2. CORE AND BLANKET LAYOUT OR GEOMETRY

2.1. General core and blanket configurations

Experimental Fast Reactors

Plant	General core and blanket configurations				
	Core geometry		Blanket geometry		Core restraint system +
Rapsodie (France)	H	R	-	AB	F
KNK-II (Germany)	H	R*	AA**	AB**	-
FBTR (India)	Q	R	AA	AB	P
PEC (Italy)	Q	-	AA	AB	-
JOYO (Japan)	H	***	***	***	P
DFR (UK)	H	-	AA	AB	F
BOR-60 (Russian Federation)	H	R	AA	AB	P
EBR-II (USA)	H	R****	-	-	-
Fermi (USA)	S	R	AA	AB	-
FFTF (USA)	H	-	-	-	-
BR-10 (Russian Federation)	H	-	-	-	F
CEFR (China)	Q	R	AA	AB	P

Demonstration or Prototype Fast Reactors

Phénix (France)	H	R	AA	AB	F
SNR-300 (Germany)	Q	R	AA	AB	-
PFBR (India)	H	R	AA	AB	P
MONJU (Japan)	H	R	AA	AB	F
PFR (UK)	H	R	AA	AB	P
CRBRP (USA)	H, Het	R	AA	AB	P
BN-350 (Kazakhstan)	Q	R	AA	AB	P
BN-600 (Russian Federation)	Q	R	AA	AB	P
ALMR (USA)	H	-	-	-	F
KALIMER-150 (Republic of Korea)	Het	R	-	-	P
SVBR-75/100 (Russian Federation)	Q	-	-	-	P
BREST-OD-300 (Russian Federation)	Q	no radial and axial blankets			P

* only 5 blanket-elements
** only inner core
*** MK-III; (R, AA, AB, respectively, in MK-I)
**** beyond the radial stainless steel reflector, + See IAEA Technical Report Series No. 246, “Status of Liquid Metal Fast Reactors”(1985), p. 273 (Fig. V-7) - core restraints

S - Square prism
Q - Approximately circular/cylindrical
Het - Heterogeneous core
AA - Axial blanket of fertile above core
AB - Axial blanket of fertile material below core
F - Free-standing core
P - Passive restraint using contact pads

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.1. General core and blanket configurations

Commercial Size Reactors

Plant	General core and blanket configurations				
	Core geometry		Blanket geometry		Core restraint system +
Super-Phénix 1 (France)	H	R	AA	AB	F
Super-Phénix 2 (France)	H	R	-	AB	-
SNR 2 (Germany)	Q	R	AA	AB	-
DFBR (Japan)	H	R	AA	AB	P
CDFR (UK)	Q	R	AA	AB	P
BN-1600 (Russian Federation)	Q	R	AA	AB	P
BN-800 (Russian Federation)	Q	R	-	AB	P
EFR	Q	R	AA	AB	F
ALMR (USA)	H, Het	R	-	-	P
SVBR-75/100 (Russian Federation)	Q	-	-	-	-
BN-1800 (Russian Federation)	Q	-	-	-	P
BREST-1200 (Russian Federation)	Q	-	no radial and axial blankets		P
JSFR-1500 (Japan)	-	-	-	-	-
Breeding core	Q	R	AA	AB	P
Break even core	Q	no radial blanket	AA	AB	P

+ See IAEA Technical Report Series No. 246, "Status of Liquid Metal Fast Reactors" (1985), p. 273 (Fig. V-7) for illustrations of core restraints

S - Square prism
Q - Approximately circular/cylindrical
Het - Heterogeneous core
AA - Axial blanket of fertile above core
AB - Axial blanket of fertile material below core
F - Free-standing core
P - Passive restraint using contact pads

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.2. Numbers of subassemblies in equilibrium core (excluding control rods)

