

## **Design and Requalification Efforts to Support the Upgrade of NSTX**

L. Dudek, J. Chrzanowski, R. Strykowski, C. Neumeyer, P. Titus, and the NSTX  
Project Team, Princeton Plasma Physics Laboratory  
P.O. Box 451, Princeton, NJ 08550

---

### **ABSTRACT**

The National Spherical Torus (NSTX) project is planning upgrades to the toroidal field, plasma current and pulse length. This involves the replacement of the center-stack, including the inner legs of the TF, OH, and inner PF coils. A second neutral beam will also be added. The increased performance of the upgrade requires qualification of both new and remaining components for higher loads.

NSTX was originally built with modest resources. Many components were recycled from previous experiments. A few components, like the inner TF joint did not have sufficient analytic consideration, and failed during operation. Center stack components are being replaced with new, more robust designs that have benefitted from the fabrication and operational experience of the original center-stack. To ensure successful operation of the tokamak with its expanded performance specifications, PPPL has begun an effort to qualify existing components that will remain in service and design replacements for, or reinforcements of, these components. Initial conceptual design efforts were based on worst case combinations of possible currents that the power supplies could deliver. This proved to be an onerous requirement and caused many of the outer coils support structures to require costly heavy reinforcement. The primary cost of the more robust structures was not the result of the cost of the structures, rather it was the cost to clear access to the area needing modification. As an operating tokamak, the outer perimeter of NSTX is filled with diagnostics and service connections that are costly to even temporarily relocate. This has led to the planned implementation of a Digital Coil Protection System (DCPS) to reduce loads to levels that are manageable for the existing components. As a minimum, all components must be qualified for the increase in normal operating loads which for a doubling of the plasma current and toroidal field will increase by roughly a factor of four. The upgrade of NSTX also includes an increase in pulse length from 1 second to 5 seconds. With the planned increase in input power supplied by the addition of the neutral beam, for a longer time, increased heat loads throughout the tokamak must be considered. Design features and analysis efforts needed to meet the upgrade loading are discussed. Mission and features of the DCPS are presented.