Contribution ID: **25** Type: **Contributed Oral**

C2Or2C-01: Analysis of quench safety and cryogenic energy recovery for FRIB High Transmission Beam Line magnets

Tuesday 20 May 2025 11:15 (15 minutes)

The High Rigidity Spectrometer (HRS) will be the centerpiece experimental tool of the Facility for Rare Isotope Beams (FRIB) fast-beam program. The HRS project is staged in two phases: the High Transmission Beam Line (HTBL) phase followed by the Spectrometer (SPS) phase. The HTBL will contain 24 superconducting quadrupole magnets (in 8 triplet cryostats), four superconducting dipole magnets, and three (non-superconducting) vertical corrector magnets. In general, these magnets will store a peak energy of 300-400 kJ and the cryogenic boil-off flow from a quench induced heat release will be primarily handled by the FRIB quench energy recovery system. The magnet cryostats will be also equipped with pressure safety devices as auxiliary protection. The FRIB quench energy recovery system has proven to be tremendously useful during the commissioning and operation of the FRIB target and pre-separator segment magnets. All these magnets were tested, commissioned with the aid of this quench energy recovery system, without losing any helium during a quench and a rather quick turn-around time from quench to normal operation of approximately 30 minutes. A thermodynamic model to estimate a magnet cryostat pressurization due to quench, and subsequent release of cryogenic helium flow to the FRIB quench energy recovery system has been developed and validated using test data. The HTBL magnet cryogenic system response (heat release, subsequent pressurization and boil-off flow) during a quench is simulated using this model. The results are utilized to predict the overall system response and address relevant design issues e.g. sizing of magnet cryostat pressure relief devices and relevant HTBL cryogenic system components. The model development, validation and the simulated results are discussed in this paper along with the sizing methodology for the relevant cryogenic components.

Author: Dr HASAN, Nusair (Michigan State University)

Co-authors: HOWARD, Jonathon (Michigan State University); Dr GANNI, Venkatarao (Michigan State University); CHOI, Yoonhyuck (Michigan State University); Dr ZHANG, Danlu (Michigan State University); Dr DU, Xiaoji (Michigan State University); Dr XU, Ting (Michigan State University); Dr CASAGRANDE, Fabio (Michigan State University)

Presenter: Dr HASAN, Nusair (Michigan State University)

Session Classification: C2Or2C - Large Scale Cryogenic Systems V: Analysis and Modeling