Session 1C:
The Impact of Make-Up Air Velocities on Atrium Smoke Control

The primary purpose of this study was to develop engineering methods to assess the impact of increased make-up air velocity in atria. The current restriction defined by NFPA 92 states that make-up air must not exceed 1.02 m/s (200 fpm) during the operation of a mechanical smoke exhaust system. This limitation not only limits creative and aesthetic atria designs but may also represent a significant cost. The present study analyzed the effect of make-up air injected by a variety of vent sizes at elevations at or below the limiting elevation of the flame through numerical simulations. This study focused on identifying worst-case scenarios for the interaction of make-up air with an axisymmetric plume, by modeling multiple configurations, observing the results, and adapting further simulations to elicit the most extreme cases. A mass flow rate diagnostic is used to assess the increase in entrainment, i.e. smoke production. This mass flow diagnostic is developed to provide a comparative analysis, assessing the increase in the rate of smoke production with a specified make-up air velocity with that produced with no mechanical make-up air. The proportional increase in entrainment is defined as an alpha factor. The most significant smoke production increase and smoke layer stabilization descent is associated with the 1 MW fire, when lesser increases observed for the 2.5 MW and 5 MW fires. As the make-up air is introduced further from the edge of the flame, the apparent effect of the airflow velocity is reduced.

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Dr. Milke is a Fellow of the Society of Fire Protection Engineers and a past president. He is also a member of the National Fire Protection Association, as well as the UL Fire Council, and the International Association of Fire Safety Science.