4. FUEL DESIGN AND PERFORMANCE

4.1. Number of fuel pins per subassembly

Experimental Fast Reactors

	Number of fuel pins per subassembly	
Plant	Core	Blanket
Rapsodie (France)	61	7
KNK-II (Germany)	169/211*	121
FBTR (India)	61	7
PEC (Italy)	91	-
JOYO (Japan)	127**	none (19 in MK-I)
DFR (UK)	1	1
BOR-60 (Russian Federation)	37	-
EBR-II (USA)	91	19
Fermi (USA)	140	25
FFTF (USA)	217	-
BR-10 (Russian Federation)	7	-
CEFR (China)	61	-

Demonstration or Prototype Fast Reactors

Phénix (France)	217	61
SNR-300 (Germany)	127	61
PFBR (India)	217	61
MONJU (Japan)	169	61
PFR (UK)	325/265/169***	85
CRBRP (USA)	217	61
BN-350 (Kazakhstan)	127	37
BN-600 (Russian Federation)	127	37
ALMR (USA)	271	-
KALIMER-150 (Republic of Korea)	271	127
SVBR-75/100 (Russian Federation)	12114 (55 subassemblies)	None
BREST-OD-300 (Russian Federation)	156/160	None

* test zone
** MK- III; (91 in MK-I)
*** dependent on pin diameter (see 4.2.1)

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.1. Number of fuel pins per subassembly

Commercial Size Reactors

	Number of fuel pins per subassembly	
Plant	Core	Blanket
Super-Phénix 1 (France)	271	91
Super-Phénix 2 (France)	271	127
SNR 2 (Germany)	271	127
DFBR (Japan)	217	127
CDFR (UK)	325	85
BN-1600 (Russian Federation)	331	91
BN-800 (Russian Federation)	127	37
EFR	331	169
ALMR (USA)	271	127
SVBR-75/100 (Russian Federation)	12114 (55 subassemblies)	None
BN-1800 (Russian Federation)	331	-
BREST-1200 (Russian Federation)	272	None
JSFR-1500 (Japan)	-	-
Breeding core	255*	217
Break even core	255*	no radial blanket

* 16 fuel pins are eliminated to arrange the inner duct for re-criticality evasion

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.2. Core fuel pin dimensions and fuel density

Experimental Fast Reactors

Plant	Core fuel pin dimensions (mm) and fuel density		
	Outer diameter	Thickness of cladding	Overall length of fuel pin
Rapsodie (France)	5.1	0.37	320
KNK-II (Germany)	6*/8.2**	0.38	1540
FBTR (India)	5.1	0.37	531.5
PEC (Italy)	6.7	0.45	1935
JOYO (Japan)	5.5***	0.35***	1533***
DFR (UK)	20	2.3	1228
BOR-60 (Russian Federation)	6	0.3	1100
EBR-II (USA)	4.42	0.305	343
Fermi (USA)	4.01	0.127	833
FFTF (USA)	5.84	0.38	2380
BR-10 (Russian Federation)	8.4	0.4	615
CEFR (China)	6.00	0.30	1622

Demonstration or Prototype Fast Reactors

Phénix (France)	6.6	0.45	850
SNR-300 (Germany)	7.6	0.38	2475
PFBR (India)	6.6	0.45	2580
MONJU (Japan)	6.5	0.47	2800
PFR (UK)	5.8/6.6/8.5	0.38	2250
CRBRP (USA)	5.84	0.38	2906
BN-350 (Kazakhstan)	6.9	0.4	2445
BN-600 (Russian Federation)	6.9	0.4	2445
ALMR (USA)	7.44	0.56	3842
KALIMER-150 (Republic of Korea)	7.4	0.55	3708.1
SVBR-75/100 (Russian Federation)	12	0.4	1638
BREST-OD-300 (Russian Federation)	9.4/9.8/10.5	0.5	2250

