

APPENDIX A

PROMETHEUS-L BASELINE PARAMETER LIST

<u>PARAMETER CATEGORY</u>	<u>PAGE NO</u>
GENERAL PLANT	A-2
REACTOR CAVITY	A-2
DRIVER SYSTEM.....	A-4
TARGET.....	A-5

PROMETHEUS-L BASELINE PARAMETER LIST

<u>GENERAL PLANT PARAMETERS</u>	<u>VALUE</u>
Net Electric Power (MWe).....	972
Gross Electric Power (MWe).....	1382
Recirculation Power (MWe).....	410
Driver Power (MWe).....	349
Auxiliary Power (MWe).....	36
Cavity Pumping Power (MWe).....	25
Total Thermal Cycle Power (MWt).....	3264
Net Thermal Power (MWt).....	3049
Blanket (MWt).....	1782
First Wall (MWt).....	1267
Usable Driver Waste Heat.....	193
Usable Pumping Waste Heat.....	22
Thermal Conversion Efficiency (%).....	42.3
Recirculating Power Fraction (%).....	30
Net System Efficiency (%).....	31
Net Thermal Power (MWt) ((1.14x2027)+780-43).....	3049
Fusion Power (MW).....	2807
Surface Heating Power	780
Neutron Power	2027
Energy Multiplication Ratio.....	1.14
Power Loss to Shield.....	-43

<u>REACTOR CAVITY</u>	<u>VALUE</u>	
Cavity Radius (m).....	5.0	
Cavity Cylinder Height (m).....	5.0	
Total Cavity Height (m).....	15.0	
FW Surface Area (m ²).....	471	
Volume (m ³).....	916	
Total Target Yield (MJ).....	497	
X-ray (MJ).....	31	
Debris (MJ).....	107	
Neutron (MJ).....	359	
Power		
Surface Heating (MW).....	780	
Neutrons (MW).....	2027	
Neutron Source Strength (n/sec).....	9.83x10 ²⁰	
FW/Blanket/Shield Characteristic		
TBR.....	1.2	
Power Multiplication.....	1.14	
Nuclear Power (MW) (2027x1.14).....	2311	
Nuclear Power Distribution		
First Wall (+Surface Heatg).....	21.1	1268
Blanket/Reflector/Plenum.....	77.1	1782
Vacuum Vessel.....	0.4	9.2
Shield (concrete).....	1.4	32.4

REACTOR CAVITY (Cont)

VALUE

First Wall System

Structural Material.....	SiC
Coolant Channel Wall Thickness (mm).....	5.0
Coolant Channel Diameter (cm).....	5.0
Mean Fiber Pore Diameter (μm).....	50.0
Porosity (%).....	10.0
Permeability (m^2).....	1.76×10^{-14}
Coolant Media.....	Liquid Lead
Surface Protection Media.....	Liq Lead Film
Surface Film Thickness (mm).....	0.4-0.6
Inlet Temperature ($^{\circ}\text{C}$).....	375
Outlet Temperature ($^{\circ}\text{C}$).....	525
Delta-T(bulk) ($^{\circ}\text{C}$).....	150
Mass Flow Rate (kg/s).....	58,770
Volume Flow Rate (kg/s).....	5.65
Coolant Flow Area(cylindrical chamber).....	$1.1775 \text{ (m}^2\text{)}$
Average Velocity (m/s).....	4.8
Reynolds Number.....	1.2×10^6
Frictional Factor.....	0.02
Coolant Path Length (m).....	12.85
Frictional Pressure Drop (MPa).....	0.615
Inlet Pressure (top)(MPa).....	1.0
Outlet Pressure (bottom)(MPa).....	1.385
Pumping Power (85% efficiency)(MW).....	4.1
Maximum SiC Temperature ($^{\circ}\text{C}$).....	775
No. Liq Lead Steam Generators.....	6
No. Liq Lead Pumps.....	2

Blanket System

Structural Material.....	SiC
SiC Min Temperature ($^{\circ}\text{C}$).....	400
SiC Max Temperature ($^{\circ}\text{C}$).....	800
Coolant Media.....	Helium
Helium Inlet Temperature ($^{\circ}\text{C}$).....	400
Helium Outlet Temperature ($^{\circ}\text{C}$).....	650
Helium Velocity (m/s).....	46
Helium Inlet Pressure (MPa).....	1.5
Pressure Drop (kPa).....	24
Neutron Multiplier.....	FW Liq Lead Coolant
Breeder Material.....	Li_2O
Li_2O Min Temperature ($^{\circ}\text{C}$).....	425
Li_2O Max Temperature ($^{\circ}\text{C}$).....	800
Li_2O Theoretical Density Fraction.....	0.8
Li_2O Density (kg/m^3).....	2.01×10^3
Beeder Volume (m^3).....	92
Avg Annual Li Burnup (%).....	0.5

