

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

	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils	Plasma
Turns	22	22	20	48	80	24	14	12	1

A.1.2 Coil Inductance Matrix (Henries)

	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils	Plasma
MA	1.42E-02	3.42E-03	1.53E-03	-1.84E-05	1.34E-04	-2.51E-04	-3.10E-04	9.52E-03	-1.79E-05
MB	3.42E-03	1.04E-02	2.84E-03	3.56E-06	-1.31E-05	-5.10E-05	-7.07E-05	7.34E-03	-1.20E-05
MC	1.53E-03	2.84E-03	9.29E-03	3.15E-05	-1.84E-04	-2.26E-04	-6.86E-05	5.19E-03	-9.57E-06
PF1A U+L	-1.84E-05	3.56E-06	3.15E-05	8.13E-04	8.56E-05	7.90E-05	5.48E-05	4.17E-21	4.06E-06
PF4 U+L	1.34E-04	-1.31E-05	-1.84E-04	8.56E-05	1.50E-02	1.14E-03	5.91E-04	-7.18E-20	1.73E-05
PF5 U+L	-2.51E-04	-5.10E-05	-2.26E-04	7.90E-05	1.14E-03	1.28E-02	3.48E-03	1.52E-18	4.26E-05
PF6 U+L	-3.10E-04	-7.07E-05	-6.86E-05	5.48E-05	5.91E-04	3.48E-03	6.23E-03	5.07E-19	3.46E-05
TF Coils	9.52E-03	7.34E-03	5.19E-03	4.17E-21	-7.18E-20	1.52E-18	5.07E-19	5.27E-02	1.51E-06
Plasma	-1.79E-05	-1.20E-05	-9.57E-06	4.06E-06	1.73E-05	4.26E-05	3.46E-05	1.51E-06	2.68E-06

A.1.3 Reference Scenario Data

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

Equilibrium ID	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils	Plasma
8	2.00E+05	2.00E+05	1.82E+05	0.00E+00	0.00E+00	0.00E+00	0	0	0
9	2.00E+05	2.00E+05	1.82E+05	0.00E+00	0.00E+00	0.00E+00	0	0	-26000

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	Time	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils	Plasma
Start	-1.900	0	0	0	0	0		0		0
Modular coils at full current	0.000	9115	9115	9115	0	0		0		0
Start Ip ramp	0.050	9115	9115	9115	0	0		0		0
SOF	0.120	9115	9115	9115	17872	3016		234		-26068
EOF	0.130	9115	9115	9115	19083	3220		250		-26068
End of discharge	4.130	0	0	0	0	0		0		0
Max		9115	9115	9115	19083	3220		250		0
Min		0	0	0	0	0		0		-26068
I2t(A2-s)		1.45E+08	1.45E+08	1.45E+08	3.09E+08	8.79E+06		52983		0
tESW(s)		1.75	1.75	1.75	0.85	0.85		1		0

Field Line Mapping Scenario	Time	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils	Plasma
Start	-0.250	0	0	0	0	0		0		0
Modular coils at full current	0.000	1823	1823	1823	0	0		0		0
Start Ip ramp	0.050	1823	1823	1823	0	0		0		0
SOF	0.150	1823	1823	1823	0	0		0		0
EOF	10.150	1823	1823	1823	0	0		0		0
End of discharge	13.150	0	0	0	0	0		0		0
Max		1823	1823	1823	0	0		0		0
Min		0	0	0	0	0		0		0
I2t(A2-s)		3.60E+07	3.60E+07	3.60E+07	0.00E+00	0.00E+00		0		0
tESW(s)		10.85	10.85	10.85	0.00	0.00		0		0

Summary		MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils	Plasma
Max	0	9115	9115	9115	19083	3220		250		0
Min	0	0	0	0	0	0		0		-26067.71
I2t(A2-s)	0	1.45E+08	1.45E+08	1.45E+08	3.09E+08	8.79E+06		52983		
tESW(s)	0	1.75	1.75	1.75	0.85	0.85		1		

Equivalent square wave times (tESW) for the coils calculated on the basis of the maximum coil current

