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P3.100 Replacement of the NSTX-U Inner PF Coils

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The National Spherical Torus eXperiment Upgrade (NSTX-U) is an experimental device funded by the U.S. Department of Energy (DOE) at the Princeton Plasma Physics Laboratory (PPPL). NSTX-U (<http://nstx-u.pppl.gov/home>) is an upgrade of the original NSTX device that operated successfully for more than 10 years as a proof-of-principle demonstration of the ST concept.

During early phases of operation of NSTX-U, one of the poloidal field coils experienced a turn-to-turn fault that necessitated a complete shutdown. Extensive reviews were performed to determine the root cause. A precise cause could not be identified but several contributing factors became apparent. It has since been decided to replace all three Inner PF upper/lower coil pairs.

The coils are water-cooled copper solenoids that are pulsed up to 20kA for durations ~ 2 seconds, repeated every 1200 seconds, 20,000 times over the lifetime of NSTX-U. During pulses the conductors experience a temperature rise that is nearly adiabatic, and hoop stress due to their self-field and the background field from neighboring coils. Between pulses, cold water enters the inlet and a cooling wave propagates through the coils as slugs of cold water heat up to the conductor temperature and then pass through the coil to the outlet.

New designs have been developed for the Inner poloidal field (PF) coils that factor in findings from the root cause analysis. Detailed analysis has been performed for both the energized state and the cooldown cycle.

Prototype coils are being fabricated to qualify multiple suppliers so parallel production lines can be deployed to minimize the overall fabrication time.

This paper reports on the replacement of the Inner PF coils including lessons learned from the failure, improvements in design, results of analysis, experience with prototype coils, and progress with the fabrication of replacement coils.

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