

2. CORE AND BLANKET LAYOUT OR GEOMETRY

2.1. General core and blanket configurations

2.1.1. Core geometry

H - Approximately hexagonal prism

Q - Approximately circular/cylindrical

S - Square prism

Het - Heterogeneous core

2.1.3. Core restraint system +

F - Free-standing core

P - Passive restraint using contact pads

2.1.2. Blanket geometry

R - Radial blanket of fertile material

AA - Axial blanket of fertile material above core

AB - Axial blanket of fertile material below core

Experimental Fast Reactors

Plant	2.1.1.	2.1.2.			2.1.3.
Rapsodie (France)	H	R		AB	F
KNK-II (Germany)	H	R*	AA**	AB**	
FBTR (India)	H	R	AA	AB	P
PEC (Italy)	Q		AA	AB	
JOYO (Japan)	H	***	***	***	P
DFR (UK)	H		AA	AB	F
BOR-60 (Russia)	H	R	AA	AB	P
EBR-II (USA)	H	R****			
Fermi (USA)	S	R	AA	AB	
FFTF (USA)	H				
BR-10 (Russia)	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 (Russia)	Q	R	AA	AB	P
ALMR (USA)	H	--	--	--	F

Commercial Size Reactors

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 (Russia)	Q	R	AA	AB	P
BN-800 (Russia)	Q	R	--	AB	P
EFR	Q	R	AA	AB	F
ALMR (USA)	H, Het	R			

* Only 5 blanket-elements, ** Only inner core, *** MK-II; (R, AA, AB, respectively, in MK-I)

**** Beyond the radial stainless steel reflector, + See IAEA Technical Report Series No. 246,

"Status of Liquid Metal Cooled Fast Reactors" (1985), p273 (Fig. V-7) for illustrations of core restraints.

CORE AND BLANKET LAYOUT OR GEOMETRY

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

2.2.1. Inner core

2.2.2. Outer core

2.2.3. Radial blanket

2.2.4. Reflector or other zone outside radial blanket including shielding and storage positions

Experimental Fast Reactors

Plant	2.2.1.	2.2.2.	2.2.3.	2.2.4.
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)	67***	0***	0***	222***
DFR (UK)****	153	189	300	1572
BOR-60 (Russia)	96-110	0	168	
EBR-II (US)	127 (total in core)	0	366****	144****
Fermi (USA)	105	0	531	222
FFTF (USA)	28	45	0	93
BR-10 (Russia)	86-90	0		34-30
CEFR (China)	82	0	157	435

Demonstration or Prototype Fast Reactors

Phénix (France)	55	48	90	1317
SNR-300 (Germany)	109	90	96	186
PFBR (India)	91	90	180	78*
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 (Russia)	136/94*****	139	362	190
ALMR (USA)	84	108	0	180

Commercial Size Reactors

Super-Phénix 1 (France)	193	171	234	1288
Super-Phénix 2 (France)	208	180	78	270*
SNR 2 (Germany)	252	162	120	
DFBR (Japan)	199	96	138	450
CDFR (UK)	193	156	234	1237
BN-1600 (Russia)	258	216	84	1087
BN-800 (Russia)	211/156*****	198	90	546
EFR	207/108*****	72	78	873
ALMR (USA)	84	108	0	180

* Reflector,

** Radial shield,

*** MK-II; (75, 0, 183, 48, respectively, in MK-I, 75 MWt)

**** Blanket is beyond the reflector in radial direction

***** Pins, not subassemblies

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

CORE AND BLANKET LAYOUT OR GEOMETRY

- 2.3. Core dimensions (mm) at 20°C
- 2.3.1. Equivalent diameter of inner core zone (mm)*
- 2.3.2. Equivalent diameter of outer core zone (mm)*
- 2.3.3. Height of fissile zone (mm)

Experimental Fast Reactors

Plant	2.3.1.	2.3.2.	2.3.3.
Rapsodie (France)		446	320
KNK-II (Germany)	358	824	600
FBTR (India)		492	320
PEC (Italy)		833	650
JOYO (Japan)		730	550
DFR (UK)		530	530
BOR-60 (Russia)		460	450
EBR-II (USA)		697	343
Fermi (USA)		831	775
FFTF (USA)	767	1202	914
BR-10 (Russia)		206	400
CEFR (China)		605.8	500

Demonstration or Prototype Fast Reactors

Phénix (France)	960	1390	850
SNR-300 (Germany)	1360	1780	950
PFBR (India)	1390	1965	1000
MONJU (Japan)	1368	1800	930
PFR (UK)	933	1470	910
CRBRP (USA)		2020	914
BN-350 (Kazakhstan)	880/1100**	1580	1000
BN-600 (Russia)	1270/1650**	2050	1030
ALMR (USA)		2427	660

Commercial Size Reactors

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 (Russia)	3160	4450	780
BN-800 (Russia)	1630/2090**	2560	880
EFR	2948/3688**	4051	1000
ALMR (USA)		2164	1070

