53-960809-CLN-01

TO: DISTRIBUTION
FROM: C NEUMEYER
SUBJECT: ALTERNATE OH COIL DESIGN
REFERENCES:

1) 53-960808-CLN-01, "Preliminary Design of Monolithic OH Coil"

This memo compares two possible OH coil designs. The first was reported in ref. 1, and utilized a 1.5 cm conductor height, 3.56 m total coil height. The second utilizes a 1.6 cm conductor height, and a 4.05 m total coil height. Both coils meet the criteria that they can be driven to a prechage peak current of 24kA with grid voltage 7.5% below nominal , and both coils can deliver 0.6 volt-sec. The second coil end of flat top current is greater than that of the first coil, and there is consequently less margin at the end of flat top for other (PF and Heating) loads. However, if necessary, the flat top duration could be reduced to accomodate the other loads.

A comparison of the coil parameters is as follows:

Parameter	**Coil 1**	**Coil 2**	**Units**
Conductor Width	1.0	1.0	cm
Conductor Height	1.5	1.6	cm
Conductor Hole Diameter*	3/16	3/16	in
Conductor Corner Radius	0.1	0.1	cm
Conductor Hole Elongation	0.0	0.0	cm
Turn-Turn & Layer-Layer Spacing	0.04	0.04	inch
#Layers	4	4	
#Turn Spaces/Layer	224	240	
#Turns/Layer	222	238	
#Turns	888	952	
R(center)	12.654	12.654	cm
Height (over turn insulation)	355.6	405.0	cm
Height above midplane (over turn insulation)	177.77	202.5	cm
Cooling path length (outer layer)*	199.5	213.9	m
Inductance	12.4	12.6	mH
Conductor Initial Temperature	20	20	deg C
20C Coil Resistance	92.9	92.6	mΩ

A comparison of the simulation results is as follows:

Parameter	Coil 1	Coil 2	Units
Precharge Current	24.0	24.0	kA
Central B	7.5	7.1	Tesla
End of Flat Top Current	-18.65	-21.3	kA
Flux Swing	0.6	0.6	Volt-Sec
Initiation Loop Voltage	5.9	5.5	Volts/Turn
Initiation Interval	20.0	20.0	mS
Plasma Ramp Time	400.0	400.0	mS
Plasma Flat Top Time	500.0	500.0	mS
ESW @ Iprecharge	0.30	0.34	sec
T_{max}	73.0	73.2	deg C
P_{max}	73.1	73.1	MW
Q_{max}	68.3	68.3	MVAR
S_{max}	94.3	94.3	MVA
ΔV_{max} (PPPL)	3.0	3.0	%
ΔV_{max} (Brunswick)	0.98	0.98	%
ΔV_{max} (Trenton)	0.65	0.65	%
P_{eoft}	50.4	65.7	MW
Q_{eoft}	53.4	52.4	MVAR
S_{eoft}	73.4	84.0	MVA

A comparison of the cooling results is as follows:

Parameter	Coil 1	Coil 2	Units
ΔP w/20C inlet for $\tau/3 = 200$ sec	650	890	psi
Flow w/20C inlet for $\tau/3 = 200$ sec	0.76	0.87	GPM
ΔP w/10C inlet for $\Delta t_{cool} = 600$ sec	284	385	psi
Flow w/10C inlet for $\Delta t_{cool} = 600$ sec	0.47	0.54	GPM

Since concern was expressed over the shortening of the solenoid in the first design, compared to the earlier OH coil, perhaps the second design is superior.

cc:

A Brooks J Citrolo T Egebo R Goldston P Heitzenroeder
M Kalish S Kaye M Ono R Parsells M Peng
S Raftopoulos S Ramakrishnan W Reiersen J Robinson
J Schmidt J Sinnis J Spitzer NSTX File