

Appendix

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A.1. ARIES-Systems-Code General Parameters

The following output is a partial listing of the general engineering and economic parameters describing the SPPS/MHH reference design as generated by the ARIES Systems Code (ASC*).

ARIES parametric/systems calculations (ver. 11.p)25-May-1995

ECONOMIC BASIS

Costing reference year	1992
Construction lead time (y)	6
Escalation/general-inflation rate (%/y) [nominal]	0.0500
Escalation/general-inflation rate (%/y) [constant]	0.0000
Ave. cost of money (AFUDC), xCOM (%/y) [nominal]	0.1135
Ave. cost of money (AFUDC), xCOM (%/y) [constant]	0.0605
Capitalization factor, fcap [nominal]	0.5614
Capitalization factor, fcapo [constant]	0.1651
Interest during construction, fIDC [nominal]	0.3178
Interest during construction, fIDC [constant]	0.1652
Dollar discount rate, dis [nominal]	0.0957
Dollar discount rate, diso [constant]	0.0435
Fixed charge rate, FCR [nominal]	0.1637
Fixed charge rate, FCR [constant]	0.0965
FW/B neutron end-of-life fluence (MW y/m ²)	16.4000

Acc. # Spares Allowance

21.98	0.0200
22.98	0.0200
23.98	0.0200
24.98	0.0400
25.98	0.0300
26.98	0.0000

Year Price Deflator

1980	1.0000
1981	1.0963
1982	1.1623
1983	1.2069
1984	1.2523
1985	1.2994
1986	1.3279
1987	1.3699
1988	1.4154
1989	1.4738
1990	1.5500
1991	1.5934
1992	1.6348

Indirect Cost Factors:

LSA= 1 2 3 4

Acc.:

91	0.1130	0.1200	0.1280	0.1510	x TDC [90]
92	0.0520	0.0520	0.0520	0.0520	x TDC [90]
93	0.0520	0.0600	0.0640	0.0870	x TDC [90]
94	0.1826	0.1848	0.1866	0.1935	x TDC [90+91+92+93]
95	0.0000	0.0000	0.0000	0.0000	x TDC [90+91+92+93+94]
96	0.2050	0.2391	0.2565	0.2808	x TDC [90+91+92+93+94]
97	0.2651	0.2736	0.2787	0.2915	x TDC [90+91+92+93+94+95+96]
98	0.0000	0.0000	0.0000	0.0000	x TDC [90+91+92+93+94+95+96]

FPC components:	volume frac.	density (kg/m ³)	frac. density	cost (1992) (\$/kg)	frac. cost	thick. (m)
V5Cr5Ti	0.300	6100.000	1.000	300.002	1.000	
Li	0.700	500.000	0.000	49.992	0.000	
Total FW		1830.000		300.002		0.014 0.014
breeding zone						0.350
V5Cr5Ti	0.100	6100.000	1.000	300.002	1.000	
Li	0.900	500.000	0.000	49.992	0.000	
Total BL(ib)		610.000		300.002		0.350
breeding zone						0.350
V5Cr5Ti	0.100	6100.000	1.000	300.002	1.000	
Li	0.900	500.000	0.000	49.992	0.000	
Total BL(ob)		610.000		300.002		0.350
primary shield						0.450
V5Cr5Ti	0.150	6100.000	1.000	300.002	0.658	
Li	0.050	500.000	0.000	49.992	0.000	
TenelonB	0.800	7800.000	1.000	9.972	0.149	
secondary shield						0.350
TenelonS	0.150	7800.000	1.000	34.985	0.076	
Li	0.050	500.000	0.000	49.992	0.000	
TenelonB	0.800	7800.000	1.000	9.972	0.116	
Total SH(ib)		7266.563		32.277		0.800
primary shield						0.450
V5Cr5Ti	0.150	6100.000	1.000	300.002	0.658	
Li	0.050	500.000	0.000	49.992	0.000	
TenelonB	0.800	7800.000	1.000	9.972	0.149	
secondary shield						0.350
TenelonS	0.150	7800.000	1.000	34.985	0.076	
Li	0.050	500.000	0.000	49.992	0.000	
TenelonB	0.800	7800.000	1.000	9.972	0.116	
Total SH(ob)		7266.563		32.277		0.800
TenelonS	0.950	7800.000	1.000	34.985	1.000	
Void	0.050	0.000	0.000	0.000	0.000	
Total VV		7410.000		34.985		0.100 0.100
FW coating material: V5Cr5Ti at operating temperature: 727.						
DP coating material: W at operating temperature: 727. (deg C)						
blanket breeder material 6Li enrichment						0.074
Nb3Sn-coil		7500.000		97.843 (\$/kg)		
NbTi-coil		7500.000		81.740		

Cost Accounts: LSA=1

LANL/UCSD fusion reactor economic evaluation (ver. 11.1) LSA=1 05/26/95

Acc. #	Account Title	M\$ (1992)
20.	land & land rights	10.438
21.	structures & site facilities	250.837
22.	reactor plant equipment	1310.280
22. 1. 1.	FW/blanket/reflector	67.721
22. 1. 2.	shield	274.552
22. 1. 3.	magnets	369.053
22. 1. 4.	supplemental-heating/CD systems	49.006
22. 1. 5.	primary structure & support	138.292
22. 1. 6.	reactor vacuum systems(unless integral elsewhere)	77.206
22. 1. 7.	power supply, switching & energy storage	50.025
22. 1. 8.	impurity control	10.865
22. 1. 9.	direct energy conversion system	0.000
22. 1.10.	ecrh breakdown system	3.919
22. 1.	reactor equipment	1040.638
22. 2.	main heat transfer & transport systems	130.659
23.	turbine plant equipment	253.964
24.	electric plant equipment	92.525
25.	miscellaneous plant equipment	49.015
26.	special materials	21.053
90.	direct cost (not including contingency)	1988.112
91.	construction services & equipment	224.657
92.	home office engineering & services	103.382
93.	field office engineering & services	103.382
94.	owner's cost	363.029
96.	project contingency	407.563
97.	interest during construction (IDC)	527.009
99.	total cost	3717.134

-----		const.	nominal
thermal power (MWth)	= 2292.8 unit direct cost (\$/kWe) [90]=	1988.1	1988.1
gross elec. power (MWe)	= 1054.7 unit overnight cost (\$/kWe) [96]=	3190.1	3190.1
net elec. power (MWe)	= 1000.0 unit total cost (\$/kWe) [99]=	3717.1	4981.0
engineering Q-value, QE	= 19.281 capital return (mill/kWeh) =	53.97	122.67
plant availability	= 0.7589 O&M(1.57%)(mill/kWeh) [40-47, 51]=	7.54	10.11
6-yr constr.: const.	nominal W/B/R replace. (mill/kWeh) [50]=	1.75	2.35
FCR= 0.0965	0.1637 decommissioning (mill/kWeh) =	0.25	0.38
fIDC= 0.1652	0.3178 D (& 3He) fuel (mill/kWeh) [02]=	0.03	0.04
fEDC= 0.0000	0.2436 LSA=1 total COE (mill/kWeh) =	63.55	135.53

Cost Accounts: LSA=3

LANL/UCSD fusion reactor economic evaluation (ver. 11.1) LSA=3 05/26/95

Acc. #	Account Title	M\$ (1992)
20.	land & land rights	10.438
21.	structures & site facilities	349.201
22.	reactor plant equipment	1514.219
22. 1. 1.	FW/blanket/reflector	75.245
22. 1. 2.	shield	305.057
22. 1. 3.	magnets	410.059
22. 1. 4.	supplemental-heating/CD systems	54.194
22. 1. 5.	primary structure & support	152.935
22. 1. 6.	reactor vacuum systems(unless integral elsewhere)	85.381
22. 1. 7.	power supply, switching & energy storage	55.322
22. 1. 8.	impurity control	12.015
22. 1. 9.	direct energy conversion system	0.000
22. 1.10.	ecrh breakdown system	4.334
22. 1.	reactor equipment	1154.542
22. 2.	main heat transfer & transport systems	204.698
23.	turbine plant equipment	253.964
24.	electric plant equipment	103.628
25.	miscellaneous plant equipment	53.628
26.	special materials	21.053
90.	direct cost (not including contingency)	2306.130
91.	construction services & equipment	295.185
92.	home office engineering & services	119.919
93.	field office engineering & services	147.592
94.	owner's cost	430.324
96.	project contingency	591.522
97.	interest during construction (IDC)	642.739
99.	total cost	4533.412

