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Factors Affecting Employee
Health & Comfort

Tobacco Smoke Signals New Challenges for Managers

Few topics that concern indoor air quality are more likely to stir emotion and create heated debate than the issue of cigarette smoking and sooner or later every employer must address this problem. In recent months, some employers and building owners have made hasty decisions regarding tobacco smoke that have threatened legal confrontations between tenants who argue that their lease gives them the right to smoke. Others have demanded that their leasing company make and pay for building provisions to accommodate smokers in their offices.

Some enterprising property managers have shown remarkable insight into this growing problem and have created solutions that have even enhanced the building's leasability. Politicians, sensitive to the feelings of their constituents, have tuned in to the "smoking in the workplace" issue, resulting in the drafting of new regulations and the implementation of new smoking laws and restrictions. Asset management firms also need help in addressing smoking issues in ways that satisfy both the smoker and the non-smoker within their properties. This is a reachable goal in the vast majority of commercial properties.

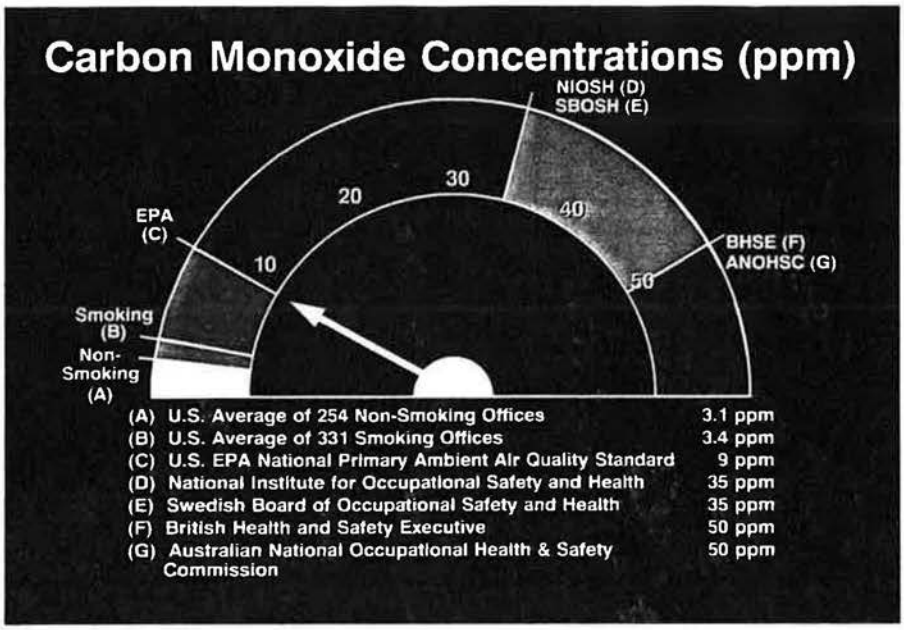
Smoke accumulation within offices may be only the tip of the iceberg. If smoke is trapped by bad ventilation so are all other indoor pollutants. Many of these invisible chemicals, dusts, fibers, bacteria and fungi can have acute or long term health affects on the building occupants. Moreover, there have been a number of lawsuits filed by individuals claiming to have suffered injury from exposure to poor indoor air quality.

Reacting solely to the visible evidence of poor ventilation omits invisible pollutants and certainly does not address the fundamental problem of inadequate ventilation. Today, according to some lawyers involved in sick building suits, it would be extremely difficult for a building manager to defend him or herself in a negligence lawsuit concerning air quality if their building does not meet the widely accepted ventilation rates of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). Since ASHRAE's office ventilation rates can accommodate, and indeed contemplate, a moderate amount of smoking, if there are smoking related complaints in an office environment, a practical response perhaps should be to check the ventilation and the operation of the HVAC system. Such an approach is consistent with HBI and NIOSH building investigation data which confirm that the majority of building IAQ complaints are related to improper or inadequate ventilation. Because ventilation is so important to overall office indoor air quality, it is not surprising that sick building complaints and even law-

suits arise in indoor environments where there is no smoking. Experience indicates that banning smoking is not a shield against IAQ litigation, and in fact, experience indicates that banning smoking in office environments without tending to the overall indoor air environment and ventilation needs, may precipitate complaints or litigation because the underlying ventilation issues may not have been addressed. Conversely, ventilating pursuant to ASHRAE standards and operating the HVAC system at optimum levels, even with moderate smoking, may be the best proactive measure against complaints and litigation because experience indicates that most complaints are ultimately linked to ventilation.

