



NSTX Upgrade

Armor Plate Backing Plate

NSTXU-CALC-24-02-00

Rev 0

February 17, 2011

Prepared By:

Larry Bryant

Reviewed By:

Irv Zatz

Pete Titus, EA Branch Head

Approved By:

Craig Prinski, Cognizant Engineer

PPPL Calculation Form

Calculation # NSTXU_CALC-24-02-00 Revision # 00 WP #: 1508

(ENG-032)

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

- 1.) To qualify the Armor backing plate calculation
- 2.) Build and evaluate a Finite Element Model for The Armor Eddy Current Analysis
- 3.) Apply Disruption Case of Magnetic Vector Potential from Opera Data Tables
- 4.) To evaluate Static and Transient dynamic structural stress results

APPENDIX 1: Show the foundations of the applied equations in the scripts used in the analysis

APPENDIX 2: Demonstrate that the Applied Electromagnetic Loads Applied is Conservative

APPENDIX 3: Demonstrate that applying the changes described results in a an excellent match in the B field and flux rate data between ANSYS and OPERA.

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

- 1.) The electromagnetic analysis modeling procedure specified by PPPL (5-7-10). This procedure has since been redesigned with a new less conservative procedure. See reference e-m
- 2.) ANSYS version 12.1 Finite Element Software and OPERA Electromagnetic program.
- 3.) Opera electromagnetic program and results available during this time period.

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

- 1.) 2-D Opera Results uniformly expanded into 3-D as provided by Ron Hatcher through Srinivas Avasarala e-mail dated 2-19-10 as "VDE cases"
- 2.) The ANSYS APDL Load Script (and the underlying assumptions) is valid for these cases
- 3.) Voltage at Vessel Boundary assumed to be zero potential
- 4.) Changes to analysis script were not repeated for the analysis since the applied loads are shown in this report to be conservative

Calculation (Calculation is either documented here or attached)

Attached

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

- 1.) The Armor Electromagnetic, Transient Dynamic and Static Structural analysis is complete based on the best OPERA information available as of May 7, 2010 and the assumptions of the merged solids.
- 2.) The max static stresses (10,993psi at loadstep17) for the identical transient loads show that this disruption profile is not significant and that the effective time constant is lower resulting in similar load reaction magnitudes between transient and static load cases.
- 3.) The reaction loads are very small at the armor attachment points to the vessel hoop loads and the vessel boundary. This demonstrates that the longer time duration of the disruption event does not necessarily imply that reaction load magnitudes will be greater.
- 4.) Revisions to the analysis script were determined to be necessary for the best correlation in the electromagnetic loads.
- 5.) Given that the revised electromagnetic procedure completed after this calculation would provide lower loads the calculation was not repeated.

Cognizant Engineer's printed name, signature, and date

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

Checker's printed name, signature, and date
