
IAQ in a Contaminated Environment

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INTRODUCTION

The purpose of this workshop was to explore the challenges of achieving good indoor air quality when there are air quality problems surrounding an indoor space. Through the three presentations and subsequent discussions, workshop participants had an opportunity to:

- gain insight into external contaminants for various types of indoor environments,
- gather ideas on how modeling outdoor environments may help planning for control of indoor environmental quality, and
- exchange concepts for enhancing indoor environmental quality in contaminated environments.

Presentations provided information on specific cases of buildings in a contaminated industrial environment and an urban downtown area. In addition, localized sources of contamination, such as exhaust from boiler plants and incinerators, or other "same building" or neighboring building sources, were discussed. Modeling of problems, ambient air pollution regulation impacts, and specific control methodologies were discussed.

DISCUSSION

The quality of the ambient, or outdoor, air is a critical factor in indoor air quality, particularly where dilution of indoor sources is the primary means of quality control. Ambient air quality varies among large geographical areas within the United States, as well as locally, where specific pollution sources may be present. On a large geographic scale, the key pollutants include ozone, sulfur dioxide, nitrogen oxides, particulate matter (especially PM₁₀, particles of less than 10 micrometers in air dynamic size), carbon monoxide, and lead. Many urban areas are "nonattainment" for national ambient air quality standards (NAAQS) on one or more of these pollutants, with special problems in the Los Angeles area, Denver, Chicago, and New York. Many other metropolitan regions are nonattainment areas as well.

The U.S. Environmental Protection Agency's (EPA) outdoor air regulations and considerations may impact the designer of an indoor environment in two ways: (1) air may be

of such poor quality as to require treatment before use indoors, and (2) for buildings located in nonattainment areas, regulations may require controls or offsets of emissions. One example of a control measure important to localized control to avoid reintrainment of contaminants is adequate stack height for combustion sources. EPA guidelines establish a stack height of 2.5 times building height for adequate dispersal of contaminants. Alternately, the stack may be designed to provide a high-velocity discharge, which compensates to some extent for stack height.

Modeling of discharges relative to air intakes offers a possible solution to many concerns about reintrainment of contaminants. The first step in these design considerations is to obtain a "wind rose" from a local airport to show the predominant wind direction and velocities. One solution to the entrainment of outdoor pollution is common sense, such as avoiding air intakes over loading docks or on busy streets. For complex buildings, or buildings in densely crowded areas where one building may be a source of contamination for another, commercially available mathematical modeling has been used for many years in the analysis of ambient air pollution. Such modeling has the potential to save time and money by providing a better understanding of outdoor air conditions during design.

The impacts of outdoor air quality on the indoor environment are well demonstrated by data (unpublished) taken from a downtown Atlanta high-rise office building. Several years of ongoing monitoring of indoor environmental parameters revealed consistent patterns of particulate contamination, with the majority of particulates in a size range below two micrometers. Street-level outdoor air showed significantly higher levels of particulates than air at upper levels of this downtown high-rise.

The high-rise building featured in this case study also faced a limited supply of outdoor air, requiring designers of an eight-floor buildout to use the IAQ procedure of ASHRAE Standard 62-1989 (ASHRAE 1989) to achieve acceptable indoor air quality. The heating, ventilating, and air-conditioning (HVAC) system was upgraded to incorporate three-stage filtration with a prefilter, bypass carbon filters, and a minipleat 80% DOP final filter. With more than four and one-half years of monitoring data on these eight floors with comparative data from other floors within the same building, it is apparent that the filtration method has resulted in sub-

stantial reductions in particulate, as well as total volatile organic compounds (TVOC). The comparative data suggest that air treatment to this degree offers one solution to inadequate or poor quality outdoor air.

Two cases of industrial office areas were examined to look at specialized problems and solutions. In one industrial example, the air supplied to control areas was heavily contaminated with various compounds of sulfur, chlorine, and nitrogen. The control tactics included isolation, positive pressurization, and gas-phase sorption. Contaminated air was passed through deep bed engineered cells using carbon, carbon-treated permanganate/alumina, and permanganate zeolite.

In the second industrial case study, a steel rolling mill faced problems controlling carbon monoxide levels in offices used in process control and research areas in and on the perimeter of the production area. Source control proved to be impractical in the short term. Dilution using outdoor air was not practical for most areas from both design and operational concerns. As an interim measure, local filtration devices typically used to control environmental tobacco smoke were deployed. These devices emit ozone and include a small carbon filter. Field results show consistent elimination of carbon monoxide and a proportional increase in carbon dioxide when the devices are operated. Long-term, source control, or alternative air treatment methods are being investigated.

In this same industrial site, areas served by air-handling units with outdoor air capability were receiving no outdoor air as a result of potential contamination from air emissions from the production process. The potential for contamination

occurred when wind conditions directed the discharge plume into the vicinity of air intakes. No short-term solution was available, but a longer term plan includes the installation of a small, local weather station linked to a proposed new facility automation system that could provide outdoor air damper control to close outdoor intakes during wind conditions that might result in contamination.

CONCLUSION

Presentations and pursuant discussions lead to the conclusion that advance planning to achieve acceptable IAQ is critical when the external environment is abnormally contaminated. Both particulate and gas-phase filtration (or chemical conversion) should be evaluated. Local recirculated air contaminant control proved effective in several cases presented. Treatment of contaminated outdoor air before use as ventilation air is essential.

It is clear from this discussion that outdoor air is not fresh air. Such common design approaches as air-side economizers should be questioned rather than assumed as acceptable energy conservation measures. In contaminated environments, including most urban areas and many locally contaminated areas, increasing the rate of outdoor air intake to a building may compound indoor air quality problems and increase the difficulty of achieving solutions. Resolving these issues in the design stage offers the most cost-effective means to good indoor air quality.