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# C1Or2B-02: Dynamic systems modeling of the Spallation Neutron Source Cryogenic Moderator System to optimize transient control and prepare for power upgrades

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Oak Ridge National Laboratory, through support of the US Department of Energy's Office of Basic Energy Sciences, has begun applying machine learning methods to improve accelerator and target performance of the Spallation Neutron Source (SNS). One application of these methods is the control optimization and power upgrade of the Cryogenic Moderator System (CMS). To study such optimizations and system modifications, a digital twin of the CMS has been developed using EcosimPro. This tool was developed to numerical model continuous-discrete systems, has functional mockup interface and unit (FMI-FMU) model connectivity, and a validated library of cryogenic components for dynamic system numerical simulations. This effort discusses steady state and transient validation of numerical results from the digital twin with experimental data. Control optimization studies were performed and focused on dampening mass flow, temperature, and pressure fluctuations during sudden losses of energy input from the SNS accelerator during beam trips. This was achieved by adjusting five decentralized proportional-integral-derivative controllers connected to four flow control valves and one electric heater. Future efforts include power uprate studies focused on increasing cooling capacity of the CMS to accept more energy input by the SNS accelerator. The current accelerator beam power is 1.4 MW and upgrades to 2.0 MW to first target station are underway are part of the Proton Power Upgrade effort. The cooling capacity of the system is sufficient for 2.0 MW operation.

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