Experimental Fast Reactors

Plant	Numbers of subassemblies in equilibrium core (excluding control rods)			
	Inner core	Outer core	Radial blanket	Reflector or other zone outside radial blanket including shielding and storage positions
Rapsodie (France)	64-73	-	276	211 (nickel)
KNK-II (Germany)	7	22	5	49
FBTR (India)	76	0	342	294
PEC (Italy)	78 (and 1 test channel)	0	0	199* and 262**
JOYO (Japan)	19 (max. 25)***	58 (max. 60)	none	223
DFR (UK)*****	153	189	300	1572
BOR-60 (Russian Federation)	80-114	0	138	
EBR-II (US)	127 (total in core)	0	366****	144****
Fermi (USA)	105	0	531	222
FFTF (USA)	28	45	0	93
BR-10 (Russian Federation)	86-90	0	-	34-30
CEFR (China)	81	-	none	622

Demonstration or Prototype Fast Reactors

Phénix (France)	55	48	90	1317
SNR-300 (Germany)	109	90	96	186
PFBR (India)	85	96	120	419
MONJU (Japan)	108	90	172	324
PFR (UK)	28	44	41	94
CRBRP (USA)	156/82 (internal blanket)	0	126	312
BN-350 (Kazakhstan)	61/48******	113	350	107
BN-600 (Russian Federation)	136/94******	139	362	190
ALMR (USA)	84	108	0	180
KALIMER-150 (Republic of Korea)	54	-	72	241
SVBR-75/100 (Russian Federation)	55	none		
BREST-OD-300 (Russian Federation)	45	64/36*******		148

* reflector
** radial shield
*** none in MK-I and MK-II
**** blanket is beyond the reflector in radial direction
***** pins, not subassemblies
****** inner zone/intermediate zone of the inner core
******* inner zone/outer zone of the outer zone

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.2. Numbers of subassemblies in equilibrium core (excluding control rods)

Commercial Size Reactors

Plant	Numbers of subassemblies in equilibrium core (excluding control rods)			
	Inner core	Outer core	Radial blanket	Reflector or other zone outside radial blanket including shielding and storage positions
Super-Phénix 1 (France)	193	171	234	1288
Super-Phénix 2 (France)	208	180	78	270*
SNR 2 (Germany)	252	162	120	450
DFBR (Japan)	199	96	138	1237
CDFR (UK)	193	156	234	-
BN-1600 (Russian Federation)	258	216	84	1087
BN-800 (Russian Federation)	211/156*****	198	90	546
EFR	207/108*****	72	78	873
ALMR (USA)	84	08	0	180
SVBR-75/100 (Russian Federation)	55	none		
BN-1800 (Russian Federation)	642		-	1001
BREST-1200 (Russian Federation)	148	108/76*******		208
JSFR-1500 (Japan)	-	-	-	-
Breeding core	288	274	96	210
Break even core	288	274	no radial blanket	306

***** inner zone/intermediate zone of the inner core

******* inner zone/outer zone of the outer zone

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.3. Core dimensions

Experimental Fast Reactors

Plant	Core dimensions (mm) at 20°C		
	Equivalent diameter of inner core zone (mm)*	Equivalent diameter of outer core zone (mm)*	Height of fissile zone (mm)
Rapsodie (France)	-	446	320
KNK-II (Germany)	358	824	600
FBTR (India)	-	492	320
PEC (Italy)	-	833	650
JOYO (Japan)	-	800	500 (550 in MK I, II)
DFR (UK)	-	530	530
BOR-60 (Russian Federation)	-	460	450
EBR-II (USA)	-	697	343
Fermi (USA)	-	831	775
FFTF (USA)	767	1202	914
BR-10 (Russian Federation)	-	206	400
CEFR (China)	-	600	450

Demonstration or Prototype Fast Reactors

Phénix (France)	960	1390	850
SNR-300 (Germany)	1353	1780	950
PFBR (India)	1353	1970	1000
MONJU (Japan)	1368	1800	930
PFR (UK)	933	1470	910
CRBRP (USA)	-	2020	914
BN-350 (Kazakhstan)	880/1100**	1580	1000
BN-600 (Russian Federation)	1270/1650**	2050	1030
ALMR (USA)	-	2427	660
KALIMER-150 (Republic of Korea)	1559	-	1000
SVBR-75/100 (Russian Federation)	1645	-	900
BREST-OD-300 (Russian Federation)	1280	1990/2296***	1100