* test zone

** driver

*** MK-III; (6.3, 0.35, 1900, respectively, in MK-I)

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.2. Core fuel pin dimensions and fuel density

Commercial Size Reactors

Plant	Core fuel pin dimensions (mm) and fuel density		
	Outer diameter	Thickness of cladding	Overall length of fuel pin
Super-Phénix 1 (France)	8.5	0.56	2700
Super-Phénix 2 (France)	8.5	0.56	2690
SNR 2 (Germany)	8.5	0.565	2900
DFBR (Japan)	8.5	0.5	3100
CDFR (UK)	6.6	0.52	2500
BN-1600 (Russian Federation)	8.5	0.55	2410
BN-800 (Russian Federation)	6.6	0.4	2000
EFR	8.2	0.52	2645
ALMR (USA)	7.44	0.56	3842
SVBR-75/100 (Russian Federation)	12	0.4	1638
BN-1800 (Russian Federation)	8.6	0.55	2300
BREST-1200 (Russian Federation)	9.1/9.6/10.4	0.5	to be determined
JSFR-1500 (Japan)	-	-	-
Breeding core	10.4	0.71	2690
Break even core	10.4	0.71	2690

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.2. Core fuel pin dimensions and fuel density

Experimental Fast Reactors

Plant	Core fuel pin dimensions (mm) and fuel density (% TD)	
	Intrinsic density of fuel pellet	Smeared density of fuel with fuel assumed to occupy whole space inside the cladding tube
Rapsodie (France)	92.0*	88.0*
KNK-II (Germany)	86.5	80.0
FBTR (India)	11.7 (86)	10.7 (78)
PEC (Italy)	95.0	87.6
JOYO (Japan)	94.0	87.0
DFR (UK)	19.0*	18.0*
BOR-60 (Russian Federation)	8.3-9.3*	-
EBR-II (USA)	17.7*	75.0
Fermi (USA)	100	100
FFTF (USA)	90.4	85.5
BR-10 (Russian Federation)	12.9*	11.7*
CEFR (China)	96.5	77.55

Demonstration or Prototype Fast Reactors

Phénix (France)	95.0	85.0
SNR-300 (Germany)	86.5	80.0
PFBR (India)	94.6	90.0
MONJU (Japan)	85.0	-
PFR (UK)	10.8*	8.6*
CRBRP (USA)	91.3	83.2
BN-350 (Kazakhstan)	10.4*	8.6*
BN-600 (Russian Federation)	10.4*	8.6*
ALMR (USA)	100	75.0
KALIMER-150 (Republic of Korea)	15.8	75.0
SVBR-75/100 (Russian Federation)	10.41*	9.65*
BREST-OD-300 (Russian Federation)	95.0	80.0

* g/cm^3

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.2. Core fuel pin dimensions and fuel density

Commercial Size Reactors

Plant	Core fuel pin dimensions (mm) and fuel density (% TD)	
	Intrinsic density of fuel pellet	Smeared density of fuel with fuel assumed to occupy whole space inside the cladding tube
Super-Phénix 1 (France)	95.5	82.6
Super-Phénix 2 (France)	95.5	-
SNR 2 (Germany)	93.0	87.0
DFBR (Japan)	95.0	83.7
CDFR (UK)	10.8*	8.6*
BN-1600 (Russian Federation)	10.4*	9.0*
BN-800 (Russian Federation)	10.4*	8.6*
EFR	96.0	82.7
ALMR (USA)	100	75.0
SVBR-75/100 (Russian Federation)	10.41*	9.65*
BN-1800 (Russian Federation)	-	11.59*
BREST-1200 (Russian Federation)	92.0	75.0
JSFR-1500 (Japan)	-	-
Breeding core	95.0	82.0
Break even core	95.0	82.0

* g/cm^3

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.3. Blanket fuel pin dimensions and density of fertile column

