids G21C 3/34); Means forming part of the bundle for inserting it into, or removing it from, the core; Means for coupling adjacent bundles [5, 2006.01]
- 3/332 • • • • Supports for spacer grids [5, 2006.01]
- 3/334 • • • Assembling the bundles [5, 2006.01]
- 3/335 • • • Exchanging elements in irradiated bundles [5, 2006.01]
- 3/336 • • • Spacer elements for fuel rods in the bundle (spacer grids G21C 3/34) [5, 2006.01]
- 3/338 • • • • Helicoidal spacer elements [5, 2006.01]
- 3/34 • • • Spacer grids [1, 2006.01]
- 3/344 • • • • formed of assembled tubular elements [5, 2006.01]
- 3/348 • • • • formed of assembled non-intersecting strips [5, 2006.01]
- 3/352 • • • • formed of assembled intersecting strips [5, 2006.01]
- 3/356 • • • • being provided with fuel element supporting members [5, 2006.01]
- 3/36 • • Assemblies of plate-shaped fuel elements or coaxial tubes [1, 2006.01]
- 3/38 • Fuel units consisting of a single fuel element in a supporting sleeve [1, 2006.01]
- 3/40 • Structural combination of fuel element with thermoelectric element for direct production of electric energy from fission heat (structural combination of fuel element with instruments for temperature measurement G21C 17/112) [1, 2006.01]
- 3/42 • Selection of substances for use as reactor fuel [1, 2006.01]
- 3/44 • • Fluid or fluent reactor fuel [1, 2006.01]
- 3/46 • • • Aqueous compositions [1, 2006.01]
- 3/48 • • • • True or colloidal solutions of the active constituent [1, 2006.01]
- 3/50 • • • • Suspensions of the active constituent; Slurries [1, 2006.01]
- 3/52 • • • Liquid metal compositions [1, 2006.01]
- 3/54 • • • Fused salt, oxide, or hydroxide compositions [1, 2006.01]
- 3/56 • • • Gaseous compositions; Suspensions in a gaseous carrier [1, 2006.01]
- 3/58 • • Solid reactor fuel [1, 2006.01]
- 3/60 • • • Metallic fuel; Intermetallic dispersions [1, 2006.01]
- 3/62 • • • Ceramic fuel [1, 2006.01]

- 3/64 • • • • Ceramic dispersion fuel, e.g. cermet [1, 2006.01]
- 5/00 **Moderator or core structure; Selection of materials for use as moderator [1, 2006.01]**
- 5/02 • Details [1, 2006.01]
- 5/04 • • Spatial arrangements allowing for Wigner growth [1, 2006.01]
- 5/06 • • Means for locating or supporting fuel elements [1, 2006.01]
- 5/08 • • Means for preventing undesired asymmetric expansion of the complete structure [1, 2006.01]
- 5/10 • • Means for supporting the complete structure [1, 2006.01]
- 5/12 • characterised by composition, e.g. the moderator containing additional substances which ensure improved heat resistance of the moderator [1, 2006.01]
- 5/14 • characterised by shape [1, 2006.01]
- 5/16 • • Shape of its constituent parts [1, 2006.01]
- 5/18 • characterised by the provision of more than one active zone [1, 2006.01]
- 5/20 • • wherein one zone contains fissile material and another zone contains breeder material [1, 2006.01]
- 5/22 • • wherein one zone is a superheating zone [1, 2006.01]
- 7/00 **Control of nuclear reaction [1, 2006.01]**
- 7/02 • by using self-regulating properties of reactor materials (arrangements that involve temperature stability G21C 7/32) [1, 2006.01]
- 7/04 • • of burnable poisons (burnable poisons in fuel rods G21C 3/326) [1, 5, 2006.01]
- 7/06 • by application of neutron-absorbing material, i.e. material with absorption cross-section very much in excess of reflection cross-section [1, 2006.01]
- 7/08 • • by displacement of solid control elements, e.g. control rods [1, 2006.01]
- 7/10 • • • Construction of control elements [1, 2006.01]
- 7/103 • • • • Control assemblies containing one or more absorbants as well as other elements, e.g. fuel or moderator elements [5, 2006.01]
- 7/107 • • • • Control elements adapted for pebble-bed reactors [5, 2006.01]
- 7/11 • • • • Deformable control elements, e.g. flexible, telescopic, articulated [5, 2006.01]
