Impurity behavior under puff-and-pump radiating divertor conditions

T.W. Petrie[1], G.D. Porter[2], N.H. Brooks[1], M.E. Fenstermacher[2], J.R. Ferron[1], M. Groth[2], A.W. Hyatt[1], R.J. La Haye[1], C.J. Lasnier[2], A.W. Leonard[1], T.C. Luce[1], P.A. Politzer[1], M.E. Rensink[2], M.J. Schaffer[1], M.R. Wade[1], J.G. Watkins[3], and W.P. West[1]

[1]General Atomics, PO Box 85608, San Diego, California 92186-5608, USA
[2]Lawrence Livermore National Laboratory, Livermore, California 94550, USA
[3]Sandia National Laboratories, Albuquerque, New Mexico 87185, USA

e-mail contact of main author: petrie@fusion.gat.com

Abstract. The effectiveness of the puff-and-pump technique to enrich a seeded impurity in the divertor relative to the core and, thereby, to maximize radiation in the divertor depends sensitively on both the magnetic geometry and the ion $B \times \nabla B$ drift direction. In the puff-and-pump scenario used here, argon impurities injected into the private flux region are inhibited from accumulation in the core plasma by enhanced plasma flows to the divertor created by a combination of deuterium gas puffing upstream of the divertor targets and particle pumping near the divertor targets. Modeling of single-null, H-mode plasmas with the UEDGE fluid transport code indicates that particle drifts in the scrape-off layer and divertor strongly affect the locations where the argon seed impurity accumulates. It is also found in double-null cases that argon always shows a larger accumulation in the divertor out of which the ion $B \times \nabla B$ drift is directed, regardless of the divertor into which the argon is injected. Experiments have shown that the degree to which the deuterium gas-puffing rate inhibits the escape of the seed impurity from the divertor(s) depends critically on the direction of the ion $B \times \nabla B$ drift and on whether the plasma is single-null or double-null. The transition in behavior from double-null to single-null character during puff-and-pump occurs for $|dRsep| = 0.4$ cm when the ion $B \times \nabla B$ drift was pointing away from the dominant divertor. The lowest argon density buildup in the main plasma of any of the configurations studied during puff-and-pump was achieved in single-null plasmas with the ion $B \times \nabla B$ drift direction away from the divertor.

PACs Nos.: 52.25.Vy, 52.40.Hf, 52.55.Fa, 52.55.Rk, 28.52.Cx