Experimental Fast Reactors

Plant	Blanket fuel pin dimensions (mm) and density (% TD) of fertile column				
	Outer diameter	Thickness of cladding	Length	Intrinsic density of pellets	Smeared density, with fuel assumed to occupy whole space inside the cladding tube
Rapsodie (France)	16.5	0.5	1079	10.5*	10.0*
KNK-II (Germany)	9.15	0.5	1363	94	89
FBTR (India)	16.5	0.5	1079	95	90
PEC (Italy)	-	-	-	-	-
JOYO (Japan)	**	**	**	-	-
DFR (UK)	34***	0.9***	2490***	-	-
BOR-60 (Russian Federation)	-	-	-	-	-
EBR-II (USA)	12.5	0.457	1397	17.7*	90
Fermi (USA)	11.3	0.25	1650	100	98
FFTF (USA)	-	-	-	-	-
BR-10 (Russian Federation)	-	-	-	-	-
CEFR (China)	-	-	-	-	-

Demonstration or Prototype Fast Reactors

Phénix (France)	13.4	0.45	1668	-	-
SNR-300 (Germany)	11.6	0.55	2475	95.0	91.0
PFBR (India)	14.33	0.6	2370	94	90.7
MONJU (Japan)	12.0	0.5	2800	93.0	90.0
PFR (UK)	13.5	1.0	1900	10.7*	10.0*
CRBRP (USA)	12.85	0.38	2959	95.6	93.2
BN-350 (Kazakhstan)	14.0	0.4	1980	93.0	90.0
BN-600 (Russian Federation)	14.0	0.4	1980	93.0	90.0
ALMR (USA)	-	-	-	-	-
KALIMER-150 (Republic of Korea)	12.0	0.55	3708	16.2*	85.0
SVBR-75/100 (Russian Federation)	none				
BREST-OD-300 (Russian Federation)	none				

** none in MK-III; (15, 0.6, 1900, respectively, in MK-I)
*** nickel reflector pins

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.3. Blanket fuel pin dimensions and density of fertile column

Commercial Size Reactors

	Blanket fuel pin dimensions (mm) and density (%TD) of fertile column				
Plant	Outer diameter	Thickness of cladding	Length	Intrinsic density of pellets	Smeared density, with fuel assumed to occupy whole space inside the cladding tube
Super-Phénix 1 (France)	15.8	0.57	1944	95.5	91.6
Super-Phénix 2 (France)	13.6	0.57	2480	-	-
SNR 2 (Germany)	15.8	0.6	2900	96.0	90.0
DFBR (Japan)	11.3	0.4	3100	95.0	-
CDFR (UK)	13.5	0.5	2000	10.8*	9.7*
BN-1600 (Russian Federation)	17.5	0.5	2000	10.6*	10.0*
BN-800 (Russian Federation)	14.0	0.4	1980	10.6*	9.7*
EFR	11.5	0.6	2645	96	89
ALMR (USA)	12.0	0.54	3842	15.7*	85
SVBR-75/100 (Russian Federation)	no radial blanket				
BN-1800 (Russian Federation)	to be determined				
BREST-1200 (Russian Federation)	no radial blanket				
JSFR-1500 (Japan)					
Breeding core	11.7	0.42	2690	95.0	90.0
Break even core	no radial blanket				

* g/cm^3

4.4. Cladding material
4.5. Wrapper material

Experimental Fast Reactors

	Cladding material		Wrapper material
Plant	Core	Blanket	
Rapsodie (France)	316	316	-
KNK-II (Germany)	1.4970	1.4981	-
FBTR (India)	316 (20% CW)	316	316 L (CW)
PEC (Italy)	316 (15%-20% CW)	-	-
JOYO (Japan)	316 (20% CW)	none**	316(20% CW) or Cr 15 Ni 20
DFR (UK)	niobium	18/8/1	-
BOR-60 (Russian Federation)	Cr16 Ni15		-
EBR-II (USA)	316	304 L	-
Fermi (USA)	Zr	304	-
FFTF (USA)	316 (20% CW)		-
BR-10 (Russian Federation)	Cr16 Ni15 Mo3 Nb	-	Cr16Ni 15 Mo3 Nb
CEFR (China)	06Cr16Ni15Mo2Mn2TiVB	-	08Cr16Ni11Mo3Ti