-----				const.	nominal
thermal power (MWth)	= 2292.8	unit direct cost (\$/kWe)	[90]=	2306.1	2306.1
gross elec. power (MWe)	= 1054.7	unit overnight cost (\$/kWe)	[96]=	3890.7	3890.7
net elec. power (MWe)	= 1000.0	unit total cost (\$/kWe)	[99]=	4533.4	6074.9
engineering Q-value, QE	= 19.281	capital return (mill/kWeh)	=	65.82	149.60
plant availability	= 0.7589	O&M(1.70%)(mill/kWeh)	[40-47,51]=	9.97	13.36
6-yr constr.: const.	nominal	W/B/R replace. (mill/kWeh)	[50]=	2.00	2.69
FCR=	0.0965	decommissioning (mill/kWeh)	=	0.75	1.13
fIDC=	0.1652	D (& 3He) fuel (mill/kWeh)	[02]=	0.03	0.04
fEDC=	0.0000	LSA=3 total COE (mill/kWeh)	=	78.57	166.81

Cost Accounts: LSA=4

LANL/UCSD fusion reactor economic evaluation (ver. 11.1) LSA=4 05/26/95

Acc. #	Account Title	M\$ (1992)
20.	land & land rights	10.438
21.	structures & site facilities	370.910
22.	reactor plant equipment	1559.414
22. 1. 1.	FW/blanket/reflector	75.245
22. 1. 2.	shield	305.057
22. 1. 3.	magnets	410.059
22. 1. 4.	supplemental-heating/CD systems	57.654
22. 1. 5.	primary structure & support	162.697
22. 1. 6.	reactor vacuum systems(unless integral elsewhere)	90.831
22. 1. 7.	power supply, switching & energy storage	58.853
22. 1. 8.	impurity control	12.782
22. 1. 9.	direct energy conversion system	0.000
22. 1.10.	ecrh breakdown system	4.610
22. 1.	reactor equipment	1177.788
22. 2.	main heat transfer & transport systems	217.764
23.	turbine plant equipment	253.964
24.	electric plant equipment	123.366
25.	miscellaneous plant equipment	57.665
26.	special materials	21.053
90.	direct cost (not including contingency)	2396.810
91.	construction services & equipment	361.918
92.	home office engineering & services	124.634
93.	field office engineering & services	208.522
94.	owner's cost	463.783
96.	project contingency	673.024
97.	interest during construction (IDC)	698.580
99.	total cost	4927.272

-----				const.	nominal	
thermal power (MWth)	=	2292.8	unit direct cost (\$/kwe)	[90]=	2396.8	2396.8
gross elec. power (MWe)	=	1054.7	unit overnight cost (\$/kwe)	[96]=	4228.7	4228.7
net elec. power (MWe)	=	1000.0	unit total cost (\$/kwe)	[99]=	4927.3	6602.6
engineering Q-value, QE	=	19.281	capital return (mill/kweh)	=	71.54	162.60
plant availability	=	0.7589	O&M(1.69%)(mill/kweh)	[40-47,51]=	10.78	14.44
6-yr constr.:	const.		nominal W/B/R replace. (mill/kweh)	[50]=	2.04	2.73
FCR=	0.0965	0.1637	decommissioning (mill/kweh)	=	1.00	1.50
fIDC=	0.1652	0.3178	D (& 3He) fuel (mill/kweh)	[02]=	0.03	0.04
fEDC=	0.0000	0.2436	LSA=4 total COE (mill/kweh)	=	85.39	181.31

Cost Accounts: LSA=2 SPSS/MHH Reference Case

LANL/UCSD fusion reactor economic evaluation (ver. 11.1) LSA=2 05/26/95

Acc. #	Account Title	M\$ (1992)
20.	land & land rights	10.438
21.	structures & site facilities	332.546
22.	reactor plant equipment	1487.238
22. 1. 1.	FW/blanket/reflector	71.483
22. 1. 2.	shield	289.804
22. 1. 3.	magnets	389.556
22. 1. 4.	supplemental-heating/CD systems	54.194
22. 1. 5.	primary structure & support	152.935
22. 1. 6.	reactor vacuum systems(unless integral elsewhere)	85.381
22. 1. 7.	power supply, switching & energy storage	55.322
22. 1. 8.	impurity control	12.015
22. 1. 9.	direct energy conversion system	0.000
22. 1.10.	ecrh breakdown system	4.334
22. 1.	reactor equipment	1115.024
22. 2.	main heat transfer & transport systems	217.764
23.	turbine plant equipment	253.964
24.	electric plant equipment	103.628
25.	miscellaneous plant equipment	51.898
26.	special materials	21.053
90.	direct cost (not including contingency)	2260.764
91.	construction services & equipment	271.292
92.	home office engineering & services	117.560
93.	field office engineering & services	135.646
94.	owner's cost	417.789
96.	project contingency	540.549
97.	interest during construction (IDC)	618.443
99.	total cost	4362.043

-----		const.	nominal
thermal power (MWth)	= 2292.8 unit direct cost (\$/kWe) [90]=	2260.8	2260.8
gross elec. power (MWe)	= 1054.7 unit overnight cost (\$/kWe) [96]=	3743.6	3743.6
net elec. power (MWe)	= 1000.0 unit total cost (\$/kWe) [99]=	4362.1	5845.2
engineering Q-value, QE	= 19.281 capital return (mill/kWeh) =	63.34	143.95
plant availability	= 0.7589 O&M(1.63%)(mill/kWeh)[40-47,51]=	9.16	12.27
6-yr constr.: const.	nominal W/B/R replace. (mill/kWeh) [50]=	1.90	2.55
FCR=	0.0965 0.1637 decommissioning (mill/kWeh) =	0.50	0.75
fIDC=	0.1652 0.3178 D (& 3He) fuel (mill/kWeh) [02]=	0.03	0.04
fEDC=	0.0000 0.2436 LSA=2 total COE (mill/kWeh) =	74.92	159.55

Power-Balance Summary

primary coolant: Li w/ IHX unless LSA=1			
thermal conversion efficiency (blanket)			0.460
thermal conversion efficiency (divertor)			0.460
thermal conversion efficiency (composite)			0.460
auxiliary site power fraction of Pg, faux			0.040
primary loop pumping power fraction of Pg, fpmp			0.010
engineering q-value, QE			19.281
recirculating power fraction, eps=1/QE			0.052
net plant efficiency			0.436
plasma q-value, Qp			1727.549
CD/heater system efficiency			0.509
CD/heater power [NB] (MW)			0.000
CD/heater power [fw] (MW):			0.208
CD/heater power [lh] (MW):			0.792
CD/heater power [rf] (MW):			1.000
CD/heater power, P(CD) (MW)			0.000
auxiliary CD/heater power (MW)			1.000
CD/heater capacity [NB] (MW)			0.000
CD/heater capacity [fw] (MW):			0.208
CD/heater capacity [lh] (MW):			20.000
CD/heater total capacity (MW):			20.208
CD/heater unit cost (\$/W):			1.745
FW current-drive frequency (MHz)			125.000
LH current-drive frequency (MHz)			8000.000
FW current-drive efficiency (mA/W)			6.270
LH current-drive efficiency (mA/W)			1.523
fusion power, P(F) (MW)			1727.549
neutron power (MW)			1381.145
fraction of fusion power in neutron channel			0.799
neutron source density (neutrons/s m ³)			8.364E+17
fusion power in charged particles, Pcp (MWt)			346.404
fraction of Pcp+Pcd to direct conversion			0.000
direct-conversion system efficiency, etadec			0.000
direct-conversion electric power, Pdc (MWe)			0.000
cycle averaged refrigeration power loss (MW)			0.000
	0.000	0.000	0.000
cycle averaged dump-resistor power loss (MW)			0.000
cycle averaged rf startup power (MW)			0.000
cycle averaged total pulsed power losses (MW)			0.000
total useful thermal power, P(TH) pk/ave (MW)	2292.827		2292.827
gross electrical output power, P(ET) (MWe)			1054.701
net electrical output power, P(E) (MWe)			1000.000