HISTORY OF TOBACCO SMOKE MEASUREMENTS

Despite all the publicity concerning tobacco smoke in offices, especially in the United States, there are actually relatively little data on levels of smoke in real-life, modern day office buildings. In the early nineteen eighties, James Repace and Alfred Lowrey performed a series of measurements for respirable-sized particle concentrations in smoke-filled spaces such as bars, bingo halls, restaurants and social gatherings. These measurements were compared with samples taken from non-smoking environments such as churches, libraries and private homes in order to demonstrate the differences in indoor air particle levels between smoking rooms and non-smoking rooms. Repace and Lowrey took their data and extended it with other similar experiments made in simulated office environments. They eventually calculated a theoretical model which estimated average particle concentrations in smoking offices was 200 micrograms per cubic meter. These researchers used much of this data to derive an indoor air quality standard based on "carcinogenic risk." This standard was so stringent that it would require the elimination of virtually all activities involving combustion (cooking, smoking, etc.) in indoor environments. Their model calculations and their measurement figures in the smoky rooms have been widely quoted in the scientific press, including draft EPA documents and formal NIOSH position papers as recent as this year. Thus showing that their data continues to have a great influence on public policy on indoor smoking. Unfortunately, Repace and Lowrey's data does not include much information from real-life smoking levels in typical offices, and most up-to-date measurements by other researchers in typical offices have shown levels several-fold lower than their early models calculated. Even these other researchers were not able to make extensive measurements in a wide variety of offices, and very often, essential



related information, such as the number of smokers, nicotine levels or ventilation parameters are missing. This is not so much because of "poor science" but simply that such measurements are expensive and difficult to perform in a large number of offices. Also, access to offices to conduct such experiments is difficult since building owners are naturally wary of tenants reactions to the presence of scientists and air monitoring instruments in their place of work.

SAMPLING OF 585 OFFICE AREAS

With a clear need for more extensive information on a subject in which public policy is constantly evolving, HBI is in a unique position to contribute some data on levels of tobacco smoke in offices because both cost and access problems are eased by HBI's routine indoor air monitoring. Clients received information on tobacco smoke levels in their normal indoor air quality reports, and the sets of data on smoke levels (and related parameters) were added into an overall database, which eventually consisted of nearly six hundred separate sets of measurements throughout 1989. At each location, the following information was collected: location details, configuration of room, office area, temperature, relative humidity, number of occupants, number of cigarettes smoked, respirable suspended particulates, nicotine, carbon monoxide and carbon dioxide. A comprehensive technical report on these tests has been completed and a paper titled "The Measurement of Environmental Tobacco Smoke in 585 Office Environments" has been accepted for publication. Several key results are presented here to show "real office" conditions compared with theoretical models used in the past.

TEST RESULTS

When Repace and Lowery calculated that smoking offices would have respirable suspended particle levels of 200 micrograms per cubic meter of air, they made an assumption that there would be about 4.7 cigarettes smoked per hour in a 1000 square foot (100 m^2) room. However, according to smoking studies conducted by HBI, cigarette consumption was higher — an average of about 6.6 cigarettes per hour per 1000 ft^2. Despite this fact, real-life respirable particle levels averaged about four times lower than the Repace and Lowrey model predicted, at 46 $\mu g/m^3$.

HBI's Other Key findings:

- Smoking density and levels of suspended particles and nicotine were all closely linked.
- There was only a weak relationship between carbon monoxide levels and the presence of smoking. It would take much higher levels of smoking than are normally found in offices before any recognized health limits for carbon monoxide would be breached.
- No relationship was discernable between carbon dioxide levels and levels of other contaminants, even when adjusted for the number of occupants in a room, and for room size. This does not mean that there is not any relationship between overall outside air intake for the building and pollutant levels. Instead, it means that room-to-room measurements of carbon dioxide need to be interpreted carefully if it is to be used as an indicator of ventilation levels. Local floor and zone variations will quickly change carbon dioxide levels, and they are best used when undertaking a "building wide" assessment, rather than an intensive study of a single room. Measurements of room air change rates are much more likely to relate to tobacco smoke levels in specific rooms than to carbon dioxide levels.

STATISTICAL ANALYSIS

With data from 585 office environments, a statistical analysis was used to help interpret HBI's findings. This analysis revealed the average levels of some key components, along with an indication of how variable they were. With this information, differences can be seen between areas where smoking was observed and where it was not observed. It was also possible to use this basic information to see the relationships between the study's different parameters. For instance, it can be determined how levels of respirable particles varied depending on the number of smokers in a given space.