Demonstration or Prototype Fast Reactors

Phénix (France)	Cr 17 Ni 13 Mo 2.5 Mn 1.5 Ti Si		
SNR-300 (Germany)	X10 Cr Ni Mo Ti B1515	1.4970	
PFBR (India)	15Cr 15Ni MoTi (CW)	15Cr 15Ni MoTi (CW)	15Cr 15Ti MoTi (CW)
MONJU (Japan)	mod 316	mod 316	mod 316
PFR (UK)	*	316	PE16/FV448
CRBRP (USA)	316 (20% CW)	316 (20% CW)	
BN-350 (Kazakhstan)	Cr16 Ni15 Mo2+MnTiSi (CW)	Cr16 Ni15 Mo2+MnTiSi (CW)	Cr13Mn Nb
BN-600 (Russian Federation)	Cr16 Ni15 Mo2+MnTiSi (CW)	Cr16 Ni15 Mo2+MnTiSi (CW)	Cr13Mn Nb
ALMR (USA)	HT-9	-	HT-9
KALIMER-150 (Republic of Korea)	HT-9	HT-9	HT-9
SVBR-75/100 (Russian Federation)	EP-823 (12%Cr)	-	-
BREST-OD-300 (Russian Federation)	EP- 823 (12Cr)	-	Cr12 Ni06Mo0.9

* various materials including Nimonic PE16
** MK-III (316 (20% CW) in MK-I)

4.4. Cladding material
4.5. Wrapper material

Commercial Size Reactors

	Cladding material (type of steel)		Wrapper material
Plant	Core	Blanket	
Super-Phénix 1 (France)	Cr 17 Ni 13 Mo 2.5 Mn 1.5 Ti Si	-	-
Super-Phénix 2 (France)	-	-	-
SNR 2 (Germany)	1.4970	1.4970	-
DFBR (Japan)	advanced austentic	advanced austenitic	advanced austenitic
CDFR (UK)	PE16	PE10	
BN-1600 (Russian Federation)	Cr16Ni15Mo2MnTiSi(CW)	Cr16Ni15Mo2MnTiSi(CW)	Cr13MnNb
BN-800 (Russian Federation)	Cr16Ni15Mo2MnTiSi(CW)	Cr16Ni15Mo2MnTiSi(CW)	Cr13MnNb
EFR	AIM1 or PE16	AIM1 or PE16	EM10 or Euralloy
ALMR (USA)	HT-9	HT-9	HT-9
SVBR-75/100 (Russian Federation)	EP-823 (12%Cr)	-	-
BN-1800 (Russian Federation)	to be determined		
BREST-1200 (Russian Federation)	EP- 823 (12Cr)	-	Cr12Ni06Mo0.9
JSFR-1500 (Japan)	-	-	-
Breeding core	ODS	ODS	PNC-FMS
Break even core	ODS	ODS	PNC-FMS

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.6. Mechanical separation of pins
4.7. Linear power

Experimental Fast Reactors

Plant	Mechanical separation of pins		Linear power (kW/m)		
	Core fuel	Blanket fuel	Maximum, fuel (at start of life)	Maximum, blanket (at end of life)	Average core
Rapsodie (France)	W	W	43	-	31
KNK-II (Germany)	G	W	45	5	24
FBTR (India)	W	W	35		27
PEC (Italy)	W	-	36.5	2.1	24.5
JOYO (Japan)	W	-	42* (driver)	-	-
DFR (UK)	F	F	370	-	250
BOR-60 (Russian Federation)	W	-	54	-	40
EBR-II (USA	-	-	34.8	4.9	23
Fermi (USA)	G	W	28	14	17
FFTF (USA)	W	-	41.3	-	23.4
BR-10 (Russian Federation)	W	-	44	-	32
CEFR (China)	W	W	40	-	26.1