Engineering Summary

tritium burnup (kg/day)	0.265
fractional burnup	0.095
tritium thru-put (no recycle) (kg/day)	2.800
blanket breeder material 6Li enrichment	0.074
projected first-wall surface area (m^2)	1171.311
14.06-MeV neutron load, I_w (MW/m^2)	1.179
14.06-MeV neutron energy multiplication in blanket, M	1.400
2.45-MeV neutron load (MW/m^2)	0.001
2.45-MeV neutron energy multiplication in blanket, M	3.700
Average neutron energy multiplication in blanket	1.401
first-wall (FW) volume (m^3)	10.343
inboard blanket volume (m^3)	172.940
outboard blanket volume (m^3)	207.252
total blanket volume (m^3)	380.192
inboard shield volume (m^3)	498.777
outboard shield volume (m^3)	632.381
penetra. shield volume (m^3)	169.674
total shield volume (m^3)	1300.831
TF-coil volume (m^3)	558.804
mass of FW/blanket/reflector (tonne)	250.845
mass of shield (tonne)	9452.571
total coil-set mass (tonne)	4191.032
mass of FPC structure (tonne)	5364.520
mass of vacuum vessel (tonne)	2171.144
FPC (FWBRSC) mass (tonne)	21430.111
fusion-power-core mass utilization, M/Pth (tonne/Mwt)	9.347
FPC mass power density, MPD (kWe/tonne)	46.663
mass of liquid-metal coolant in FW/B/S (tonne)	174.707
total mass of liquid-metal coolant (tonne)	436.767
system power density (MW/m^3)	0.570
blanket power density (MW/m^3)	6.031

Parameter Summary

plasma aspect ratio, A	12.078
major toroidal radius, Rt (m)	13.950
minor plasma radius, ap(xp) (m)	1.155
circularized plasma radius, rp (m)	1.633
plasma vertical elongation, b/a(xp)	2.000
plasma triangularity, d(xp)	0.001
fusion power, P(F) (MW)	1727.549
total useful thermal power, P(TH) pk/ave (MW)	2292.827 2292.827
gross electrical output power, P(ET) (MWe)	1054.701
net electrical output power, P(E) (MWe)	1000.000
CD/heater power, P(CD) (MW)	0.000
auxiliary CD/heater power (MW)	1.000
fusion power density (MW/m ³)	2.351
current-drive efficiency factor, gamma (10 ¹⁹ A/m ² W)	0.513
beta	0.050
poloidal-beta/aspect	0.240
plasma ion temp. [dens.-weight.-vol.-avg.] (keV)	10.000
plasma electron temp. [dens.-weight.-vol.-avg.] (keV)	10.496
plasma (total) ion density (10 ²⁰ /m ³)	1.314
plasma electron density (10 ²⁰ /m ³)	1.464
calculated Lawson parameter (10 ²⁰ s/m ³)	2.545
ITER-89P -confinement multiplier, Ha	1.958
ITER-H90P-confinement multiplier, Hc	0.343
SPPS Lackner-Gottardi confinement multiplier, Hd	2.312
on-axis toroidal field (T)	4.942
magnetic field at the coil (T)	14.331
divertor-plate peak particle surface heat flux (MW/m ²)	(5.641)
radiation fraction, frad (bremsstrahlung+synchrotron)	0.213
plasma q-value, Qp	1727.549
engineering q-value, QE	19.281
14.06-MeV neutron load, Iw (MW/m ²)	1.179
2.45-MeV neutron load (MW/m ²)	0.001
FPC mass power density, MPD (kWe/tonne)	46.663
LSA=2 total COE (mill/kWeh)	74.922

COE versus LSA	
LSA	COE
	(mill/kWeh)
1	63.545
2	74.922
3	78.573
4	85.386

A.2. ARIES-Systems-Code Cost Summary

The following output is a complete listing of the cost accounts for the SPPS/MHH reference design as generated by the ARIES Systems Code (ASC*).

Acc. #	Account Title	fusion reactor economic evaluation (ver. 11.1) M\$ (1992)
20. 1.	land & privilege acquisition	
20. 2.	relocation of buildings, utilities, highways, etc.	
20.	land & land rights	10.438
21. 1. 1.	general yard improvements	
21. 1. 2.	waterfront improvements	
21. 1. 3.	transportation access (off site)	
21. 1.	site improvements & facilities	18.441
21. 2. 1.	basic building structures	127.590
21. 2. 2.	building services	2.943
21. 2. 3.	containment structures	
21. 2. 4.	architectural	11.035
21. 2.	reactor building	141.567
21. 3. 1.	basic building structures	27.768
21. 3. 2.	building services	3.270
21. 3. 3.	architectural	2.452
21. 3.	turbine building	33.490
21. 4. 1.	intake structures	
21. 4. 2.	discharge structures	
21. 4. 3.	unpressurized intake & discharge conduits	
21. 4. 4.	recirculating structures	
21. 4. 5.	cooling tower systems	
21. 4.	cooling system structures	7.908
21. 5. 1.	basic building structures	8.756
21. 5. 2.	building services	0.578
21. 5. 3.	architectural	0.654
21. 5.	power supply & energy storage building	9.988
21. 6. 1.	reactor auxiliaries building(incl. switchgear bay)	3.555
21. 6. 2.	hot cell building	78.995
21. 6. 3.	fuel storage building	12.697
21. 6. 4.	control room building	5.068
21. 6. 5.	diesel generator building	3.351
21. 6. 6.	administration building	1.422
21. 6. 7.	service building	3.073
21. 6. 8.	cryogenics building	1.488
21. 6. 9.	miscellaneous structures & building work	3.008
21. 6.10.	thermal storage building	0.000
21. 6.	miscellaneous buildings	112.658

21. 7.	ventilation stack	1.974	
21.98.	spare parts allowance	6.521	
21.99.	contingency allowance		
21.	structures & site facilities		332.546
22. 1. 1. 1.	first wall (FW)	5.395	
22. 1. 1. 2.	wall modifiers(coatings, liners, limiters, etc.)		
22. 1. 1. 3.	blanket (structure, breeder, n-multiplier, etc.)	66.088	
22. 1. 1. 4.	reflector		
22. 1. 1. 5.	manifolds		
22. 1. 1. 6.	other		
22. 1. 1.	FW/blanket/reflector		71.483
22. 1. 2. 1.	primary	289.804	
22. 1. 2. 2.	secondary	0.000	
22. 1. 2.	shield		289.804
22. 1. 3. 1.	toroidal field coils	389.556	
22. 1. 3. 2.	ohmic-heating coils	0.000	
22. 1. 3. 3.	equilibrium field coils	0.000	
22. 1. 3. 4.	divertor field coils	0.000	
22. 1. 3. 5.	other coils		
22. 1. 3.	magnets		389.556
22. 1. 4. 1.	beam heating(neutral, ion or electron)	0.000	
22. 1. 4. 2.	rf heating	54.194	
22. 1. 4. 3.	laser heating		
22. 1. 4. 4.	other heating systems		
22. 1. 4.	supplemental-heating/CD systems		54.194
22. 1. 5. 1.	reactor structure		
22. 1. 5. 2.	equipment support structure		
22. 1. 5.	primary structure & support		152.935
22. 1. 6. 1.	plasma chamber vacuum(incl. pumps/comp./pipe)	13.986	
22. 1. 6. 2.	magnet dewar vacuum(incl. pumps/comp./pipe)		
22. 1. 6. 3.	suppl. heating vacuum(incl. pumps/comp./pipe)		
22. 1. 6. 4.	direct convertor vacuum(incl. pumps/comp./pipe)		
22. 1. 6. 5.	reactor vacuum system(low grade)		
22. 1. 6. 6.	reactor vacuum wall	71.395	
22. 1. 6. 7.	reactor vacuum tank/enclosure		
22. 1. 6.	reactor vacuum systems(unless integral elsewhere)		85.381
22. 1. 7. 1.	EF-coil power supplies		
22. 1. 7. 2.	OH-coil power supplies		
22. 1. 7. 3.	TF-coil power supplies		
22. 1. 7. 4.	DF-coil power supplies		
22. 1. 7. 5.	other power supplies	1.537	
22. 1. 7. 6.	current drive power supplies	0.000	
22. 1. 7. 7.	control system		
22. 1. 7. 8.	central energy storage		
22. 1. 7. 9.	other incl. busbars	53.785	
22. 1. 7.	power supply, switching & energy storage		55.322
22. 1. 8.	impurity control		12.015

