An Algorithm to Provide Real Time Neutral Beam Substitution in the DIII–D Tokamak*

J.C. Phillips
General Atomics, P.O. Box 85608, San Diego, California 92185-5608

A key component of the DIII–D tokamak fusion experiment is a flexible and easy to expand digital control system which actively controls a large number of parameters in real-time. These include plasma shape, position, density, and total stored energy. This system, known as the PCS (plasma control system), also has the ability to directly control auxilliary plasma heating, such as the 20 MW of neutral beams routinely used on DIII–D.

This paper describes the implementation of a real-time algorithm allowing substitution of one neutral beam for another, given a fault in the originally scheduled beam. Previously, in the event of a fault in one of the high voltage beams, the actual power profile for the shot might be deficient, resulting in a less useful or wasted shot. Using this new real-time algorithm, a stand by neutral beam may substitute within milliseconds for another which has faulted. Since single shots can have substantial value, this is an important advance to DIII–D's capabilities and utilization.

Detailed results are presented, along with a description not only of the algorithm but of the simulation setup required to prove the algorithm without the costs normally associated with using actual physics operational time.

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