Table 1-2 Typical characteristics of the thermodynamic cycle for six reference power reactor types

Characteristic	BWR	PWR(W)	PHWR	HTGR	AGR	LMFBR
Reference design						
Manufacturer	General Electric	Westinghouse	Atomic Energy of Canada, Ltd.	General Atomic	National Nuclear Corp.	Novatome
System (reactor station)	BWR/6	(Sequoyah)	CANDU-600	(Fulton)[a]	HEYSHAM 2	(Superphenix)
Steam-cycle						
No. coolant systems	1	2	2	2	2	3
Primary coolant	H_2O	H_2O	D_2O	He	CO_2	Liq. Na
Secondary coolant	—	H_2O	H_2O	H_2O	H_2O	Liq. Na/H_2O
Energy conversion						
Gross thermal power, MW(th)	3579	3411	2180	3000	1550	3000
Net electrical power, MW(e)	1178	1148	638	1160	618	1200
Efficiency (%)	32.9	33.5	29.3	38.7	40.0	40.0
Heat transport system						
No. primary loops and pumps	2	4	2	6	8	4
No. intermediate loops	—		—	—	—	8
No. steam generators	—	4	4	6	4	8
Steam generator type	—	U tube	U tube	Helical coil	Helical coil	Helical coil
Thermal hydraulics						
Primary coolant						
Pressure (MPa)	7.17	15.5	10.0	4.90	4.30	~0.1
Inlet temp. (°C)	278	286	267	318	334	395
Ave. outlet temp. (°C)	288	324	310	741	635	545
Core flow rate (Mg/s)	13.1	17.4	7.6	1.42	3.91	16.4
Volume (L) or mass (kg)	—	3.06×10^5	1.20×10^5	(9550 kg)	5.3×10^6	(3.20×10^6 kg) Na/H_2O
Secondary coolant						
Pressure (MPa)	—	5.7	4.7	17.2	16.0	~0.1/17.7
Inlet temp. (°C)	—	224	187	188	156.0	345/235
Outlet temp. (°C)	—	273	260	513	541.0	525/487

Source: Knief [4], except AGR-HEYSHAM 2 data are from Alderson [1] and the PWR (W)-Sequoyah data from Coffey [3].

[a]Designed but not built.

Table 1-3 Typical characteristics of the fuel for six reference power reactor types

Characteristic	BWR	PWR(W)	PHWR	HTGR	AGR	LMFBR[a]
Reference design						
Manufacturer	General Electric	Westinghouse	Atomic Energy of Canada, Ltd.	General Atomic	National Nuclear Corp.	Novatome
System (reactor station)	BWR/6	(Sequoyah)	CANDU-600	(Fulton)	HEYSHAM 2	(Superphenix)
Moderator	H_2O	H_2O	D_2O	Graphite	Graphite	–
Neutron energy	Thermal	Thermal	Thermal	Thermal	Thermal	Fast
Fuel production	Converter	Converter	Converter	Converter	Converter	Breeder
Fuel[b]						
Particles						
Geometry	Cylindrical pellet	Cylindrical pellet	Cylindrical pellet	Coated microspheres	Cylindrical pellet	Annular pellet
Dimensions (mm)	10.4*D* × 10.4*H*	8.2*D* × 13.5*H*	12.2*D* × 16.4*H*	400–800 μm *D*	14.51*D* × 14.51*H*	7.0 *D*
Chemical form	UO_2	UO_2	UO_2	UC/ThO_2	UO_2	PuO_2/UO_2
Fissile (wt% 1st core ave.)	1.7 ^{235}U	2.6 ^{235}U	0.711 ^{235}U	93 ^{235}U	2.2 ^{235}U	15–18 ^{239}Pu
Fertile	^{238}U	^{238}U	^{238}U	Th	^{238}U	Depleted U
Pins						
Geometry	Pellet stack in clad tube	Pellet stack in clad tube	Pellet stack in clad tube	Cylindrical fuel stack	Pellet stack in clad tube	Pellet stack in clad tube
Dimensions (mm)	12.27*D* × 4.1 m*H*	9.5*D* × 4 m*H*	13.1*D* × 490*L*	15.7*D* × 62*L*	14.89*D* × 987*H*	8.65*D* × 2.7 m*H*(C) 15.8*D* × 1.95 m*H*(BR)
Clad material	Zircaloy-2	Zircaloy-4	Zircaloy-4	Graphite	Stainless steel	Stainless steel
Clad thickness (mm)	0.813	0.57	0.42	–	0.38	0.7
Assembly						
Geometry[c]	8 × 8 square rod array	17 × 17 square rod array	Concentric circles	Hexagonal graphite block	Concentric circles	Hexagonal rod array
Rod pitch (mm)	16.2	12.6	14.6	–	25.7	9.7 (C)/17.0 (BR)
No. rod locations	64	289	37	132 (SA)/76 (CA)[d]	37	271 (C)/91 (BR)
No. fuel rods	62	264	37	132 (SA)/76 (CA)[d]	36	271 (C)/91 (BR)
Outer dimensions (mm)	139	214	102*D* × 495*L*	360*F* × 793*H*	190.4 (inner)	173*F*
Channel	Yes	No	No	No	Yes	Yes
Total weight (kg)	273	–	–	–	342	–