22. 1. 9. 1.	vacuum tank	
22. 1. 9. 2.	direct convertor modules	
22. 1. 9. 3.	thermal panels	
22. 1. 9. 4.	power conditioning equipment	
22. 1. 9.	direct energy conversion system	0.000
22. 1.10.	ecrh breakdown system	4.334
22. 1.	reactor equipment	1115.024
22. 2. 1. 1.	pumps & motor drives(modular & nonmodular)	
22. 2. 1. 2.	piping	
22. 2. 1. 3.	heat exchangers	
22. 2. 1. 4.	tanks(dump,make-up,clean-up,trit.,hot storage)	
22. 2. 1. 5.	clean-up system	
22. 2. 1. 6.	thermal insulation, piping & equipment	
22. 2. 1. 7.	tritium extraction	
22. 2. 1. 8.	pressurizer	
22. 2. 1. 9.	other	
22. 2. 1.	primary coolant system	185.293
22. 2. 2. 1.	pumps & motor drives(modular & nonmodular)	
22. 2. 2. 2.	piping	
22. 2. 2. 3.	heat exchangers	
22. 2. 2. 4.	tanks(dump,make-up,clean-up,trit.,hot storage)	
22. 2. 2. 5.	clean-up system	
22. 2. 2. 6.	thermal insulation, piping & equipment	
22. 2. 2. 7.	tritium extraction	
22. 2. 2. 8.	pressurizer	
22. 2. 2. 9.	other	
22. 2. 2.	intermediate coolant system	32.365
22. 2. 3. 1.	pumps & motor drives(modular & nonmodular)	
22. 2. 3. 2.	piping	
22. 2. 3. 3.	heat exchangers	
22. 2. 3. 4.	tanks(dump,make-up,clean-up,trit.,hot storage)	
22. 2. 3. 5.	clean-up system	
22. 2. 3. 6.	thermal insulation, piping & equipment	
22. 2. 3. 7.	tritium extraction	
22. 2. 3. 8.	pressurizer	
22. 2. 3. 9.	other	
22. 2. 3.	secondary coolant system	0.106
22. 2. 4.	thermal storage system	0.000
22. 2.	main heat transfer & transport systems	217.764
22. 3. 1. 1.	refrigeration	0.000
22. 3. 1. 2.	piping	
22. 3. 1. 3.	fluid circulation driving system	
22. 3. 1. 4.	tanks	
22. 3. 1. 5.	purification	
22. 3. 1.	magnet cooling system	0.000
22. 3. 2. 1.	refrigeration	
22. 3. 2. 2.	piping	
22. 3. 2. 3.	fluid circulation driving system	
22. 3. 2. 4.	tanks	

22. 3. 2. 5.	purification	
22. 3. 2.	shield & structure cooling system	2.361
22. 3. 3. 1.	refrigeration	
22. 3. 3. 2.	pipng	
22. 3. 3. 3.	fluid circulation driving system	
22. 3. 3. 4.	tanks	
22. 3. 3. 5.	purification	
22. 3. 3.	supplemental heating system cooling system	
22. 3. 4. 1.	refrigeration	
22. 3. 4. 2.	pipng	
22. 3. 4. 3.	fluid circulation driving system	
22. 3. 4. 4.	tanks	
22. 3. 4. 5.	purification	
22. 3. 4.	power supply cooling system	
22. 3. 5.	other cooling systems (ECCS)	
22. 3.	auxiliary cooling systems	2.361
22. 4. 1.	liquid waste processing & equipment	
22. 4. 2.	gaseous wastes & off-gas processing system	
22. 4. 3.	solid waste processing equipment	
22. 4.	radioactive waste treatment & disposal	4.228
22. 5. 1.	fuel injection systems	11.399
22. 5. 2.	fuel processing systems	12.767
22. 5. 3.	fuel storage	5.700
22. 5. 4.	atmospheric tritium recovery	2.910
22. 5. 5.	water tritium recovery systems	5.700
22. 5. 6.	blanket tritium recovery systems	5.700
22. 5. 7.	other	
22. 5.	fuel handling & storage systems	44.175
22. 6. 1. 1.	blanket & coil maintenance equipment	
22. 6. 1. 2.	components rotated into service to allow maint.	
22. 6. 1. 3.	other maintenance equipment	
22. 6. 1.	maintenance equipment	
22. 6. 2.	special heating systems(start-up,trace, etc.)	
22. 6. 3.	coolant receiving, storage & make-up systems	
22. 6. 4.	gas systems	
22. 6. 5.	building vacuum systems	
22. 6.	other reactor plant equipment	38.549
22. 7. 1.	reactor i&c equip.(burn control, diagnostics, etc.	
22. 7. 2.	radiation monitoring systems	
22. 7. 3.	isolated indicating & recording gauges, etc.	
22. 7.	instrumentation & control(i&c)	35.974
22.98.	spare parts allowance	29.162
22.99.	contingency allowance	
22.	reactor plant equipment	1487.238

23. 1. 1.	turbine-generators & accessories	
23. 1. 2.	foundations	
23. 1. 3.	standby exciters	
23. 1. 4.	lubricating system	
23. 1. 5.	gas systems	
23. 1. 6.	reheaters	
23. 1. 7.	shielding	
23. 1. 8.	weather-proof housing	
23. 1.	turbine-generators	215.934
23. 2.	misc. turbine-generator equipment	
23. 3. 1.	water intake common facilities	
23. 3. 2.	circulating water systems	
23. 3. 3.	cooling towers	
23. 3. 4.	other systems which reject heat to the atmosphere	
23. 3.	heat rejection systems	33.050
23. 4. 1.	condensers	
23. 4. 2.	condensate system	
23. 4. 3.	gas removal system	
23. 4. 4.	turbine by-pass systems(excl. piping)	
23. 4.	condensing systems	
23. 5. 1.	regenerators & recuperators	
23. 5. 2.	pumps	
23. 5. 3.	tanks	
23. 5.	feed heating system	
23. 6. 1.	turbine auxiliaries	
23. 6. 2.	auxiliaries cooling system(excl. piping)	
23. 6. 3.	make-up treat. system(excl. piping)	
23. 6. 4.	chemical treat. & condensate purification systems	
23. 6. 5.	central lubrication service system(excl. piping)	
23. 6.	other turbine plant equipment	
23. 7.	instrumentation & control(i&c) equipment	
23.98.	spare parts allowance	4.980
23.99.	contingency allowance	
23.	turbine plant equipment	253.964
24. 1. 1.	generator circuits	
24. 1. 2.	station service	
24. 1.	switchgear	