* equivalent diameter means the diameter of a cylindrical zone with the same cross-sectional area as the actual zone

** inner zone/intermediate zone of the inner core

*** inner zone/outer zone of the outer zone

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.3. Core dimensions

Commercial Size Reactors

Plant	Core dimensions (mm) at 20°C		
	Equivalent diameter of inner core zone (mm)*	Equivalent diameter of outer core zone (mm)*	Height of fissile zone (mm)
Super-Phénix 1 (France)	2600	3700	1000
Super-Phénix 2 (France)	2900	3970	1200
SNR 2 (Germany)	-	4130	1000
DFBR (Japan)	2450	2990	1000
CDFR (UK)	2250	3000	1150
BN-1600 (Russian Federation)	3160	4450	780
BN-800 (Russian Federation)	1630/2092**	2561	880
EFR	2948/3688**	4051	1000
ALMR (USA)	-	2164	1070
SVBR-75/100 (Russian Federation)	1645	-	900
BN-1800 (Russian Federation)	-	5167	800
BREST-1200 (Russian Federation)	3350	4150/4750***	1100
JSFR-1500 (Japan)	-	-	-
Breeding core	3890	5380	1000
Break even core	3890	5380	1000

* equivalent diameter means the diameter of a cylindrical zone with the same cross-sectional area as the actual zone

** inner zone/intermediate zone of the inner core

*** inner zone/outer zone of the outer zone

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.4. Radial blanket dimensions
2.5. Axial blanket dimensions

Experimental Fast Reactors

Plant	Radial blanket dimensions (mm) at 20°C		Axial blanket dimensions (mm) at 20°C		
	Outer diameter or equivalent diameter of zone	Height of fertile column	Thickness of upper axial blanket within fuel pin	Thickness of upper axial blanket above top of fuel pin	Thickness of lower axial blanket within fuel pin
Rapsodie (France)	1270	1077	0	0	0
KNK-II (Germany)	-	980	200	-	200
FBTR (India)	1260	1000	0	235	0
PEC (Italy)	1551*	2419*	180	-	225
JOYO (Japan)	**	**	**	-	**
DFR (UK)	1980	2490	142	-	0
BOR-60 (Russian Federation)	770	900	100	-	150
EBR-II (USA)	1562***	1397***	0	-	0
Fermi (USA)	2030	1650	356	-	356
FFTF (USA)	1778*	1198*	144*	-	144*
BR-10 (Russian Federation)	-	-	0	-	0
CEFR (China)	-	-	100	0	250

Demonstration or Prototype Fast Reactors

Phénix (France)	1880	1668	0	260	300
SNR-300 (Germany)	2130	1750	400	-	400
PFBR (India)	2508	1600	300	0	300
MONJU (Japan)	2400	1600	300	-	350
PFR (UK)	1840	1460	102	460****	450
CRBRP (USA)	2850	1625	356	-	356
BN-350 (Kazakhstan)	2490	1580	300	-	400350
BN-600 (Russian Federation)	3000	1580	300	-	-
ALMR (USA)	no radial blanket	-	-	no radial blanket	-
KALIMER-150 (Republic of Korea)	1931	1000	-	no radial blanket	-
SVBR-75/100 (Russian Federation)	2090	-	-	300	-
BREST-OD-300 (Russian Federation)	no radial blanket	-	-	no radial blanket	-

* reflector dimensions
** none in MK-III; (1400, 1400, 400, 400, respectively, in MK- II, MK-I)
*** reflector outer diameter-1019 mm, reflector height-1583 mm
**** not fitted in all fuel types

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.4. Radial blanket dimensions
2.5. Axial blanket dimensions