Source: Knief [4] except AGR-HEYSHAM 2 data are from Alderson [1], and LMFBR pin and pellet diameters are from Vendryes [5].

[a]LMFBR-core (C), radial blanket (BR), axial blanket (BA).

[b]Fuel dimensions: diameter (*D*), height (*H*), length (*L*), (across the) flats (*F*), (width of) square (*S*).

[c]LWRs have utilized a range of number of rods.

[d]HTGR-standard assembly (SA), control assembly (CA).

Table 2-3 Typical core thermal performance characteristics for six reference power reactor types

Characteristic	BWR	PWR(W)	PHWR	HTGR	AGR	LMFBR[a]
Core						
Axis	Vertical	Vertical	Horizontal	Vertical	Vertical	Vertical
No. of assemblies						
Axial	1	1	12	8	8	1
Radial	748	193	380	493	332	364 (C) 233 (BR)
Assembly pitch (mm)	152	215	286	361	460	179
Active fuel height (m)	3.81	3.66	5.94	6.30	8.296	1.0 (C) 1.6 (C + BA)
Equivalent diameter (m)	4.70	3.37	6.29	8.41	9.458	3.66
Total fuel weight (ton)	156 UO_2	101 UO_2	98.4 UO_2	1.72 U 37.5 Th	113.5 UO_2	32 MO_2
Reactor vessel						
Inside dimensions (m)	$6.05D \times 21.6H$	$4.83D \times 13.4H$	$7.6D \times 4L$	$11.3D \times 14.4H$	$20.25D \times 21.87H$	$21D \times 19.5H$
Wall thickness (mm)	152	224	28.6	4.72 m min	5.8 m	25
Material[b]	SS-clad carbon steel	SS-clad carbon steel	Stainless steel	Prestressed concrete	Concrete helical prestressed	Stainless steel
Other features			Pressure tubes	Steel liners	Steel lined	Pool type
Power density core average (kW/L)	54.1	105	12	8.4	2.66	280
Linear heat rate						
Core average (kW/m)	19.0	17.8	25.7	7.87	17.0	29
Core maximum (kW/m)	44.0	42.7	44.1	23.0	29.8	45
Performance						
Equilibrium burnup (MWD/T)	27,500	27,500	7500	95,000	18,000	100,000
Average assembly residence (full-power days)			470	1170	1320	
Refueling						
Sequence	$\frac{1}{4}$ per yr	$\frac{1}{3}$ per yr	Continuous on-line	$\frac{1}{4}$ per yr	Continuous on-line	Variable
Outage time (days)	30	30		14–20		32

Source: Knief [3], except AGR data are from Alderson [1] and Debenham [2].

[a]LMFBR: core (C), radial blanket (BR), axial blanket (BA).

[b]SS = stainless steel.