Demonstration or Prototype Fast Reactors

Phénix (France)	W	W	45	41	27
SNR-300 (Germany)	G	W	36	23	23
PFBR (India)	W	W	45	35	28.7
MONJU (Japan)	W	W	36	27	21
PFR (UK)	G	G	48	50	27.0
CRBRP (USA)	W	W	40.3	54.1	26.7
BN-350 (Kazakhstan)	W	W	40	48	24
BN-600 (Russian Federation)	W	W	47	48	28
ALMR (USA)	W	-	34	-	22
KALIMER-150 (Republic of Korea)	W	W	28.7	28.49	20.12
SVBR-75/100 (Russian Federation)	G	-	36		24.3
BREST-OD-300 (Russian Federation)	G	no radial blanket	41.9/39.5/32.6	-	-

* MK III; (32 and 40, in MK-I at 75 MWt and MK-II, respectively)

W - wire wrapped
G - grids
F fins on pin cladding

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.6. Mechanical separation of pins
4.7. Linear power

Commercial Size Reactors

Plant	Mechanical separation of pins		Linear power (kW/m)		
	Core fuel	Blanket fuel	Maximum, fuel, (at start of life)	Maximum, blanket (at end of life)	Average core
Super-Phénix 1 (France)	W	W	48	48	30
Super-Phénix 2 (France)	W	W	48	48	30
SNR 2 (Germany)	G	W	45	-	-
DFBR (Japan)	W	W	41	-	25
CDFR (UK)	G	W	43	63	28
BN-1600 (Russian Federation)	W	W	48.7	39.6	30
BN-800 (Russian Federation)	W	W	48	48	31
EFR	W	W	52	41	26
ALMR (USA)	W	W	31	34	19
SVBR-75/100 (Russian Federation)	G	-	36	-	24.5
BN-1800 (Russian Federation)	W	-	41	-	24
BREST-1200 (Russian Federation)	-	-	41.9/39.5/32.6	-	-
JSFR-1500 (Japan)	-	-	-	-	-
Breeding core	W	W	40	to be determined	25
Break even core	W	no radial blanket	41	no radial blanket	25

W - wire wrapped
G - grids
F - fins on pin cladding

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.8. Maximum cladding surface temperature of core fuel pin
4.9. Fission product gas volume per pin

Experimental Fast Reactors

Plant	Maximum cladding surface temperature of core fuel pin (°C)	Fission product gas volume per pin (cm^3)	
		Core fuel pin	Blanket fuel pin
Rapsodie (France)	635**	2.5	2
KNK-II (Germany)	600**	16	16
FBTR (India)	600**	1.9	-
PEC (Italy)	700	15.6	-
JOYO (Japan)	675*	10 (15 in MK-1)	none, 60 (in MK-1)
DFR (UK)	400	0	0
BOR-60 (Russian Federation)	710	7.3	-
EBR-II (USA)	580	2.4	12.8
Fermi (USA)	566	0	-
FFTF (USA)	680	19.0	-
BR-10 (Russian Federation)	565	4.8	-
CEFR (China)	670	10.3***	7

Demonstration or Prototype Fast Reactors

Phénix (France)	650**	13	12
SNR-300 (Germany)	600**	25	89
PFBR (India)	697	25.7	93.4
MONJU (Japan)	675****	-	-
PFR (UK)	670	14	34
CRBRP (USA)	732	21.1	133
BN-350 (Kazakhstan)	600	20.6	46
BN-600 (Russian Federation)	695	20.6	46
ALMR (USA)	609	31.6	-
KALIMER-150 (Republic of Korea)	35	to be determined	
SVBR-75/100 (Russian Federation)	600	44.3	-
BREST-OD-300 (Russian Federation)	644	47/51.7/60.3	-