24. 2. 1.	station service & startup transformers	
24. 2. 2.	low voltage unit substation & lighting transformer	
24. 2. 3.	battery system	
24. 2. 4.	diesel engine generators	
24. 2. 5.	gas turbine generators	
24. 2. 6.	motor generator sets	
24. 2.	station service equipment	
24. 3. 1.	main control board for electric system	
24. 3. 2.	auxiliary power & signal boards	
24. 3.	switchboards (incl. heat tracing)	
24. 4. 1.	gen. station grounding sys. & cathodic protection	
24. 4.	protective equipment	
24. 5. 1.	concrete cable tunnels, trenches & envelopes	
24. 5. 2.	cable trays & support	
24. 5. 3.	conduit	
24. 5. 4.	other structures	
24. 5.	electrical structures & wiring containers	
24. 6. 1.	generator circuits wiring	
24. 6. 2.	station service power wiring	
24. 6. 3.	control wiring	
24. 6. 4.	instrument wiring	
24. 6. 5.	containment penetrations	
24. 6.	power & control wiring	
24. 7. 1.	reactor building lighting	
24. 7. 2.	turbine building lighting	
24. 7. 3.	reactor auxiliaries building lighting	
24. 7. 4.	radioactive waste building lighting	
24. 7. 5.	fuel storage building lighting	
24. 7. 6.	miscellaneous buildings lighting	
24. 7. 7.	yard lighting	
24. 7.	electrical lighting	
24.98.	spare parts allowance	
24.99.	contingency allowance	
24.	electric plant equipment	103.628
25. 1. 1.	cranes, hoists, monorails, & conveyors	
25. 1. 2.	railway	
25. 1. 3.	roadway equipment	
25. 1. 4.	watercraft	
25. 1. 5.	vehicle maintenance equipment	
25. 1.	transportation & lifting equipment	

25. 2. 1.	air systems(excl. piping)	
25. 2. 2.	water systems(excl. piping)	
25. 2. 3.	auxiliary heating boilers(excl. piping)	
25. 2.	air & water service systems	
25. 3. 1.	local communications systems	
25. 3. 2.	signal systems	
25. 3.	communications equipment	
25. 4. 1.	safety equipment	
25. 4. 2.	shop, laboratory, & test equipment	
25. 4. 3.	office equipment & furnishings	
25. 4. 4.	change room equipment	
25. 4. 5.	environmental monitoring equipment	
25. 4. 6.	dining facilities	
25. 4.	furnishings & fixtures	
25.98.	spare parts allowance	
25.99.	contingency allowance	
25.	miscellaneous plant equipment	51.898
26. 1.	reactor coolant	20.358
26. 2.	intermediate coolant	
26. 3.	turbine cycle working fluids	
26. 4.	other materials	0.409
26. 5.	Ar reactor-building cover gas	0.285
26.98.	spare parts allowance	
26.99.	contingency allowance	
26.	special materials	21.053

LANL/UCSD fusion reactor economic evaluation (ver. 11.1) LSA=2 05/26/95

Acc. #	Account Title	M\$ (1992)	
20.	land & land rights	10.438	
21.	structures & site facilities	332.546	
22.	reactor plant equipment	1487.238	
23.	turbine plant equipment	253.964	
24.	electric plant equipment	103.628	
25.	miscellaneous plant equipment	51.898	
26.	special materials	21.053	
90.	direct cost (not including contingency)		2260.764
91.	construction services & equipment		271.292
92. 1.	systems engineering		
92. 2.	management		
92. 3.	quality assurance		
92. 4.	safety & environmental engineering		
92.	home office engineering & services		117.560
93. 1.	construction management		
93. 2.	inspection		
93. 3.	preoperational testing		
93.	field office engineering & services		135.646
94. 1.	project administration		
94. 2.	staff training & plant startup		
94. 3.	inventories & spares		
94.	owner's cost		417.789
95.	process contingency		
96.	project contingency		540.549
97.	interest during construction (IDC)		618.443
98.	escalation during construction (EDC)		
99.	total cost		4362.043

-----				const.	nominal
thermal power (MWth)	= 2292.8	unit direct cost (\$/kWe)	[90]=	2260.8	2260.8
gross elec. power (MWe)	= 1054.7	unit overnight cost (\$/kWe)	[96]=	3743.6	3743.6
net elec. power (MWe)	= 1000.0	unit total cost (\$/kWe)	[99]=	4362.1	5845.2
engineering Q-value, QE	= 19.281	capital return (mill/kWeh)	=	63.34	143.95
plant availability	= 0.7589	O&M(1.63%)(mill/kWeh)	[40-47, 51]=	9.16	12.27
6-yr constr.: const.	nominal	W/B/R replace. (mill/kWeh)	[50]=	1.90	2.55
FCR=	0.0965	decommissioning (mill/kWeh)	=	0.50	0.75
fIDC=	0.1652	D (& 3He) fuel (mill/kWeh)	[02]=	0.03	0.04
fEDC=	0.0000	LSA=2 total COE (mill/kWeh)	=	74.92	159.55

A.3. ARIES-Systems-Code Cost Database

The following output is a complete listing of the cost database for the SPPS/MHH reference design as generated by the ARIES Systems Code (ASC*).

cost data base (ver. 10.1) LSA=2

Acc. #	Account Title	UC(1992) = 1.6348 x UC(1980)	LSA factor	unit cost(1980)	# of units	refs.
20 1 0 0	land & privilege acquisition		1.0000	0.000E+00	1.000E+00	
20 2 0 0	relocation of buildings, utilities, highways, etc.		1.0000	0.000E+00	1.000E+00	
20 0 0 0	land & land rights		1.0000	6.385E+03 \$/acre	1.000E+03 28	
21 1 1 0	general yard improvements		1.0000	0.000E+00	1.000E+00	
21 1 2 0	waterfront improvements		1.0000	0.000E+00	1.000E+00	
21 1 3 0	transportation access (off site)		1.0000	0.000E+00	1.000E+00	
21 1 0 0	site improvements & facilities		1.0000	0.000E+00	1.000E+00	
21 2 1 0	basic building structures		0.9000	1.128E+07 \$	1.000E+00 10	
21 2 2 0	building services		0.9000	3.725E+02 \$/m^3	2.328E+05 30	
21 2 3 0	containment structures		0.9000	2.000E+06 \$	1.000E+00 13, 14, +	
21 2 4 0	architectural		0.9000	7.500E+06 \$	1.000E+00 30	
21 2 0 0	reactor building		0.9000	0.000E+00	1.000E+00 13, 14, +	
21 3 1 0	basic building structures		1.0000	1.610E-02 \$/Weg	1.055E+09 32	
21 3 2 0	building services		1.0000	2.000E+06 \$	1.000E+00 13, 14, +	
21 3 3 0	architectural		1.0000	1.500E+06 \$	1.000E+00 13	
21 3 0 0	turbine building		1.0000	0.000E+00	1.000E+00	
21 4 1 0	intake structures		0.6670	0.000E+00	1.000E+00	
21 4 2 0	discharge structures		0.6670	0.000E+00	1.000E+00	
21 4 3 0	unpressurized intake & discharge conduits		0.6670	0.000E+00	1.000E+00	
21 4 4 0	recirculating structures		0.6670	0.000E+00	1.000E+00	
21 4 5 0	cooling tower systems		0.6670	0.000E+00	1.000E+00	
21 4 0 0	cooling system structures		0.6670	6.874E-03 \$/Weg	1.055E+09 2, 13, 14	
21 5 1 0	basic building structures		0.6670	8.030E+06 \$	1.000E+00 13, 14	
21 5 2 0	building services		0.6670	5.300E+05 \$	1.000E+00 13, 14	
21 5 3 0	architectural		0.6670	6.000E+05 \$	1.000E+00 13	
21 5 0 0	power supply & energy storage building		0.6670	0.000E+00	1.000E+00	
21 6 1 0	reactor auxiliaries building(incl. switchgear bay)		0.6670	3.260E+06 \$	1.000E+00 13, 14	
21 6 2 0	hot cell building		0.9000	5.369E+07 \$	1.000E+00 13, 14	
21 6 3 0	fuel storage building		0.9000	8.630E+06 \$	1.000E+00 13, 14	
21 6 4 0	control room building		1.0000	3.100E+06 \$	1.000E+00 13, 14	
21 6 5 0	diesel generator building		1.0000	2.050E+06 \$	1.000E+00 13, 14	
21 6 6 0	administration building		1.0000	8.700E+05 \$	1.000E+00 13, 14	
21 6 7 0	service building		1.0000	1.880E+06 \$	1.000E+00 13, 14	
21 6 8 0	cryogenics building		1.0000	9.100E+05 \$	1.000E+00 13, 14	
21 6 9 0	miscellaneous structures & building work		1.0000	1.840E+06 \$	1.000E+00 13, 14	
21 6 10 0	thermal storage buildings		0.9000	0.000E+00 \$/s	0.000E+00 31	
21 6 0 0	miscellaneous buildings		0.6670	0.000E+00	1.000E+00	
21 7 0 0	ventilation stack		0.6670	1.810E+06 \$	1.000E+00 13, 14	
21 98 0 0	spare parts allowance		0.6670	2.000E-02 fraction	-1.000E+00 2, 13, 14	
21 99 0 0	contingency allowance		0.6670	0.000E+00	-1.000E+00 2, 13, 14	
21 0 0 0	structures & site facilities		0.6670	0.000E+00	1.000E+00	
22 1 1 1	first wall (FW)		0.9500	1.835E+02 \$/kg	1.893E+04	
22 1 1 2	wall modifiers(coatings, liners, limiters, etc.)		0.9500	0.000E+00	1.000E+00	
22 1 1 3	blanket (structure, breeder, n-multiplier, etc.)		0.9500	1.835E+02 \$/kg	2.319E+05	
22 1 1 4	reflector		0.9500	0.000E+00	1.000E+00	

