Prototype Development of a Safety Quench Detection System of the KSTAR TF Superconducting Coils

H. Yonekawa, Y-O. Kim, I-S. Woo, Y. Chu, and K-R. Park

National Fusion Research Institute

The KSTAR TF superconducting coils system is equipped with a primary Quench Detection System (QDS) that monitors normal voltage on superconductors, which method is the most reliable and general in the field of superconductivity applications. There could be, however, an extremely unlikely case that the primary QDS misses quench and/or the shut-down sequence fails; and such undetected quench may lead to a hazardous situation if burning superconductors destroy the tokamak. A Safety Quench Detection system (SQD) aims to prevent thermal runaway of the superconductors beyond the design basis of the TF coils by means of monitoring absolute and differential (flow meter) pressure of supercritical helium (SHe) cooling the TF coils at supply and/or return manifolds in the distribution box #2.

A prototype with a complete chain of instruments was developed and integrated with the KSTAR device to evaluate the conceptual design of SQD. The SQD prototype consists of pressure transducers, signal interfaces, logic solvers, and mimic interlock systems, which instruments are supposed to be referred as the basis of production models for KSTAR and future devices. The SQD prototype satisfies the 2oo3 voting architecture for sensing and simulates dual electric power trains for 3 instrument cubicles, which are located approximately 10 m beneath the KSTAR tokamak so that these instruments are exposed to utmost harsh magnetic field and radiation from the tokamak. Signals from the instruments are continuously measured by a DAQ system with EPICS at approximately 10 sample/s.

A series of functional tests of the SQD prototype was conducted while the KSTAR superconducting coils were cooled by SHe and, in some cases, operating for plasma experiments in the 2014 KSTAR campaign; whereas, quench did not occurred.