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INVESTIGATIONS OF VENTILATION RATE, SMOKING ACTIVITY AND INDOOR AIR QUALITY AT FOUR LARGE OFFICE BUILDINGS

GUY B. OLDAKER III[1], W. DAVID TAYLOR[2]* AND KEN B. PARRISH[2]

[1]16 Shaffer Lane, Morgantown, WV 26505, USA
[2]R.J. Reynolds Tobacco Company, Winston-Salem, NC 27102, USA

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ABSTRACT

Four large office buildings were investigated to assess relationships among ventilation rate, smoking activity, and indicators of indoor air quality. Inspections of heating, ventilating, and air conditioning systems indicated that they were adequately designed, operated, and maintained. During the tests, all four HVAC systems provided ventilation rates essentially conforming to ASHRAE Standard 62-1989. IAQ indicators included respirable suspended particles, formaldehyde, volatile organic compounds, carbon dioxide , and carbon monoxide. Environmental tobacco smoke indicators included ultraviolet particulate matter, fluorescent particulate matter, and nicotine. Results show that with the HVAC systems adequately designed, operated in accordance with the current ASHRAE Standard, and properly maintained, all indicators were below applicable standards, regardless of smoking policy.

Keywords: Indoor air quality (IAQ), ventilation rate, smoking activity, office buildings, HVAC systems

INTRODUCTION

The last decade has seen increasing emphasis on issues relating to the quality of the indoor environment. This emphasis stems in great part from the relatively large proportion of time people spend there. The authors' indoor air quality (IAQ) research program has included surveys to assess exposures to airborne contaminants, in general, and environmental tobacco smoke (ETS), in particular, in various indoor microenvironments such as offices (1).

In 1989, the American Society of Heating, Ventilating, and Air-Conditioning Engineers (ASHRAE) published Standard 62-1989 titled "Ventilation for Acceptable Indoor Air Quality" (2). This consensus standard has two procedures for demonstrating acceptable IAQ, these include the Ventilation Rate Procedure and the Indoor Air Quality Procedure Briefly, the Ventilation Rate Procedure first requires ensuring that the quality of the outdoor air supply is acceptable. This procedure uses certain U.S. National Ambient Air Quality Standards (NAAQS) as criteria for acceptability. (The NAAQS applies to sulphur dioxide (SO_2); particles (identified as PM_{10}); carbon monoxide (CO); oxidants (as ozone (O_3)); nitrogen dioxide (NO_2); and lead.) Second, the procedure specifies minimal rates for outdoor air supplied to spaces on the bases of application and maximal occupancy. For example, 10 L sec^{-1} $person^{-1}$ is the minimal rate required for office spaces with a maximal occupancy of 7 persons per 100 m^2. Ventilation conforming to this procedure "is deemed to provide acceptable indoor air quality, ipso facto."

By contrast, the Indoor Air Quality Procedure relies on direct assessment of IAQ. Assessment includes both quantitative evaluations (by measuring contaminants in the indoor air) and subjective evaluations (*e.g.*, by administering questionnaires to occupants). This procedure also uses the NAAQS for acceptability criteria. These criteria are supplemented with guideline concentrations and exposure times for other contaminants including