

## A.1 Initial Operation

### A.1.1 Coil Set Definition

#### A.1.1.1 Current Centroid Locations

Coil centroids are defined by the TBD coil set.

#### A.1.1.2 Turns per Coil

	M1	M2	M3	PF1A	PF4	PF6	Plasma
Turns	22	22	20	48	80	14	1

#### A.1.2 Coil Inductance Matrix (Henries)

	M1	M2	M3	PF1A	PF4	PF6	Plasma
M1	1.50E-02	3.42E-03	1.53E-03	-2.18E-05	1.34E-04	-3.10E-04	-1.79E-05
M2	3.42E-03	1.12E-02	2.84E-03	5.19E-06	-1.40E-05	-6.89E-05	-1.19E-05
M3	1.53E-03	2.84E-03	9.76E-03	4.14E-05	-1.84E-04	-6.88E-05	-9.55E-06
PF1A	-4.05E-05	1.62E-05	7.58E-05	8.22E-04	8.14E-05	5.35E-05	3.97E-06
PF4	1.34E-04	-1.40E-05	-1.84E-04	8.14E-05	1.52E-02	5.90E-04	1.73E-05
PF6	-3.10E-04	-6.89E-05	-6.88E-05	5.35E-05	5.90E-04	6.24E-03	3.46E-05
Plasma	-1.79E-05	-1.19E-05	-9.55E-06	3.97E-06	1.73E-05	3.46E-05	2.68E-06

#### A.1.3 Reference Scenario Data

##### A.1.3.1 Reference Equilibria (amp-turns per coil)

Equilibrium ID	M1	M2	M3	PF1A	PF4	PF6	Plasma	Comment
8	2.00E+05	2.00E+05	1.82E+05	0.00E+00	0.00E+00	0.00E+00	0	First Plasma S1
9	2.00E+05	2.00E+05	1.82E+05	0.00E+00	0.00E+00	0.00E+00	-26000	First Plasma S2

##### A.1.3.2 Current Waveforms

Conductor currents are given in amperes. *Maxima are shown in blue, minima in red.*

0.5T First Plasma Scenario	t(s)	M1	M2	M3	PF1A	PF4	PF6	Plasma
	-4.000	0	0	0	0	0	0	0
	0.000	9115	9115	9115	0	0	0	0
	0.050	9115	9115	9115	0	0	0	0
	0.120	9115	9115	9115	18109	2947	227	-26068
	0.123	9115	9115	9115	18466	3005	231	-26068
	0.130	9115	9115	9115	19299	3141	241	-26068

Maximum		9115	9115	9115	19299	3141	241	0
Minimum		0	0	0	0	0	0	-26068
I2t (A2-s)		2.71E+08	2.74E+08	2.67E+08	6.04E+07	6.02E+06	5.40E+04	
tESW (s)		3.26	3.30	3.21	0.16	0.61	0.93	

Field Line Mapping Scenario	t(s)	M1	M2	M3	PF1A	PF4	PF6	Plasma
	-0.300	0	0	0	0	0	0	0
	0.000	1823	1823	1823	0	0	0	0
	0.100	1823	1823	1823	0	0	0	0
	0.200	1823	1823	1823	0	0	0	0
	2.600	1823	1823	1823	0	0	0	0
	10.100	1823	1823	1823	0	0	0	0
Maximum		1823	1823	1823	0	0	0	0
Minimum		0	0	0	0	0	0	0
I2t (A2-s)		3.61E+07	3.59E+07	3.65E+07	0.00E+00	0.00E+00	0.00E+00	
tESW (s)		10.86	10.81	10.98	0.00	0.00	0.00	

Summary		M1	M2	M3	PF1A	PF4	PF6	Plasma
Maximum		9115	9115	9115	19299	3141	241	0
Minimum		0	0	0	0	0	0	-26068
Max I2t (A2-s)		2.71E+08	2.74E+08	2.67E+08	6.04E+07	6.02E+06	5.40E+04	
tESW (s) at max current		3.26	3.30	3.21	0.16	0.61	0.93	

### A.1.3.3 Temperature History

Coil temperatures are in Kelvin. *Maxima are shown in blue.*

0.5T First Plasma Scenario	t(s)	M1	M2	M3	PF1A	PF4	PF6
	-4.000	85	85	85	85	85	85
	0.000	89	89	89	85	85	85
	0.050	89	89	89	85	85	85
	0.120	89	89	89	85	85	85
	0.123	89	90	89	85	85	85
	0.130	89	90	89	85	85	85
	3.311	90	91	90	86	85	85
Dissipated Energy (J)	0.000	2.81E+06	2.79E+06	2.27E+06	4.66E+04	2.22E+04	1.82E+02
							7.95E+06