* MK-III, midwall; (620 in MK-I, 650 in MK-II)
** best estimate; without hot-spot factors
*** not including the gas volume incorporated press spring
**** midwall

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.8. Maximum cladding surface temperature of core fuel pin
4.9. Fission product gas volume per pin

Commercial Size Reactors

Plant	Maximum cladding surface temperature of core fuel pin (°C)	Fission product gas volume per pin (cm^3)	
		Core fuel pin	Blanket fuel pin
Super-Phénix 1 (France)	620**	43	40
Super-Phénix 2 (France)	627**	-	-
SNR 2 (Germany)	570**	52	150
DFBR (Japan)	700***	-	-
CDFR (UK)	670	-	-
BN-1600 (Russian Federation)	675	50	-
BN-800 (Russian Federation)	700	18	46
EFR	635**	47	100
ALMR (USA)	609	31.6	-
SVBR-75/100(Russian Federation)	600	44.3	-
BN-1800 (Russian Federation)	to be determined		
BREST-1200 (Russsia)	650	to be determined	no radial blankets
JSFR-1500 (Japan)	-	-	-
Breeding core	700****	-	-
Break even core	700****	-	-

** best estimate; without hot-spot factors
*** midwall

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.10. Pressure of fission products
4.11. Method of detecting failed pins

Experimental Fast Reactors

Plant	Pressure of fission products (gas in fuel pin at operating temperature and maximum burnup) (MPa)	Method of detecting failed pins			
Rapsodie (France)	12.8	-	DB	DS	-
KNK-II (Germany)	2.6	DM	-	-	CGM
FBTR (India)	6.0	DM	-	-	CGM
PEC (Italy)	5.0	DM*	DB	-	CGM
JOYO (Japan)	7.3	DM	-	-	CGM
DFR (UK)	-	-	DB	-	CGM
BOR-60 (Russian Federation)	10.0	DM	-	-	CGM
EBR-II (USA)	12.4	DM	-	-	CGM
Fermi (USA)	0.0	-	-	-	CGM
FFTF (USA)	4.28	-	-	-	CGM
BR-10 (Russian Federation)	5.0	DM	-	-	CGM
CEFR (China)	2.8	-	DB	-	CGM

Demonstration or Prototype Fast Reactors

Phénix (France)	-	DM	DB	DS	CGM
SNR-300 (Germany)	3.1	DM	-	-	CGM
PFBR (India)	5.8	DM	-	-	CGM
MONJU (Japan)	6.9	DM	-	-	CGM
PFR (UK)	5.6	-	DB	DS	CGM
CRBRP (USA)	4.93	DM	-	-	-
BN-350 (Kazakhstan)	4.4	DM	-	-	CGM
BN-600 (Russian Federation)	5.0	DM	DB	-	CGM
ALMR (USA)	6.7	-	-	-	
KALIMER-150 (Republic of Korea)	7.6	to be determined			CGM
SVBR-75/100 (Russian Federation)	3.0	-	-	-	CGM
BREST-OD-300 (Russian Federation)	3.0	DM	DB	-	CGM

* test channel

DM - Delayed neutron detection (main primary circuit pipes)
DB - Delayed neutron detection (bypass pipes
DS - Delayed neutron detection (special pipework)
CGM - Cover gas monitoring system

