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CFD modeling and testing of an extended-duct air delivery system in high bay buildings

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Abstract

Mixing ventilation in high-bay buildings conditioned by rooftop units involves supplying and returning air near the ceiling. Several problems occur in tall spaces, such as higher return air temperatures in the summer and excessive stratification in the winter. An air delivery strategy was investigated that involves supplying and returning air at different heights depending on the season. In the summer, air is supplied low and returned just above the occupied zone to cool the occupied zone directly, letting the upper zone stratify. In the winter, air is supplied high and returned low to draw warm air down from the ceiling, thus promoting destratification. This system's performance was investigated through a computational fluid dynamics (CFD) study. CFD modeling results reveal the effects of supply and return duct locations on room airflow and stratification generation. The room temperature gradient is less sensitive to return duct height than to supply duct height, though increasing the return duct height slightly reduced

stratification and the average room temperature. CFD modeling results were validated against full-scale experimental testing results with good agreement.