Commercial Size Reactors

Plant	Radial blanket dimensions (mm) at 20°C		Axial blanket dimensions (mm) at 20°C		
	Outer diameter or equivalent diameter of zone	Height of fertile column	Thickness of upper axial blanket within fuel pin	Thickness of upper axial blanket above top of fuel pin	Thickness of lower axial blanket within fuel pin
Super-Phénix 1 (France)	4700	1600	300	0	300
Super-Phénix 2 (France)	4325	1510	0	-	300
SNR 2 (Germany)	5080	1600	500	-	500
DFBR (Japan)	3570	1700	350	-	350
CDFR (UK)	3800	1800	300	-	300
BN-1600 (Russian Federation)	4800	1150	0	-	350
BN-800 (Russian Federation)	2750	1580	0	-	350
EFR	4383	1000	150	-	250
ALMR (USA)	2427	1473	0	203	0
SVBR-75/100(Russian Federation)	2090	-	-	300	-
BN-1800 (Russian Federation)	to be determined				
BREST-1200 (Russian Federation)	no radial blanket		no axial blanket		
JSFR-1500 (Japan)	-	-	-	-	-
Breeding core	5780	1400	200	-	200
Break even core	no radial blanket		150	-	200

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.6. Lattice pitch of components on centre plane of core
2.7. Fuel subassembly dimensions
2.8. Fuel enrichment

Experimental Fast Reactors

Plant	Lattice pitch of components on centre plane of core (mm)		Fuel subassembly Dimensions (mm)		Fuel enrichment
	At 20°C	At operating temperature	Width across flats	Subassembly length	Number of fuel enrichment zones
Rapsodie (France)	50.8	-	49.8	1661.5	1
KNK-II (Germany)	129	-	108	2250	2
BTR (India)	50.8	51.1	49.8	1661.5	1
PEC (Italy)	81.5	82	85.5	3000	1
JOYO (Japan)	81.5	82.0	78.5	2970	2*
DFR (UK)	23.4	23.5	-	-	1
BOR-60 (Russian Federation)	45	-	44	1575	1
EBR-II (USA)	58.93	59.34	58.17	2340	1
Fermi (USA)	68.4	-	67.2	2450	1
FFTF (USA)	120.0	120.6	118	3658	2
BR-10 (Russian Federation)	27	-	26.1	833	1
CEFR (China)	61	61.37	59	2592	1

Demonstration or Prototype Fast Reactors

Phénix (France)	127	-	124	4300	2
SNR-300 (Germany)	115	-	110	3700	2
PFBR (India)	135	135.9	131.3	4500	2
MONJU (Japan)	116	116.5	105	4200	2
PFR (UK)	145.3	146.2	142.0	3800	2
CRBRP (USA)	121	122	116	4270	1
BN-350 (Kazakhstan)	98	98.5	96	3500	3
BN-600 (Russian Federation)	98.4	99.0	96	3500	3
ALMR (USA)	161.4	162	157.1	4775	2
KALIMER-150 (Republic of Korea)	161	161.8	157	4755.7	1
SVBR-75/100 (Russian Federation)	223.88	-	225.45	1845	4
BREST-OD-300 (Russian Federation)	167.7	169	166.5	3850	1

* MK – III, one in MK - I and MK - II

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.6. Lattice pitch of components on centre plane of core
2.7. Fuel subassembly dimensions
2.8. Fuel enrichment

Commercial Size Reactors

Plant	Lattice pitch of components on centre plane of core (mm)		Fuel subassembly Dimensions (mm)		Fuel enrichment
	At 20°C	At operating temperature	Width across flats	Subassembly length	Number of fuel enrichment zones
Super-Phénix 1 (France)	179	180	173	5400	2
Super-Phénix 2 (France)	-	-	-	4850	2
SNR 2 (Germany)	185	-	180	-	-
DFBR (Japan)	158	-	145	4600	2
CDFR (UK)	147.0	147.9	141.2	4000	2
BN-1600 (Russian Federation)	188	189	184	4500	2
BN-800 (Russian Federation)	100	100.6	94.5	3500	3
EFR	188	189.3	183	4800	3
ALMR (USA)	161.4	162	157.1	4775	1
SVBR-75/100(Russian Federation)	223.88	-	225.45	1845	4
BN-1800 (Russian Federation)	188	-	189.3	4500	1
BREST-1200 (Russian Federation)	231.2	233	230	3850	1
JSFR-1500 (Japan)	-	-	-	-	-
Breeding core	206	207	192	4570	2
Break even core	206	207	192	4570	2

