An Incompressible Fluid Model for High-Speed Pellet Propagation in Guide-tubes*

F.W. Perkins

General Atomics

This work reports theoretical models developed to support optimization of pellet-fueling. Experiments show pellet penetration will be optimized by high-field-side, high-speed launch. In present pellet systems, acceleration takes place outside the main tokamak chamber and pellets must propagate at high velocity through curved guide tubes to reach the desired HFS launch point. If the pellet velocity V exceeds a critical value $V_c \approx 300$ m/s, then centrifugal force will breakup the pellet in agreement with observations. In the limit $V \gg V_c$, the pellet material can be modeled as an incompressible granular fluid of DT dust fragments and an equation is developed for its length l along the guide tube. The solution shows that l depends only on the angle the guide tube bends and not on the pellet speed. If a v-notch guide tube is used with a right-angle bend, the pellet as emerges as a highly elongated DT dust cloud, essentially a fluid jet. Further analysis shows this jet to be unstable and breakup into a series of droplets is expected. Ablation calculations based on droplet size result in poor penetration.

*Work supported by US DOE under DE-FC02-04ER54698.