22	1	1	5	manifolds	0.9500	0.000E+00	1.000E+00
22	1	1	6	other	0.9500	0.000E+00	1.000E+00
22	1	1	0	FW/blanket/reflector	0.9500	0.000E+00	1.000E+00
22	1	2	1	primary	0.9500	1.974E+01 \$/kg	9.453E+06 10
22	1	2	2	secondary	0.9500	1.974E+01 \$/kg	0.000E+00 10
22	1	2	0	shield	0.9500	0.000E+00	1.000E+00
22	1	3	1	toroidal field coils	0.9500	5.985E+01 \$/kg	4.191E+06 10
22	1	3	2	ohmic-heating coils	0.9500	5.000E+01 \$/kg	0.000E+00 10
22	1	3	3	equilibrium field coils	0.9500	5.000E+01 \$/kg	0.000E+00 10
22	1	3	4	divertor field coils	0.9500	5.000E+01 \$/kg	0.000E+00 10
22	1	3	5	other coils	0.9500	0.000E+00	1.000E+00
22	1	3	0	magnets	0.9500	0.000E+00	1.000E+00
22	1	4	1	beam heating(neutral, ion or electron)	0.9400	2.110E+00 \$/W	0.000E+00 28+
22	1	4	2	rf heating	0.9400	1.745E+00 \$/W	2.021E+07 28+
22	1	4	3	laser heating	0.9400	0.000E+00	1.000E+00
22	1	4	4	other heating systems	0.9400	0.000E+00	1.000E+00
22	1	4	0	supplemental-heating/CD systems	0.9400	0.000E+00	1.000E+00
22	1	5	1	reactor structure	0.9400	0.000E+00	1.000E+00
22	1	5	2	equipment support structure	0.9400	0.000E+00	1.000E+00
22	1	5	0	primary structure & support	0.9400	1.855E+01 \$/kg	5.365E+06 28
22	1	6	1	plasma chamber vacuum(incl. pumps/comp./pipe)	0.9400	6.985E+04 \$/m^3/s	1.303E+02 26
22	1	6	2	magnet dewar vacuum(incl. pumps/comp./pipe)	0.9400	0.000E+00	1.000E+00
22	1	6	3	suppl. heating vacuum(incl. pumps/comp./pipe)	0.9400	0.000E+00	1.000E+00
22	1	6	4	direct converter vacuum(incl. pumps/comp./pipe)	0.9400	0.000E+00	1.000E+00
22	1	6	5	reactor vacuum system(low grade)	0.9400	0.000E+00	1.000E+00
22	1	6	6	reactor vacuum wall	0.9400	2.140E+01 \$/kg	2.171E+06
22	1	6	7	reactor vacuum tank/enclosure	0.9400	0.000E+00	1.000E+00
22	1	6	0	reactor vacuum systems(unless integral elsewhere)	0.9400	0.000E+00	1.000E+00
22	1	7	1	EF-coil power supplies	0.9400	1.223E+01 \$/kVA	1.000E-02 10
22	1	7	2	OH-coil power supplies	0.9400	1.855E+01 \$/kVA	1.000E-02 10
22	1	7	3	TF-coil power supplies	0.9400	3.709E+01 \$/kVA	1.000E-09 10
22	1	7	4	DF-coil power supplies	0.9400	3.709E+01 \$/kVA	1.000E-06 10
22	1	7	5	other power supplies	0.9400	1.000E+06	1.000E+00
22	1	7	6	current drive power supplies	0.9400	3.709E+01 \$/kVAR	0.000E+00 10
22	1	7	7	control system	0.9400	0.000E+00	1.000E+00
22	1	7	8	central energy storage	0.9400	0.000E+00	1.000E+00
22	1	7	9	other incl. busbars	0.9400	3.500E+07 \$	1.000E+00
22	1	7	0	power supply, switching & energy storage	0.9400	0.000E+00	1.000E+00
22	1	8	0	impurity control	0.9400	4.450E+04 \$/m^2	1.757E+02 10
22	1	9	1	vacuum tank	0.9400	0.000E+00	1.000E+00
22	1	9	2	direct converter modules	0.9400	0.000E+00	1.000E+00
22	1	9	3	thermal panels	0.9400	0.000E+00	1.000E+00
22	1	9	4	power conditioning equipment	0.9400	0.000E+00	1.000E+00
22	1	9	0	direct energy conversion system	0.9400	0.000E+00	1.000E+00
22	1	10	0	ecrh breakdown system	0.9400	2.820E+06 \$	1.000E+00 13
22	1	0	0	reactor equipment	0.9400	0.000E+00	1.000E+00
22	2	1	1	pumps & motor drives(modular & nonmodular)	1.0000	0.000E+00	1.000E+00
22	2	1	2	piping	1.0000	0.000E+00	1.000E+00
22	2	1	3	heat exchangers	1.0000	0.000E+00	1.000E+00
22	2	1	4	tanks(dump,make-up, clean-up, trit., hot storage)	1.0000	0.000E+00	1.000E+00
22	2	2	1	c clean-up system	1.0000	0.000E+00	1.000E+00

