

PPPL Calculation Form

Calculation # NSTXU-CALC-24-01 Revision # 00 _____ WP #, if any _____
(ENG-032)

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

To qualify the NSTX upgrade changes to the vacuum vessel midsection, required to accommodate: 1.) the addition of a second Neutral Beam at Port J; and 2.) the larger diameter port at Port L to prevent an optical interference with the Thomson Scattering laser beam. Specifically, to determine the maximum stress in the vacuum vessel midsection and port extensions under the worst-case simultaneously applied load condition: 1.) vacuum/ atmospheric pressure load; 2.) magnetostatic Toroidal Field coil torsional load; and 3.) electromagnetic transient plasma disruption load.

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

[1] NSTX Structural Design Criteria Document, I. Zatz[2] NSTX Design point, June 2010
http://www.pppl.gov/~neumeyer/NSTX_CSU/Design_Point.html[3] Hicks, C.M.: "Shock and Vibration Handbook", McGraw-Hill, New York, NY, 1995.

Assumptions (Identify all assumptions made as part of this calculation.)The combination of Current Scenario #79 and the Centered Plasma Disruption Scenario was assumed worst-case for the vacuum vessel, since it results in the maximum out-of-plane torque and the largest induced eddy currents in the vessel wall. Several other current and disruption scenario combinations should be run to confirm this assumption.

Calculation (Calculation is either documented here or attached)
See attached

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

The results of the one-way coupled electromagnetic-static structural analysis shows the maximum stress occurs at the intersection of vessel wall and the J-K port cap extension, along the perimeter weld seam, and is below the maximum allowed by the NSTX Structural Design Criteria. A detailed fatigue analysis of the weld, submodeled from the global model with the full inventory of loads for the worst-case current scenario, is required to fully qualify the NSTX upgrade changes.

Cognizant Engineer's printed name, signature, and date

Marc Smith

George Labik

Craig Priniski

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

Checker's printed name, signature, and date

Ali Zolfahari

1. Assure that inputs were correctly selected and incorporated into the design.
2. Calculation considers, as appropriate:
 - Performance Requirements (capacity, rating, system output)
 - Design Conditions (pressure, temperature, voltage, etc.)
 - Load Conditions (seismic, wind, thermal, dynamic)
 - Environmental Conditions (radiation zone, hazardous material, etc.)
 - Material Requirements
 - Structural Requirements (foundations, pipe supports, etc.)
 - Hydraulic Requirements (NPSH, pressure drops, etc.)
 - Chemistry Requirements
 - Electrical Requirements (power source, volts, raceway, insulation)
 - Equipment Reliability (FMEA)
 - Failure Effects on Surrounding Equipment
3. Assumptions necessary to perform the design activity are adequately described and reasonable.
4. An appropriate calculation method was used.
5. The results are reasonable compared to the inputs.

NOTE: BY SIGNING CALCULATION, CHECKER ACKNOWLEDGES THAT THE CALCULATION HAS BEEN APPROPRIATELY CHECKED AND THAT THE APPLICABLE ITEMS LISTED ABOVE HAVE BEEN INCLUDED AS PART OF THE CHECK.