- 7/113 • • • • Control elements made of flat elements; Control elements having cruciform cross-section [5, 2006.01]
- 7/117 • • • • Clusters of control rods; Spider construction [5, 2006.01]
- 7/12 • • • Means for moving control elements to desired position (dropping control rods into the reactor core in an emergency G21C 9/02) [1, 2006.01]
- 7/14 • • • • Mechanical drive arrangements [1, 2006.01]
- 7/16 • • • • Hydraulic or pneumatic drive arrangements [1, 2006.01]
- 7/18 • • • Means for obtaining differential movement of control elements [1, 2006.01]
- 7/20 • • • Disposition of shock-absorbing devices [1, 2006.01]
- 7/22 • • by displacement of a fluid or fluent neutron-absorbing material [1, 2006.01]
- 7/24 • • Selection of substances for use as neutron-absorbing material [1, 2006.01]

7/26	• by displacement of the moderator or parts thereof [1, 2006.01]	15/00	Cooling arrangements within the pressure vessel containing the core; Selection of specific coolants [1, 2006.01]
7/27	• • Spectral shift control [5, 2006.01]	15/02	• Arrangement or disposition of passages in which heat is transferred to the coolant, e.g. for coolant circulation through the supports of the fuel elements [1, 2006.01]
7/28	• by displacement of the reflector or parts thereof [1, 2006.01]	15/04	• • from fissile or breeder material [1, 2006.01]
7/30	• by displacement of reactor fuel or fuel elements [1, 2006.01]	15/06	• • • in fuel elements [1, 2006.01]
7/32	• by varying flow of coolant through the core [1, 2006.01]	15/08	• • from moderating material [1, 2006.01]
7/34	• by utilisation of a primary neutron source [1, 2006.01]	15/10	• • from reflector or thermal shield [1, 2006.01]
7/36	• Control circuits [1, 2006.01]	15/12	• • from pressure vessel; from containment vessel [1, 2006.01]
9/00	Emergency protection arrangements structurally associated with the reactor (emergency cooling arrangements G21C 15/18) [1, 2006.01]	15/14	• • from ducts conducting a hot fluid; from ducts comprising auxiliary apparatus, e.g. pumps, cameras [1, 2006.01]
9/004	• Pressure suppression [5, 2006.01]	15/16	• comprising means for separating liquid and steam [1, 2006.01]
9/008	• • by rupture-discs or -diaphragms [5, 2006.01]	15/18	• Emergency cooling arrangements; Removing shut-down heat [1, 2006.01]
9/012	• • by thermal accumulation or by steam condensation, e.g. ice condensers [5, 2006.01]	15/20	• Partitions or thermal insulation between fuel channel and moderator, e.g. in pressure tube reactors [1, 2006.01]
9/016	• Core catchers [5, 2006.01]	15/22	• Structural association of coolant tubes with headers or other pipes, e.g. in pressure tube reactors [1, 4, 2006.01]
9/02	• Means for effecting very rapid reduction of the reactivity factor under fault conditions, e.g. reactor fuse [1, 2006.01]	15/24	• Promoting flow of the coolant [1, 2006.01]
9/027	• • by fast movement of a solid, e.g. pebbles [5, 2006.01]	15/243	• • • for liquids [5, 2006.01]
9/033	• • by an absorbent fluid [5, 2006.01]	15/247	• • • for liquid metals [5, 2006.01]
9/04	• Means for suppressing fires [1, 2006.01]	15/25	• • • using jet pumps [5, 2006.01]
9/06	• • Means for preventing accumulation of explosives gases, e.g. recombiners [5, 2006.01]	15/253	• • • for gases, e.g. blowers [5, 2006.01]
11/00	Shielding structurally associated with the reactor [1, 2006.01]	15/257	• • using heat-pipes [5, 2006.01]
11/02	• Biological shielding [1, 2006.01]	15/26	• • by convection, e.g. using chimneys, using divergent channels [1, 2006.01]
11/04	• • on waterborne craft [1, 2006.01]	15/28	• Selection of specific coolants (if serving as the moderator G21C 5/12) [1, 2006.01]
11/06	• Reflecting shields, i.e. for minimising loss of neutrons [1, 2006.01]	17/00	Monitoring; Testing [1, 2006.01]
11/08	• Thermal shields; Thermal linings, i.e. for dissipating heat from gamma radiation which would otherwise heat an outer biological shield [1, 2006.01]	17/003	• Remote inspection of vessels, e.g. pressure vessels [5, 2006.01]
