During the launch sequence of the United Launch Alliance Delta IV launch vehicle, large amounts of pure hydrogen are introduced into the launch table and ignited by Radial-Outward-Firing-Ignitors (ROFIs). This ignition results in a significant flame, or plume, that rises upwards out of the launch table due to buoyancy. The presence of the plume causes increased and unwanted heat loads on the surface of the vehicle. A proposed solution is to add a series of fans and structures to the existing launch table configuration that are designed to inject ambient air in the immediate vicinity of the launch vehicle's nozzles to suppress the plume rise. In addition to the air injection, secondary fan systems can be added around the launch table openings to further suppress the hydrogen plume. The proposed air injection solution is validated by computational fluid dynamics simulations that capture the combustion and compressible flow observed during the Delta IV launch sequence. A solution to the hydrogen plume problem will have direct influence on the efficiency of the launch vehicle: lower heat loads result in thinner vehicle insulation and thus allow for a larger payload mass. Current results show that air injection around the launch vehicle nozzles and air suppression around the launch table openings significantly reduces the size of the plume around the launch vehicle prior to liftoff.