* 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

CORE AND BLANKET LAYOUT OR GEOMETRY

- 2.4. Radial blanket dimensions (mm) at 20°C
 - 2.4.1. Outer diameter or equivalent diameter of zone
 - 2.4.2. Height of fertile column
- 2.5. Axial blanket dimensions (mm) at 20°C
 - 2.5.1. Thickness of upper axial blanket within fuel pin
 - 2.5.2. Thickness of upper axial blanket above top of fuel pin
 - 2.5.3. Thickness of lower axial blanket within fuel pin
 - 2.5.4. Thickness of lower axial blanket below bottom of fuel pin

Plant	Experimental Fast Reactors					
	2.4.1.	2.4.2.	2.5.1.	2.5.2.	2.5.3.	2.5.4.
Rapsodie (France)	1270	1077	0	0	0	263
KNK-II (Germany)		980	200		200	
FBTR (India)	1260	1000	0	235	0	235
PEC (Italy)	1551*	2419*	180		225	
JOYO (Japan)	**	**	**		**	
DFR (UK)	1980	2490	142		0	
BOR-60 (Russia)	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 (Russia)			0		0	
CEFR (China)	1019	1100	300		300	

Demonstration or Prototype Fast Reactors						
Phénix (France)	1880	1668	0	260	300	0
SNR-300 (Germany)	2130	1750	400		400	
PFBR (India)	2735	1600	300	0	300	0
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		350	
BN-600 (Russia)	3000	1580	300		400	
ALMR (USA)	No radial blanket		No axial blanket			

Commercial Size Reactors						
Super-Phénix 1 (France)	4700	1600	300	0	300	0
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 (Russia)	4800	1150	0		350	
BN-800 (Russia)	2750	1580	0		350	
EFR	4383	1000	150		250	
ALMR (USA)	2427	1473	0	203	0	203

* Reflector dimensions,

** MK II; (1400, 1400, 400, 400, respectively, in MK-I),

*** Reflector outer diameter - 1019 mm, reflector height - 1583 mm

**** Not fitted in all fuel types

CORE AND BLANKET LAYOUT OR GEOMETRY

<u>2.6.</u>	Lattice pitch of components (mm) on centre plane of core
2.6.1.	At 20°C
2.6.2.	At operating temperature
<u>2.7.</u>	Fuel subassembly dimensions (mm)
2.7.1.	Width across flats
2.7.2.	Subassembly length
<u>2.8.</u>	Fuel enrichments
2.8.1.	Number of fuel enrichment zones

Experimental Fast Reactors

Plant	2.6.1.	2.6.2.	2.7.1.	2.7.2.	2.8.1.
Rapsodie (France)	50.8		49.8	1661.5	1
KNK-II (Germany)	129		108	2250	2
FBTR (India)	50.8	51.1	49.8	1661.5	1
PEC (Italy)	86	87.1	85.5	3000	1
JOYO (Japan)	81.5*	82.0*	78.5*	2970*	1
DFR (UK)	23.4	23.5			1
BOR-60 (Russia)	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 (Russia)	27		26.1	833	1
CEFR (China)	61.5	61.9	58.5	2282	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 (Russia)	98.4	99.0	96	3500	3
ALMR (USA)	161.4	162	157.1	4775	2

Commercial Size Reactors

Super-Phénix 1 (France)	179	180	173	5400	2
Super-Phénix 2 (France)				4850	
SNR 2 (Germany)	185		180		2
DFBR (Japan)	158		145	4600	2
CDFR (UK)	147.0	147.9	141.2	4000	2
BN-1600 (Russia)	188	189	184	4500	2
BN-800 (Russia)	100	100.6	94.5	3500	3
EFR	188	189.3	183	4800	3
ALMR (USA)	161.4	162	157.1	4775	1

* MK - I and MK - II

CORE AND BLANKET LAYOUT OR GEOMETRY

- 2.8. Fuel enrichment zones*
- 2.8.2. Inner core enrichment (%)
- 2.8.3. Outer core enrichment (%)
- 2.8.4. Intermediate core enrichment (if applicable)

Experimental Fast Reactors

Plant	2.8.2.	2.8.3.	2.8.4.
Rapsodie (France)	30% PuO ₂ + 70% UO ₂		
KNK-II (Germany)	88.1-95.1	37 U5	
FBTR (India)	55 ^{*****}		
PEC (Italy)	28.5		
JOYO (Japan)	48 ^{**}		
DFR (UK)	75		
BOR-60 (Russia)	45-75		
EBR-II (USA)	67		
Fermi (USA)	25.6		
FFTF (USA)	20.3 ^{***}	24.6 ^{****}	
BR-10 (Russia)	90		
CEFR (China)	49		

Demonstration or Prototype Fast Reactors

Phénix (France)	18	23	
SNR-300 (Germany)	25 Pu _{tot}	36 Pu _{tot}	
PFBR (India)	21.0	28	
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 (Russia)	17 (UO ₂)	26 (UO ₂)	21 (UO ₂)
ALMR (USA)	21.0	25.2	

Commercial Size Reactors

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 (Russia)	18.2	21.1	
BN-800 (Russia)	19.5	24.7	22.1
EFR	18.3	26.9	22.4
ALMR (USA)	23.2		

* Enrichment = mass of fissile atoms / mass of fissile and fertile atoms (ie. U²³⁵ in U-based fuels; U²³⁵ + all Pu Isotopes in U/Pu-based fuels)

** MK II; (36 in MK-I)

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

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

***** 70 in the initial core