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Upstream Density for Plasma Detachment with Conventional and Lithium Vapor-Box Divertors[1] RJ GOLDSTON, Princeton Plasma Physics Laboratory, JA SCHWARTZ, Princeton University — Fusion power plants are likely to require detachment of the divertor plasma from material targets. The lithium vapor box divertor is designed to achieve this, while limiting the flux of lithium vapor to the main plasma. We develop a simple model of near-detachment to evaluate the required upstream plasma density, for both conventional and lithium vapor-box divertors, based on particle and dynamic pressure balance between up- and down-stream, at near-detachment conditions. A remarkable general result is found, not just for lithium-induced detachment, that the upstream density divided by the Greenwald-limit density scales as $(P^{5/8}/B^{3/8})T_{det}^{1/2}/(\epsilon_{cool} + \gamma T_{det})$, with no explicit size scaling. T_{det} is the temperature just before strong pressure loss, $\sim 1/2$ of the ionization potential of the dominant recycling species, ϵ_{cool} is the average plasma energy lost per injected hydrogenic and impurity atom, and γ is the sheath heat transmission factor. A recent 1-D calculation (A. Kallenbach et al. PPCF **58** (2016) 04501) agrees well with this scaling. The implication is that the plasma exhaust problem cannot be solved by increasing R. Instead significant innovation, such as the lithium vapor box divertor, will be required.

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