REACTOR CAVITY (Cont)

VALUE

Blanket System (Cont)		
Peak-to-Average Burnup (%).....		3
Tritium Inventory (g).....		100
Tritium Generation Rate (g/day).....		362
BET Surface Area (m ² /kg).....		50 Grain
Radius (μm).....		10
Grain Diffusion Coefficient:		
Pre-exponential Factor (m ² /s).....	6.81x10 ⁻⁷	
Activation energy (kJ/mol).....	84.8	
Purge Composition.....		He + 0.2%H ₂
Amount of Protium in Purge (%).....		0.2
Helium Purge Pressure (MPa).....		0.2
No. Helium Steam Generators.....		6
No. Helium Reheaters.....		6
No. Helium Recirculators.....		6
Vacuum System		
Cavity Pressure @0 °C (mtorr,Pb).....		3.0
Background Gas Density (cm ⁻³).....		3.5x10 ¹³
No. Vacuum Pumping Ports.....		3
No. Vacuum Pumps/Port.....		10
Vacuum Pumping Port Diameter (m).....		2
Vacuum Pump Type.....		Cryogenic
Vacuum Vessel Material.....		Ferretic Steel
Cavity Exhaust (total).....	34.7 mg/s...	289,900 l/s
	<u>mg/s</u>	<u>l/s</u>
Hydrogen (mg/s).....	7.6.....	126,400
Deuterium.....	8.16.....	67,800
Tritium.....	12.24.....	67,800
Helium (mg/s).....	6.7.....	27,900

DRIVER SYSTEM

VALUE

Driver Type.....		KrF Excimer Laser
Target Illumination Scheme.....		Direct Drive, Symmetric
Amplifier Type.....		Electric Discharge
Beam Combination Type.....		Non-Linear Crossed Raman
Pulse Compression Type.....	Non-Linear	Stimulated Brillouin Scattering
Number of Beams.....		60
Repetition Rate (pps).....		5.65
Driver Output Energy (MJ).....		4.0
Single Pulse Efficiency.....		6.5%
Pulse Power.....	64%	
Discharge Laser	14%	
Transport into Raman Cell.....	98%	
Raman Accumulator.....	88%	
Transport into SBS Cell.....	98%	
SBS Cell	88%	
Downstream Optics.....	95%	
Single Pulse Input Energy (MJ).....		62

<u>DRIVER SYSTEM (Cont)</u>	<u>VALUE</u>
Driver System Power (MWe).....	345
Laser Power (MWe).....	344
Gas Flow Power (MWe).....	1.5
Driver Overall Efficiency.....	6.47%
Discharge Lasers (Number).....	960
Output Energy (kJ).....	5.9
Output Pulse Length (ns).....	250
Size (lxwxh, m).....	2.0x0.44x0.44
Raman Accumulator Cells (Number).....	60
Output Energy (kJ).....	81
Output Pulse Length (ns).....	250
Size (lxwxh, m).....	5.0x1.8x1.8
Stimulated Brillouin Cells (Number).....	60
Output Energy (kJ).....	70
Output Pulse Length (ns).....	5.6
Size (lxwxh, m).....	37.5x0.9x0.9
Delay Optics (Number Sets).....	60
Pockels Cell (4, wxh)(m).....	0.9x0.9
Polarizer Plate (2, wxh)(m).....	1.65x0.9
Quarter-Wave Plate (2, wxh).....	0.9x0.9
Delay Line Mirror (4, wxh).....	0.9x0.9
Downstream Optics (Number Sets).....	60
Turning Mirror (2, wxh)(m).....	0.97x0.69
Vacuum Interface Mirror (wxh).....	0.97x0.69
Turning Mirror (wxh)(m).....	0.97x0.69
Pinhole Collimating Mirror.....	0.97x0.69
Target Focusing Mirror (wxh).....	0.97x0.69
Grazing Incidence Mirror.....	3.95x0.69

<u>TARGET</u>	<u>VALUES</u>
Target Type.....	Direct Drive Single-Shell
Number of Beams.....	60
Beam Profile.....	\sin^2x/x^2
Beam Focus.....	Initially Tangential
Illumination Nonuniformity.....	<1%
Driver Output Energy (MJ).....	4.0
Target Gain.....	124
Target Yield (MJ).....	497
Neutron Energy (MJ).....	359
Debris Energy (MJ).....	107
X-ray Energy (MJ).....	31
Fusion Power (MW).....	2807
Neutron Power (MW).....	2027
Surface Heating Power (MW).....	780
Final Beam Transport Efficiency (%).....	100
Peak Power Pulse Length (ns).....	5.6
Repetition Rate (pps).....	5.65
Fuel Burnup Fraction.....	29%
Tritium Throughput (g/day).....	1496