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.9. Fuel enrichment zones*

Experimental Fast Reactors

Plant	Fuel enrichment zones*		
	Inner core enrichment (%)	Outer core enrichment (%)	Intermediate core enrichment (if applicable)
Rapsodie (France)	30% PuO_2 + 70% UO_2	-	-
KNK-II (Germany)	88.1-95.1	37 (^{235}U)	-
FBTR (India)	55**	-	-
PEC (Italy)	28.5	-	-
JOYO (Japan)	30***	34****	-
DFR (UK)	75	-	-
BOR-60 (Russian Federation)	56-90	-	-
EBR-II (USA)	67	-	-
Fermi (USA)	25.6	-	-
FFTF (USA)	20.3*****	24.6******	-
BR-10 (Russian Federation)	90	-	-
CEFR (China)	-	64.4	-

Demonstration or Prototype Fast Reactors

Phénix (France)	18	23	-
SNR-300 (Germany)	25 Pu_{tot}	36 Pu_{tot}	-
PFBR (India)	20.7	27.7	-
MONJU (Japan)	16	21	-
PFR (UK)	22.0	28.5	-
CRBRP (USA)	-	32.8	-
BN-350 (Kazakhstan)	17 (UO_2)	26 (UO_2)	21 (UO_2)
BN-600 (Russian Federation)	17 (UO_2)	26 (UO_2)	21 (UO_2)
ALMR (USA)	21.0	25.2	-
KALIMER-150 (Republic of Korea)	21.1	-	-
SVBR-75/100 (Russian Federation)	16.1	-	-
BREST-OD-300 (Russian Federation)	14.6 (Pu+MA)	-	-

* Enrichment = mass of fissile atoms/mass of fissile and fertile atoms (i. e. ^{235}U in U-based fuels; ^{235}U + all Pu isotopes in U/Pu-based fuels)

** 70 in the initial core

*** none in MK-I, -II

**** 30 and 33 in MK- I,- II, respectively

***** 0.2243 w/o Pu/(U+Pu) (Pu-88% fissile)

****** 0.2737 w/o Pu/(U+Pu) (Pu-88% fissile)

2. CORE AND BLANKET LAYOUT OR GEOMETRY (cont.)

2.9. Fuel enrichment zones*

Commercial Size Reactors

Plant	Fuel enrichment zones*		
	Inner core enrichment (%)	Outer core enrichment (%)	Intermediate core enrichment (if applicable)
Super-Phénix 1 (France)	16	19.7	-
Super-Phénix 2 (France)	-	-	-
SNR 2 (Germany)	18 Pu_{tot}	23 Pu_{tot}	-
DFBR (Japan)	11	16	-
CDFR (UK)	15.0	20.5	-
BN-1600 (Russian Federation)	18.2	21.1	-
BN-800 (Russian Federation)	19.5	24.7	22.1
EFR	18.3	26.9	22.4
ALMR (USA)	23.2	-	-
SVBR-75/100 (Russian Federation)	-	16.1	-
BN-1800 (Russian Federation)	-	14.8	-
BREST-1200 (Russian Federation)	-	13.8 (Pu+MA)	-
JSFR-1500 (Japan)	-	-	-
Breeding core	11.5**	13.0**	-
Break even core	11.5**	13.1**	-

* Enrichment = mass of fissile atoms/mass of fissile and fertile atoms (i.e. ^{235}U in U-based fuels; ^{235}U + all Pu isotopes in U/Pu-based fuels)

** ^{235}U and Pu fissile/ fissile and fertile