4.10. Pressure of fission products
4.11. Method of detecting failed pins

Commercial Size Reactors

Plant	Pressure of fission products (gas in fuel pin at operating temperature and maximum burnup) (MPa)	Method of detecting failed pins			
Super-Phénix 1 (France)	4.0	-	-	DS	CGM
Super-Phénix 2 (France)	-	-	-	DS**	CGM
SNR 2 (Germany)	5.0	-	-	-	-
DFBR (Japan)	-	-	-	DS	CGM
CDFR (UK)	-	-	DB	DS	CGM
BN-1600 (Russian Federation)	-	DM	DB	-	CGM
BN-800 (Russian Federation)	5.0	DM	DB	-	CGM
EFR	6.2	DM	-	-	-
ALMR (USA)	6.7	-	-	-	CGM
SVBR-75/100 (Russian Federation)	7.6	to be determined			CGM
BN-1800 (Russian Federation)	-	DM	DB	to be determined	
BREST-1200 (Russian Federation)	to be determined	DM	DB	-	CGM
JSFR-1500 (Japan)	-	-	-	-	
Breeding core	10.7	-	-	DS	CGM
Break even core	10.7	-	-	DS	CGM

** in-vessel instrumentation

DM - Delayed neutron detection (main primary circuit pipes)
DB - Delayed neutron detection (bypass pipes
DS - Delayed neutron detection (special pipework)
CGM - Cover gas monitoring system

4.12. Methods of locating failed pins

Experimental Fast Reactors

Plant	Methods of locating failed pins			
Rapsodie (France)	SSm	GT	DSp	-
KNK-II (Germany)	SSm	-	DSp	WSp
FBTR (India)	-	-	-	-
PEC (Italy)	SSm (SSm*)	-	-	-
JOYO (Japan)	-	-	-	WSp
DFR (UK)	-	GT**	-	-
BOR-60 (Russian Federation)	-	-	DSp	WSp
EBR-II (USA)	-	GT	-	-
Fermi (USA)	-	GT (Kr, Xe)	-	-
FFTF (USA)	-	-	DSp	-
BR-10 (Russian Federation)	-	-	-	-
CEFR (China)	-	-	DSp	WSp

Demonstration or Prototype Fast Reactors

Phénix (France)	SSm	-	-	-
SNR-300 (Germany)	SSm	-	-	WSp
PFBR (India)	SSm	-	-	-
MONJU (Japan)	-	GT	-	-
PFR (UK)	SSm	GT	-	-
CRBRP (USA)	-	GT	DSp	-
BN-600 (Russian Federation)	-	-	DSp	-
ALMR (USA)	SSm	GT	-	-
KALIMER-150 (Republic of Korea)	-	GT	-	-
SVBR-75/100 (Russian Federation)	-	-	DSp	-
BREST-OD-300 (Russian Federation)	-	GT	DSp	WSp

* test channel
** a few experimental pins only

SSm - Sodium sampling to allow transfer and monitoring of delayed neutron precursors
GT - Gas tagging with selected isotopes in pin
DSp - Dry sipping method to induce release of fission products
WSp - Wet sipping method to induce release of fission products

4. FUEL DESIGN AND PERFORMANCE (cont.)

4.12. Methods of locating failed pins

Commercial Size Reactors

Plant	Methods of locating failed pins			
Super-Phénix 1 (France)	SSm	-	-	-
Super-Phénix 2 (France)	SSm	-	-	-
SNR 2 (Germany)	-	-	-	-
DFBR (Japan)	SSm	-	DSp	-
CDFR (UK)	SSm			
BN-1600 (Russian Federation)	to be determined			
BN-800 (Russian Federation)	***	-	DSp	-
EFR	SSm	-	-	-
ALMR (USA)	SSm	GT	-	-
SVBR-75/100 (Russian Federation)	-		DSp	-
BN-1800 (Russian Federation)	-	-	DSp	-
BREST-1200 (Russian Federation)	to be determined			
JSFR-1500 (Japan)	-	-	-	-
Breeding core	SSm	-	-	-
Break even core	SSm	-	-	-

*** locating of section with failed pins

SSm - Sodium sampling to allow transfer and monitoring of delayed neutron precursors
GT - Gas tagging with selected isotopes in pin
DSp - Dry sipping method to induce release of fission products
WSp - Wet sipping method to induce release of fission products