13/00	Pressure vessels; Containment vessels; Containment in general [1, 2006.01]	17/007	• • Inspection of the outer surfaces of vessels [5, 2006.01]
13/02	• Details [1, 2006.01]	17/01	• • Inspection of the inner surfaces of vessels [5, 2006.01]
13/024	• • Supporting constructions for pressure vessels or containment vessels [5, 2006.01]	17/013	• • Inspection vehicles [5, 2006.01]
13/028	• • Seals, e.g. for pressure vessels or containment vessels [5, 2006.01]	17/017	• Inspection or maintenance of pipe-lines or tubes in nuclear installations [5, 2006.01]
13/032	• • Joints between tubes and vessel walls, e.g. taking into account thermal stresses [5, 2006.01]	17/02	• Devices or arrangements for monitoring coolant or moderator [1, 2006.01]
13/036	• • • the tube passing through the vessel wall, i.e. continuing on both sides of the wall [5, 2006.01]	17/022	• • for monitoring liquid coolants or moderators [5, 2006.01]
13/04	• • Arrangements for expansion and contraction [1, 2006.01]	17/025	• • • for monitoring liquid metal coolants [5, 2006.01]
13/06	• • Sealing-plugs [1, 2006.01]	17/028	• • for monitoring gaseous coolants [5, 2006.01]
13/067	• • • for tubes, e.g. standpipes; Locking devices for plugs [5, 2006.01]	17/032	• • Reactor-coolant flow measuring or monitoring [5, 2006.01]
13/073	• • • Closures for reactor-vessels, e.g. rotatable [5, 2006.01]	17/035	• • Moderator- or coolant-level detecting devices [5, 2006.01]
13/08	• Vessels characterised by the material; Selection of materials for pressure vessels [1, 2006.01]	17/038	• • Boiling detection in moderator or coolant [5, 2006.01]
13/087	• • Metallic vessels [5, 2006.01]	17/04	• • Detecting burst slugs [1, 2006.01]
13/093	• • Concrete vessels [5, 2006.01]	17/06	• Devices or arrangements for monitoring or testing fuel or fuel elements outside the reactor core, e.g. for burn-up, for contamination (G21C 17/08, G21C 17/10 take precedence; detecting leaking fuel elements during reactor operation G21C 17/04) [1, 2006.01]
13/10	• Means for preventing contamination in event of leakage [1, 2006.01]		

- 17/07 • • Leak testing [5, 2006.01]
- 17/08 • Structural combination of reactor core or moderator structure with viewing means, e.g. with television camera, periscope, window [1, 2006.01]
- 17/10 • Structural combination of fuel element, control rod, reactor core, or moderator structure with sensitive instruments, e.g. for measuring radioactivity, strain [1, 2006.01]
- 17/104 • • Measuring reactivity [5, 2006.01]
- 17/108 • • Measuring reactor flux [5, 2006.01]
- 17/112 • • Measuring temperature [5, 2006.01]
- 17/116 • • Passages or insulators, e.g. for electric cables [5, 2006.01]
- 17/12 • • Sensitive element forming part of control element [1, 2006.01]
- 17/14 • Period meters [1, 2006.01]
- 19/00 Arrangements for treating, for handling, or for facilitating the handling of, fuel or other materials which are used within the reactor, e.g. within its pressure vessel [1, 2, 2006.01]**
- 19/02 • Details of handling arrangements [1, 2006.01]
- 19/04 • • Means for controlling flow of coolant over objects being handled; Means for controlling flow of coolant through channel being serviced [1, 2006.01]
- 19/06 • • Means for supporting or storing fuel elements or control elements [1, 4, 2006.01]
- 19/07 • • • Storage racks; Storage pools [5, 2006.01]
- 19/08 • • Means for heating fuel elements before introduction into the core; Means for heating or cooling fuel elements after removal from the core [1, 2006.01]
- 19/10 • • Lifting devices or pulling devices adapted for co-operation with fuel elements or with control elements [1, 2006.01]
- 19/105 • • • with grasping or spreading coupling elements [5, 2006.01]
- 19/11 • • • with revolving coupling elements, e.g. socket coupling [5, 2006.01]
- 19/115 • • • with latching devices and ball couplings [5, 2006.01]