2	22	2	1	6	thermal insulation, piping & equipment	1.0000	0.000E+00	1.000E+00	
2	22	2	1	7	tritium extraction	1.0000	0.000E+00	1.000E+00	
2	22	2	1	8	pressurizer	1.0000	0.000E+00	1.000E+00	
2	22	2	1	9	other	1.0000	0.000E+00	1.000E+00	
2	22	2	1	0	primary coolant system	1.0000	4.943E-02	\$/wth	2.293E+09
2	22	2	2	1	piping	1.0000	0.000E+00		10
2	22	2	2	2	pumps & motor drives(modular & nonmodular)	1.0000	0.000E+00		
2	22	2	2	3	heat exchangers	1.0000	0.000E+00		
2	22	2	2	4	tanks(dump,make-up, clean-up, trit., hot storage)	1.0000	0.000E+00		
2	22	2	2	5	clean-up system	1.0000	0.000E+00		
2	22	2	2	6	thermal insulation, piping & equipment	1.0000	0.000E+00		
2	22	2	2	7	tritium extraction	1.0000	0.000E+00		
2	22	2	2	8	pressurizer	1.0000	0.000E+00		
2	22	2	2	9	other	1.0000	0.000E+00		
2	22	2	2	0	intermediate coolant system	1.0000	8.634E-03	\$/wth	2.293E+09
2	22	2	2	1	pumps & motor drives(modular & nonmodular)	1.0000	0.000E+00		10
2	22	2	2	2	piping	1.0000	0.000E+00		
2	22	2	2	3	heat exchangers	1.0000	0.000E+00		
2	22	2	2	4	tanks(dump,make-up, clean-up, trit., hot storage)	1.0000	0.000E+00		
2	22	2	2	3	clean-up system	1.0000	0.000E+00		
2	22	2	2	5	thermal insulation, piping & equipment	1.0000	0.000E+00		
2	22	2	2	3	tritium extraction	1.0000	0.000E+00		
2	22	2	2	7	pressurizer	1.0000	0.000E+00		
2	22	2	2	8	other	1.0000	0.000E+00		
2	22	2	2	3	secondary coolant system	1.0000	2.819E+00	\$/wth	2.293E+04
2	22	2	2	0	thermal storage system	1.0000	0.000E+00	\$/s	10
2	22	2	2	4	main heat transfer & transport systems	1.0000	0.000E+00		31
2	22	2	2	0	refrigeration	0.9400	7.546E+01	\$/unit	1.290E-02
2	22	2	2	3	piping	0.9400	0.000E+00		23
2	22	2	2	1	fluid circulation driving system	0.9400	0.000E+00		
2	22	2	2	3	tanks	0.9400	0.000E+00		
2	22	2	2	3	purification	0.9400	0.000E+00		
2	22	2	2	1	magnet cooling system	0.9400	0.000E+00		
2	22	2	2	3	refrigeration	0.9400	0.000E+00		
2	22	2	2	2	piping	0.9400	0.000E+00		
2	22	2	2	3	fluid circulation driving system	0.9400	0.000E+00		
2	22	2	2	3	tanks	0.9400	0.000E+00		
2	22	2	2	4	purification	0.9400	0.000E+00		
2	22	2	2	5	shield & structure cooling system	0.9400	6.700E-04	\$/wth	1.000E+00
2	22	2	2	0	refrigeration	0.9400	0.000E+00		13
2	22	2	2	3	piping	0.9400	0.000E+00		
2	22	2	2	3	fluid circulation driving system	0.9400	0.000E+00		
2	22	2	2	3	tanks	0.9400	0.000E+00		
2	22	2	2	3	purification	0.9400	0.000E+00		
2	22	2	2	3	supplemental heating system cooling system	0.9400	0.000E+00		
2	22	2	2	3	refrigeration	0.9400	0.000E+00		
2	22	2	2	4	piping	0.9400	0.000E+00		
2	22	2	2	3	fluid circulation driving system	0.9400	0.000E+00		
2	22	2	2	4	tanks	0.9400	0.000E+00		
2	22	2	2	4	purification	0.9400	0.000E+00		
2	22	2	2	0	power supply cooling system	0.9400	0.000E+00		

222	3	5	0	other cooling systems (ECCS)	0.9400	0.000E+00	1.000E+00
222	4	0	0	auxiliary cooling systems	0.9400	0.000E+00	1.000E+00
222	4	1	0	liquid waste processing & equipment	0.9400	0.000E+00	1.000E+00
222	4	2	0	gaseous wastes & off-gas processing system	0.9400	0.000E+00	1.000E+00
222	4	3	0	solid waste processing equipment	0.9400	0.000E+00	1.000E+00
222	4	0	0	radioactive waste treatment & disposal	0.9400	1.200E-03 \$/wth	13,14
222	5	1	0	fuel injection systems	0.9400	3.709E+06 \$	2.000E+00
222	5	2	0	fuel processing systems	0.9400	3.709E+04 \$/unit	2.240E+02
222	5	3	0	fuel storage	0.9400	3.709E+06 \$	1.000E+00
222	5	4	0	atmospheric tritium recovery	0.9400	1.484E+04 \$/m^3/hr	1.276E+02
222	5	5	0	water tritium recovery systems	0.9400	3.709E+06 \$	1.000E+00
222	5	6	0	blanket tritium recovery systems	0.9400	3.709E+06 \$	1.000E+00
222	5	7	0	other	0.9400	0.000E+00	1.000E+00
222	5	0	0	fuel handling & storage systems	0.9400	0.000E+00	1.000E+00
222	6	1	1	blanket & coil maintenance equipment	0.9400	0.000E+00	1.000E+00
222	6	1	2	components rotated into service to allow maint.	0.9400	0.000E+00	1.000E+00
222	6	1	3	other maintenance equipment	0.9400	0.000E+00	1.000E+00
222	6	1	0	maintenance equipment	0.9400	0.000E+00	1.000E+00
222	6	2	0	special heating systems(start-up, trace, etc.)	0.9400	0.000E+00	1.000E+00
222	6	3	0	coolant receiving, storage & make-up systems	0.9400	0.000E+00	1.000E+00
222	6	4	0	gas systems	0.9400	0.000E+00	1.000E+00
222	6	5	0	building vacuum systems	0.9400	0.000E+00	1.000E+00
222	6	0	0	other reactor plant equipment	0.9400	1.094E-02 \$/wth	13,14
222	7	1	0	reactor i&c equip.(burn control, diagnostics, etc.	0.9400	0.000E+00	1.000E+00
222	7	2	0	radiation monitoring systems	0.9400	0.000E+00	1.000E+00
222	7	3	0	isolated indicating & recording gauges, etc.	0.9400	2.341E+07 \$	13,14
222	7	0	0	instrumentation & control(i&c)	0.9400	2.000E-02 fraction	2,13,14
222	98	0	0	spare parts allowance	0.9400	0.000E+00	-1.000E+00
222	99	0	0	contingency allowance	0.9400	0.000E+00	-1.000E+00
222	0	0	0	reactor plant equipment	1.0000	0.000E+00	1.000E+00
223	1	1	0	turbine-generators & accessories	1.0000	0.000E+00	1.000E+00
223	1	2	0	foundations	1.0000	0.000E+00	1.000E+00
223	1	3	0	standby exciters	1.0000	0.000E+00	1.000E+00
223	1	4	0	lubricating system	1.0000	0.000E+00	1.000E+00
223	1	5	0	gas systems	1.0000	0.000E+00	1.000E+00
223	1	6	0	reheaters	1.0000	0.000E+00	1.000E+00
223	1	7	0	shielding	1.0000	0.000E+00	1.000E+00
223	1	8	0	weather-proof housing	1.0000	0.000E+00	1.000E+00
223	2	1	0	turbine-generators	1.0000	1.252E-01 \$/weg	30
223	2	0	0	misc. turbine-generator equipment	1.0000	0.000E+00	1.000E+00
223	3	1	0	water intake common facilities	1.0000	0.000E+00	1.000E+00
223	3	2	0	circulating water systems	1.0000	0.000E+00	1.000E+00
223	3	3	0	cooling towers	1.0000	0.000E+00	1.000E+00
223	3	4	0	other systems which reject heat to the atmosphere	1.0000	0.000E+00	1.000E+00
223	3	0	0	heat rejection systems	1.0000	1.633E-02 \$/wth	30
223	4	1	0	condensers	1.0000	0.000E+00	1.000E+00
223	4	2	0	condensate system	1.0000	0.000E+00	1.000E+00
223	4	3	0	gas removal system	1.0000	0.000E+00	1.000E+00
223	4	4	0	turbine by-pass systems(excl. piping)	1.0000	0.000E+00	1.000E+00
223	4	0	0	condensing systems	1.0000	0.000E+00	1.000E+00
223	5	1	0	regenerators & recuperators	1.0000	0.000E+00	1.000E+00