Field Line Mapping Scenario	t(s)	M1	M2	M3	PF1A	PF4	PF6
	-0.300	85	85	85	0	0	0
	0.000	85	85	85	0	0	0
	0.100	85	85	85	0	0	0
	0.200	85	85	85	0	0	0
	2.600	85	85	85	0	0	0
	10.100	86	86	86	0	0	0
	11.422	86	86	86	0	0	0
Dissipated Energy (J)	0.000	3.50E+05	3.41E+05	2.91E+05	0.00E+00	0.00E+00	0.00E+00
							9.82E+05

Summary		M1	M2	M3	PF1A	PF4	PF6
Max Final Temperature		90	91	90	86	85	85
Max Dissipated Energy (J)		2.81E+06	2.79E+06	2.27E+06	4.66E+04	2.22E+04	1.82E+02
							7.95E+06

#### A.1.3.4 Electrical Power Requirements

##### Initial Power Supply and Cabling Requirements and Modeling Assumptions

For the First Plasma and Field Line Mapping Scenarios, DC power will be supplied by existing C-site supplies.

Power supply requirements for these reference scenarios have been calculated based on the following assumptions:

[1] All coils of the same type (e.g. all M1 coils) are connected in series. All coils in the same circuit are connected in series.

Circuit configurations are defined in the table below.

[2] No allowance was made for current limiting reactors in any of the circuits. It was assumed that the bus inductance was negligible.

[3] The following bus resistances (in milli-ohms) were assumed: M1 (4.04), M2/3 (3.17), PF1A (2.37), PF4 (10.4), PF6 (5.57).

[4] DC ratings were calculated based on a 15 minute pulse repetition rate.

Initial capability required	0.5T First Plasma 0.1T Field Line Mapping	M1	M2/3	PF1A	PF4	PF6
9 MW	Max I2t (A2-s)	2.7E+08	2.7E+08	6.0E+07	6.0E+06	5.4E+04
101 MVA	tESW (s)	3.26	3.30	0.16	0.61	0.93
10 MJ	Required DC rating (A)	549	552	259	82	8
	Power Supply	R-10	2 R-5 in parallel	R-20	UCLA and R-5 in series	R-5
	Voltage Rating (V)	200	300	500	800	300
	Current Rating (kA)	10	10	20	5	5

**A.1.4 Pulsed Heat Loads**

Pulsed heat loads calculated on the basis of the worst case scenario for each coil.

**A.1.4.1 Maximum Temperature and Energy Deposition**

<b>Pulsed heat Loads</b>	<b>M1</b>	<b>M2</b>	<b>M3</b>	<b>PF1A</b>	<b>PF4</b>	<b>PF6</b>
Initial Temperature (K)	85	85	85	85	85	85
Max Temperature (K)	90	91	90	86	85	85
Energy Deposited (J)	2.81E+06	2.79E+06	2.27E+06	4.66E+04	2.22E+04	1.82E+02
						7.95E+06

**A.1.4.2 LN2 Consumption During Pulsed Operation**

<b>Max LN2 Consumption</b>	<b>Tsat (K)</b>	<b>Psat (MPa)</b>	<b>hfg (kJ/kg)</b>	<b>Mass per pulse (kg)</b>	<b>Density (kg/m3)</b>	<b>(m3/kg)</b>	<b>Volume (m3)</b>	<b>(liters)</b>	<b>(gallons)</b>	
Per shot		78	0.1093654	198.3014	40.071935	805.73502	0.0012411	0.049733391	49.733391	13 per shot
Time between shots (minutes)	15									
Hours per day	8									
Full pwr shots per day	32									420 per day
Operating days per week	5									2102 per wk

**A.1.4.2 LN2 Delivery Requirements**

	<b>Gallons per Truck 6500</b>	<b>Trucks</b>
<b>Pulsed heat loads only</b>		
Max pulsed heat loads		0.32 per week
Field line mapping		0.06 per week
First Plasma		0.04 per week
<b>Parasitic loads only</b>		
Normal		2.12 per week
150C Bakeout		2.86 per week
<b>Cooldown only</b>		1.63