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CONTROL IMPROVEMENTS FOR THE DIII–D CRYO SYSTEM*

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The cryogenic system at General Atomic's DIII–D Tokamak Fusion Facility provides cryo-pumping for the fusion vessel and neutral beams, cooling for the super-conducting magnets for electron cyclotron heating, and cooling for the deuterium pellet injector. The cryo system, built in the 1980s, has been upgraded to integrate control using one programmable logic controller (PLC). This integration of control has provided the ability to make improvements to the control of the cryo system. Control improvements that will be described in this paper include:

Night/Weekend Mode: When the Night/Weekend Mode is requested by the cryo operator, the PLC increases the liquefier make rate and keeps the helium compressors at the appropriate loading until the helium storage dewar is filled, then ramps down the liquefier make rate and compressor loading, and shuts down the secondary compressor, reducing the electrical power consumption.

Neutral Beam PLC Upgrades: Cryogen control valve instrumentation upgrades along with integration into the PLC have allowed for more reliable control of the neutral beam cryo panels. Upgrades for the nitrogen subcooler valves for the neutral beam nitrogen cryo panels allow PLC logic to automatically switch to flow through subcoolers after cooldown. This has reduced the amount of liquid nitrogen used to keep the nitrogen cryo panels cold.

Cryopump Tuning: The upper and lower cryopumps in the tokamak are typically defrosted after every discharge. The defrost procedure can upset the helium gas management system, affecting control of other cryo subsystems. Integrating control and monitoring of these subsystems allows analysis of this and other transients. As a result, several changes have been made to the logic of the cryopumps to reduce upsets, reduce re-cooldown time, and improve reliability of the cryo system.

Monitoring of Nitrogen Use: Mass flow meters have been installed to track the use of liquid and gaseous nitrogen in the cryo system. These flow meters are read and trended by the cryo PLC. This has allowed improved monitoring and control of liquid nitrogen and nitrogen gas used in the DIII–D facility.

Other control system improvements that will be discussed include: Remote operation, cryopump cooldown and operation, gas management system, overall cryogen and power savings, reduced operator call-ins and trouble reports.

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