23	5	2	0	0	pumps	1.0000	0.000E+00	1.000E+00		
23	5	3	0	0	tanks	1.0000	0.000E+00	1.000E+00		
23	5	0	0	0	feed heating system	1.0000	0.000E+00	1.000E+00		
23	6	1	0	0	turbine auxiliaries	1.0000	0.000E+00	1.000E+00		
23	6	2	0	0	auxiliaries cooling system(excl. piping)	1.0000	0.000E+00	1.000E+00		
23	6	3	0	0	make-up treat. system(excl. piping)	1.0000	0.000E+00	1.000E+00		
23	6	4	0	0	chemical treat. & condensate purification systems	1.0000	0.000E+00	1.000E+00		
23	6	5	0	0	central lubrication service system(excl. piping)	1.0000	0.000E+00	1.000E+00		
23	6	0	0	0	other turbine plant equipment	1.0000	0.000E+00	1.000E+00		
23	7	0	0	0	instrumentation & control(i&c) equipment	1.0000	0.000E+00	1.000E+00		
23	98	0	0	0	spare parts allowance	1.0000	2.000E-02	-1.000E+00	fraction	2,13,14
23	99	0	0	0	contingency allowance	1.0000	0.000E+00	-1.000E+00	fraction	2,13,14
23	0	0	0	0	turbine plant equipment	1.0000	0.000E+00	1.000E+00		
24	1	1	0	0	generator circuits	0.8400	0.000E+00	1.000E+00		
24	1	2	0	0	station service	0.8400	0.000E+00	1.000E+00		
24	1	0	0	0	switchgear	0.8400	0.000E+00	1.000E+00		
24	2	1	0	0	station service & startup transformers	0.8400	0.000E+00	1.000E+00		
24	2	2	0	0	low voltage unit substation & lighting transformer	0.8400	0.000E+00	1.000E+00		
24	2	3	0	0	battery system	0.8400	0.000E+00	1.000E+00		
24	2	4	0	0	diesel engine generators	0.8400	0.000E+00	1.000E+00		
24	2	5	0	0	gas turbine generators	0.8400	0.000E+00	1.000E+00		
24	2	6	0	0	motor generator sets	0.8400	0.000E+00	1.000E+00		
24	2	0	0	0	station service equipment	0.8400	0.000E+00	1.000E+00		
24	3	1	0	0	main control board for electric system	0.8400	0.000E+00	1.000E+00		
24	3	2	0	0	auxiliary power & signal boards	0.8400	0.000E+00	1.000E+00		
24	3	0	0	0	switchboards (incl. heat tracing)	0.8400	0.000E+00	1.000E+00		
24	4	1	0	0	gen. station grounding sys. & cathodic protection	0.8400	0.000E+00	1.000E+00		
24	4	0	0	0	protective equipment	0.8400	0.000E+00	1.000E+00		
24	5	1	0	0	concrete cable tunnels, trenches & envelopes	0.8400	0.000E+00	1.000E+00		
24	5	2	0	0	cable trays & support	0.8400	0.000E+00	1.000E+00		
24	5	3	0	0	conduit	0.8400	0.000E+00	1.000E+00		
24	5	4	0	0	other structures	0.8400	0.000E+00	1.000E+00		
24	5	0	0	0	electrical structures & wiring containers	0.8400	0.000E+00	1.000E+00		
24	6	1	0	0	generator circuits wiring	0.8400	0.000E+00	1.000E+00		
24	6	2	0	0	station service power wiring	0.8400	0.000E+00	1.000E+00		
24	6	3	0	0	control wiring	0.8400	0.000E+00	1.000E+00		
24	6	4	0	0	instrument wiring	0.8400	0.000E+00	1.000E+00		
24	6	5	0	0	containment penetrations	0.8400	0.000E+00	1.000E+00		
24	6	0	0	0	power & control wiring	0.8400	0.000E+00	1.000E+00		
24	7	1	0	0	reactor building lighting	0.8400	0.000E+00	1.000E+00		
24	7	2	0	0	turbine building lighting	0.8400	0.000E+00	1.000E+00		
24	7	3	0	0	reactor auxiliaries building lighting	0.8400	0.000E+00	1.000E+00		
24	7	4	0	0	radioactive waste building lighting	0.8400	0.000E+00	1.000E+00		
24	7	5	0	0	fuel storage building lighting	0.8400	0.000E+00	1.000E+00		
24	7	6	0	0	miscellaneous buildings lighting	0.8400	0.000E+00	1.000E+00		
24	7	7	0	0	yard lighting	0.8400	0.000E+00	1.000E+00		
24	7	0	0	0	electrical lighting	0.8400	0.000E+00	1.000E+00		
24	98	0	0	0	spare parts allowance	0.8400	4.000E-02	-1.000E+00	fraction	
24	99	0	0	0	contingency allowance	0.8400	0.000E+00	-1.000E+00	fraction	
24	0	0	0	0	electric plant equipment	0.8400	6.879E-02	1.097E+09	\$/weg	30+spare
25	1	1	0	0	cranes, hoists, monorails, & conveyors	0.9000	0.000E+00	1.000E+00		

25	1	0	cranes, hoists, monorails, & conveyors	0.9000	0.000E+00	1.000E+00
25	1	0	railway	0.9000	0.000E+00	1.000E+00
25	1	3	roadway equipment	0.9000	0.000E+00	1.000E+00
25	1	4	watercraft	0.9000	0.000E+00	1.000E+00
25	1	5	vehicle maintenance equipment	0.9000	0.000E+00	1.000E+00
25	1	0	transportation & lifting equipment	0.9000	0.000E+00	1.000E+00
25	2	1	air systems(excl. piping)	0.9000	0.000E+00	1.000E+00
25	2	1	water systems(excl. piping)	0.9000	0.000E+00	1.000E+00
25	2	3	auxiliary heating boilers(excl. piping)	0.9000	0.000E+00	1.000E+00
25	2	0	air & water service systems	0.9000	0.000E+00	1.000E+00
25	3	1	local communications systems	0.9000	0.000E+00	1.000E+00
25	3	2	signal systems	0.9000	0.000E+00	1.000E+00
25	3	0	communications equipment	0.9000	0.000E+00	1.000E+00
25	4	1	safety equipment	0.9000	0.000E+00	1.000E+00
25	4	2	shop, laboratory, & test equipment	0.9000	0.000E+00	1.000E+00
25	4	3	office equipment, & furnishings	0.9000	0.000E+00	1.000E+00
25	4	4	change room equipment	0.9000	0.000E+00	1.000E+00
25	4	0	environmental monitoring equipment	0.9000	0.000E+00	1.000E+00
25	4	5	dining facilities	0.9000	0.000E+00	1.000E+00
25	4	0	furnishings & fixtures	0.9000	0.000E+00	1.000E+00
25	98	0	spare parts allowance	0.9000	3.000E-02	fraction
25	99	0	contingency allowance	0.9000	0.000E+00	fraction
26	1	0	miscellaneous plant equipment	0.9000	3.248E-02	\$/weg
26	1	0	reactor coolant	1.0000	2.851E+01	\$/kg
26	2	0	intermediate coolant	1.0000	0.000E+00	1.000E+00
26	3	0	turbine cycle working fluids	1.0000	0.000E+00	1.000E+00
26	4	0	other materials	1.0000	2.500E+05	\$
26	5	0	Ar reactor-building cover gas	1.0000	7.500E-01	\$/m^3
26	98	0	spare parts allowance	1.0000	0.000E+00	fraction
26	99	0	contingency allowance	1.0000	0.000E+00	fraction
26	99	0	special materials	1.0000	0.000E+00	1.000E+00
90	0	0	direct cost (not including contingency)	1.0000	0.000E+00	1.000E+00
91	0	0	construction services & equipment	1.0000	1.200E-01	fraction
92	1	0	systems engineering	1.0000	0.000E+00	1.000E+00
92	2	0	management	1.0000	0.000E+00	1.000E+00
92	3	0	quality assurance	1.0000	0.000E+00	1.000E+00
92	4	0	safety & environmental engineering	1.0000	0.000E+00	1.000E+00
92	0	0	home office engineering & services	1.0000	5.200E-02	fraction
93	1	0	construction management	1.0000	0.000E+00	1.000E+00
93	2	0	inspection	1.0000	0.000E+00	1.000E+00
93	3	0	operational testing	1.0000	0.000E+00	1.000E+00
93	0	0	field office engineering & services	1.0000	6.000E-02	fraction
94	1	0	project administration	1.0000	0.000E+00	1.000E+00
94	2	0	staff training & plant startup	1.0000	0.000E+00	1.000E+00
94	3	0	inventories & spares	1.0000	0.000E+00	1.000E+00
94	0	0	owner's cost	1.0000	1.848E-01	fraction
95	0	0	process contingency	1.0000	0.000E+00	fraction
95	0	0	project contingency	1.0000	2.391E-01	fraction
96	0	0	interest during construction (IDC)	1.0000	1.652E-01	fraction
97	0	0	escalation during construction (EDC)	1.0000	0.000E+00	fraction
98	0	0	total cost	1.0000	0.000E+00	(1.000E+09 we)