Evidence for anomalous effects on the current evolution in the tokamak hybrid operating scenarios

T.A. Casper 1), R.J. Jayakumar 1), S.L. Allen 1), C.T. Holcomb 1), L.L. LoDestro 1), M.A. Makowski 1), L.D. Pearlstein 1), H.L. Berk 2), C.M. Greenfield 3), T.C. Luce 3), C.C. Petty 3), P.A. Politzer 3), and M.R. Wade 3)

1) Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, CA 94550, USA

2) Institute for Fusion Studies, The University of Texas, Austin, Texas, USA

3) General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA

e-mail contact of main author: casper1@llnl.gov

Abstract. Alternatives to the usual picture of advanced tokamak (AT) discharges are those that form when anomalous thermal conductivity and/or resistivity alter the plasma current and pressure profiles to achieve stationary characteristics through self-organizing mechanisms where a measure of desired AT features is maintained without external current-profile control. Regimes exhibiting these characteristics are those where the safety factor (q) evolves to a stationary profile with the on-axis and minimum $q \sim 1$. Operating scenarios with fusion performance exceeding H-mode at the same plasma current and where the inductively driven current density achieves a stationary configuration with either small or non-existing sawteeth should enhance the performance of ITER and future burning plasma experiments. We present simulation results of anomalous current profile formation and evolution using theory-based hyper-resistive models. These simulations are stimulated by experimental observations with which we compare and contrast the simulated evolution. We find that the hyper-resistivity is sufficiently strong to modify the current profile evolution to achieve conditions consistent with experimental observations. Modeling these anomalous effects is important for developing a capability to scale current experiments to future burning plasmas.