PPPL Calculation Form

Calculation # NSTXU-Calc-11-07-00 Revision #0 WP #, if any _

(ENG-032)

Title: Halo Current Heating of IBDhs Thermal Shims

Purpose of Calculation: (Define why the calculation is being performed.)

Assess heating of the IBDhs Thermal Shims from a halo current strike.

References (List any source of design information including computer program titles and revision levels.)

1) Disruption_scenario_currents_v2.xlsx by Jon Menard specifying magnitude and duration of halo current. Worse case taken as "Vertical drift to inboard, very slow quench, halo" with 2MA plas current, 0.1 s quench time and .35 HCF
2) "2016-08-16 SST Sandwich heat transfer test with Perforated Sheet.xlsx" by S Jursczynski test data results for Perforated thermal shim
3) "IBD Thermal Isolation Peer Review" by A Brooks summarizing above test results

Assumptions (Identify all assumptions made as part of this calculation.)

The electrical resistance of the thermal shim should scale as the thermal resistance. Test results measuring the thermal conductance are compared to the thermal conductance of a solid shim to determine the scale factor.

Calculation (Calculation is either documented here or attached)

See attached spreadsheet

Conclusion (Specify whether or not the purpose of the calculation was accomplished.)

Temperature rise in shims is calculated to be **15.1 C** which is deemed insignificant.

Cognizant Engineer's printed name, signature, and date

Art Brooks Digitally signed by Art Brooks DN: cn=Art Brooks, o=PPPL, ou=Engineering, email=abrooks@pppl.gov, c=US Date: 2016.12.02 15:56:20 -05'00'

I have reviewed this calculation and, to my professional satisfaction, it is properly performed and correct.

Checker's printed name, signature, and date

Carmela Ciummo Digitally signed by Carmela Ciummo Date: 2016.12.02 07:58:18 -05'00'

Estimate of Halo Current Heating in IBD Thermal Shims

Heating is dependent on electrical resistance of shim which should scale as the thermal resistance

Thermal					
	Effective Heat Transfer Coefficent, h	65	w/m2-C		
	Thickness	0.001524	m		
	Thermal Conductivity of SS	15	w/m-C		
	Conductance thru .060" SS, k/thk	9843	w/m2-C		
	Thermal Resistance Ratio	151.42			
Electrical					
	Electrical Resistivity of SS	7.40E-07	ohm-m		
	Scaled Resistivity	1.12E-04	ohm-m		
Halo Current					
	Plasma Current	2.00E+06	amps		
	Halo Current Fraction (slow Quench)	0.35			
	Halo Current	700000	amps		
	Time (slow Quench)	0.1	s		
	Toroidal Peaking Factor	1.2			
	Halo Strike Area - full IBD	0.52	m2		
	Peak Current Density	1.62E+06	amps/m2		
Shim Heating					
	Number of Shims	48			
	Area per shim	0.01079268	m2		
	Mesh volume fraction	0.5			
	Metal Volume	8.22402E-06	m3		
	Specific Heat of SS	500	J/kg-C		
	Density	7800	kg/m3		
	Thermal Capacitance per shim	32.07368572	J/C		
	Resistance per shim	1.58E-05	ohm		
	Current Per shim	1.75E+04	amps		
	I2R Heating per shim	4.85E+03	w		
	Total Energy per shim	4.85E+02	J		
	Temperature Rise	**15.1**	**C**		