A.1.3.3 Temperature History

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

0.5T First Plasma Scenario	Time	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils
	-1.900	85	85	85	85	85		85	
	0.000	86	86	86	85	85		85	
	0.050	86	86	86	85	85		85	
	0.120	87	87	87	85	85		85	
	0.130	87	87	87	85	85		85	
	4.130	88	88	88	89	85		85	
Dissipated Energy (J)		1.41E+06	1.38E+06	1.16E+06	2.60E+05	3.27E+04		1.79E+02	

4.25E+06

Field Line Mapping Scenario	Time	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils
	-0.250	85	85	85	85	85		85	
	0.000	85	85	85	85	85		85	
	0.050	85	85	85	85	85		85	
	0.150	85	85	85	85	85		85	
	10.150	86	86	86	85	85		85	
	13.150	86	86	86	85	85		85	
Dissipated Energy (J)		3.38E+05	3.31E+05	2.78E+05	0.00E+00	0.00E+00		0.00E+00	

9.47E+05

Summary		MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils
Max Final Temperature		88	88	88	89	85		85	
Max Dissipated Energy (J)		1.41E+06	1.38E+06	1.16E+06	2.60E+05	3.27E+04		1.79E+02	

4.25E+06

A.1.3.4 Circuit Characteristics and Requirements

A.1.2.4.1 Circuit Resistance and Bus Inductance

	MA	MB+MC	PF1A U+L	PF4 U+L	PF6 U+L
Initial coil resistance (mΩ)	9.275	16.682	0.795	3.712	3.387
Bus resistance (mΩ)	4.355	3.414	2.619	11.058	5.997
Initial loop resistance (mΩ)	13.629	20.096	3.414	14.770	9.384
Bus inductance (μH)	4.250	4.250	4.250	4.250	4.250

A.1.3.4.2 Circuit Inductance (μH)

	MA	MB+MC	PF1A U+L	PF4 U+L	PF6 U+L	Plasma
MA	14232.4	4948.6	-18.4	133.9	-310.3	-17.9
MB+MC	4948.6	25405.0	35.1	-197.0	-139.3	-21.6
PF1A U+L	-18.4	35.1	817.7	85.6	54.8	4.1
PF4 U+L	133.9	-197.0	85.6	15029.5	590.6	17.3
PF6 U+L	-310.3	-139.3	54.8	590.6	6230.5	34.6
Plasma	-17.9	-21.6	4.1	17.3	34.6	2.7

A.1.3.4.3 Power Supply Assignments and Ratings

	MA	MB+MC	PF1A U+L	PF4 U+L	PF6 U+L
Power supply assignments	R10	2R5(P)	R20	R5+PEI(S)	R5
	DF	T1, T2	IF	T3, PEI	T4
Nominal circuit pulsed current rating (A)	10000	10000	20000	5000	5000
OC voltage (V)	229.58	344.37	575.3	894.55	344.37
Equivalent resistance (Ohms)	0.00458	0.00632	0.004135	0.01808	0.01272

A.1.3.4.4 Power Supply Requirements

	MA	MB+MC	PF1A U+L	PF4 U+L	PF6 U+L
Max I _{2t} (A ² -s)	1.45E+08	1.45E+08	3.09E+08	8.79E+06	5.30E+04
tESW (s)	1.45	1.45	0.77	0.35	0.00
Required DC rating (A)	402	402	586	99	8

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

Equivalent square wave times (tESW) for the power supplies calculated on the basis of the power supply current rating

A.1.4 Pulsed Cryogenic 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

Pulsed heat Loads	MA	MB	MC	PF1A U+L	PF4 U+L	PF5 U+L	PF6 U+L	TF Coils	
Initial Temperature (K)	85	85	85	85	85	85	85	85	85
Max Temperature (K)	88	88	88	89	85	85	85	85	85
Energy Deposited (J)	1.41E+06	1.38E+06	1.16E+06	2.60E+05	3.27E+04	0.00E+00	1.79E+02	0.00E+00	4.25E+06

A.1.4.2 LN2 Consumption During Pulsed Operation

Max LN2 Consumption	Tsat (K)	Psat (MPa)	hfg (kJ/kg)	Mass per pulse (kg)	Density (kg/m ³)	Volume (m ³)	(liters)	(gallons)	
Per shot	78	0.10936535	198.3014	21.42446644	805.735	0.001241	0.02659	26.5899656	7.0 per shot
Time between shots (minutes)	15								
Hours per day	8								
Full pwr shots per day	32								224.8 per day
Operating days per week	5								1123.9 per wk