- 19/12 • • Arrangements for exerting direct hydraulic or pneumatic force on fuel element or on control element [1, 2006.01]
- 19/14 • characterised by their adaptation for use with horizontal channels in the reactor core [1, 2006.01]
- 19/16 • Articulated or telescopic chutes or tubes for connection to channels in the reactor core [1, 2006.01]
- 19/18 • Apparatus for bringing fuel elements to the reactor charge area, e.g. from a storage place [1, 2006.01]
- 19/19 • Reactor parts specifically adapted to facilitate handling, e.g. to facilitate charging or discharging of fuel elements [3, 2006.01]
- 19/20 • Arrangements for introducing objects into the pressure vessel; Arrangements for handling objects within the pressure vessel; Arrangements for removing objects from the pressure vessel [1, 2006.01]
- 19/22 • • Arrangements for obtaining access to the interior of a pressure vessel whilst the reactor is operating [1, 2006.01]
- 19/24 • • • by using an auxiliary vessel which is temporarily sealed to the pressure vessel [1, 2006.01]
- 19/26 • Arrangements for removing jammed or damaged fuel elements or control elements; Arrangements for moving broken parts thereof [1, 2006.01]
- 19/28 • Arrangements for introducing fluent material into the reactor core; Arrangements for removing fluent material from the reactor core [1, 2006.01]
- 19/30 • • with continuous purification of circulating fluent material, e.g. by extraction of fission products [1, 2006.01]
- 19/303 • • • specially adapted for gases (decontamination of gases G21F 9/02) [5, 2006.01]
- 19/307 • • • specially adapted for liquids (decontamination of liquids G21F 9/04) [5, 2006.01]
- 19/31 • • • • for molten metals [5, 2006.01]
- 19/313 • • • • using cold traps [5, 2006.01]
- 19/317 • • • Recombination devices for radiolytic dissociation products [5, 2006.01]
- 19/32 • Apparatus for removing radioactive objects or materials from the reactor discharge area, e.g. to a storage place; Apparatus for handling radioactive objects or materials within a storage place or removing them therefrom (disposal of waste material G21F 9/00) [1, 2006.01]
- 19/33 • Apparatus or processes for dismantling strings of spent fuel elements (G21C 19/34 takes precedence) [2, 2006.01]
- 19/34 • Apparatus or processes for dismantling nuclear fuel, e.g. before reprocessing [1, 5, 2006.01]
- 19/36 • • Mechanical means only [1, 2006.01]
- 19/365 • • • Removing cannings or casings from fuel [5, 2006.01]
- 19/37 • • • • by separating into pieces both the canning or the casing and the fuel element, e.g. by cutting or shearing [5, 2006.01]
- 19/375 • • • Compacting devices, e.g. for fuel assemblies [5, 2006.01]
- 19/38 • • Chemical means only [1, 2006.01]
- 19/40 • Arrangements for preventing occurrence of critical conditions, e.g. during storage [1, 2006.01]
- 19/42 • Reprocessing of irradiated fuel [1, 2006.01]
- 19/44 • • of irradiated solid fuel [1, 2006.01]
- 19/46 • • • Aqueous processes [1, 2006.01]
- 19/48 • • • Non-aqueous processes [1, 2006.01]
- 19/50 • • of irradiated fluid fuel [1, 2006.01]
- 21/00 Apparatus or processes specially adapted to the manufacture of reactors or parts thereof [1, 2006.01]**
- 21/02 • Manufacture of fuel elements or breeder elements contained in non-active casings [1, 2006.01]
- 21/04 • • by vibrational compaction or tamping [1, 2006.01]
- 21/06 • • by swaging [1, 2006.01]
- 21/08 • • by a slip-fit cladding process [1, 2006.01]
- 21/10 • • by extrusion, drawing, or stretching [1, 2006.01]
- 21/12 • • by hydrostatic or thermo-pneumatic canning [1, 2006.01]
- 21/14 • • by plating in a fluid [1, 2006.01]
- 21/16 • • by casting or dipping techniques [1, 2006.01]
- 21/18 • Manufacture of control elements covered by group G21C 7/00 [1, 2006.01]
- 23/00 Adaptations of reactors to facilitate experimentation or irradiation [3, 2006.01]**