Abstract Submitted
for the GEC20 Meeting of
The American Physical Society

Plasma decay around control grid apertures of medium voltage direct current circuit breaker with a thermionic hollow cathode[1]
JIAN CHEN, ALEXANDER V. KHRABROV, IGOR D. KAGANOVICH, Princeton Plasma Physics Laboratory, DAVID SMITH, SVETLANA SELEZNEVA, General Electric Global Research — We report recent progress on modeling the interruption phase in a medium voltage direct current (MVDC) circuit breaker with a hollow thermionic cathode. When switching to the interruption phase, a negative bias is applied to the control grid, discharge is not sustained any more at the anode side and plasma starts decaying. Plasma decay is governed by the formation of an ion matrix sheath in the grid apertures, competing with ongoing ionization. Prior work indicates maximal interruption current density j_{max} ~5 A/cm^2 but for thermionic cathode, the expectation is that a higher density ~15 A/cm^2 can be achieved. Our model can help find optimal grid dimensions that don't compromise breaker operation in the closed phase and guarantee its successful opening phase. A two-dimensional asymmetric model of plasma decay around the control grid aperture was implemented into the 3D particle-in-cell code WARP. It has been modified to simulate particle collisions needed for plasma modeling and validated against previously developed 1D EDIPIC code and experimental data.

[1]The information, data, or work presented herein was funded in part by the Advanced Research Projects Agency-Energy (ARPA-E), U.S. Department of Energy, under Award Number DE-AR0001107.

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Date submitted: 12 Jun 2020 Electronic form version 1.4