Statisticians from the Department of Biostatistics, Epidemiology and Systems Science (DBESS), at the Medical University of South Carolina in Charleston, were asked to undertake a more sophisticated examination of the data called Discriminant Analysis. In this analysis, a computer is "blindfolded" to whether a room is used for smoking and is asked to make its best guess as to the presence or absence of smokers based on the air quality data. The results of this analysis can then be compared with the actual smoking or non-smoking status of each room.

COMPUTER PREDICTION

What did the computer say about the difference between smoking and non-smoking rooms? Firstly, the only parameters it needed to use to make its predictions were respirable particles and nicotine; carbon monoxide for instance, did not help. It was able to predict that a set of data came from a non-smoking room with amazing accuracy; it scored 96.1 out of 100 on this test. It was not as successful at predicting that a set of data came from a smoking room. In this test, it only classified 41.4 percent of the sets of data correctly.

What this result means is that in 41.4 percent of the rooms we sampled that were

used for smoking, the air quality was different enough from non-smoking rooms to be discernable. In the remainder (58.6 percent) of the rooms used for smoking, the air quality was not significantly different than a non-smoking room. Obviously, the more smoking taking place in a room, the more likely the computer would correctly classify it as a "smoking room."

We can also learn something from the computer's 96.1 percent success rate at predicting a non-smoking space. Only in the 3.9 percent remainder was there "spill-over" of tobacco smoke into areas where no smoking was actually observed. This finding shows that, in general, conventional office ventilation and partitioning is successfully separating smokers from non-smokers.

CONCLUSIONS FROM THESE ANALYSES

By sampling the air in hundreds of buildings, HBI was able to compile some unique databases on different pollutants, giving us the opportunity to see, for the first time in many cases, what levels of these substances are in our office environments. We therefore, have to rely less on calculations and models derived from smaller scale field measurements.

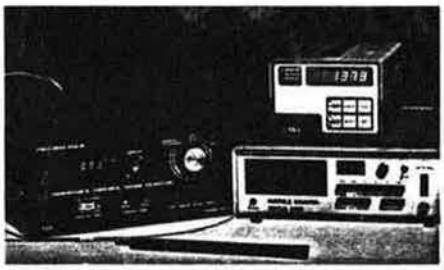
This series of air sampling tests for tobacco smoke shows us that, based on earlier calculations, smoking in offices does not add significantly to the pollutant load in reasonably well-ventilated rooms; and that there appears to be less tobacco smoke in offices than was thought.

What is particularly significant about these results are the implications for the ASHRAE ventilation standard 62-89. In this standard, ASHRAE indicates that acceptable indoor air quality can be maintained with a minimum ventilation rate for offices of 20 cfm per person (10 l/s) "with a moderate amount of smoking." This work helps to better define the limits of "moderate" smoking. It also underscores ASHRAE's approach on the effectiveness of office ventilation systems to remove internally generated pollution.

REDUCING TOBACCO SMOKE IN THE WORKPLACE

It is obvious that excessive exposure to any indoor pollutant is undesirable. If in any particular workplace tobacco smoke is a concern, there are a lot of options to reduce or eliminate the irritating effects that may occur when this substance builds up to unacceptable levels.

If large numbers of staff are complaining about cigarette smoke in their building, or if there is a visible haze across large open plan areas or along corridors, managers have to think carefully about their actions. Complete smoking bans in a building — the ultimate "source control" option — may not solve the fundamental cause of the problem and may backfire by transferring complaints from non-smoking employees to disgruntled smokers.



Airborne particulate monitors

FIND THE CAUSES

The first step any building manager should take when faced with these problems is to determine why tobacco smoke is accumulating in the building at all. HBI has reviewed its database on nearly 700 building studies over the past 10 years and found that 56 percent of these buildings have been operating with grossly inadequate ventilation. Similar findings have come from groups such as the U.S. National Institute of Occupational Safety & Health (NIOSH) and many other private and public investigators. Under conditions of poor ventilation, all internally generated pollutants, including tobacco smoke, will build up and recirculate. These include oxides of nitrogen and sulfur, formaldehyde and other volatile chemicals, airborne dusts and fibers plus numerous bacteria and fungi, pollens, insect fragments and animal dander. Of these pollutants, only tobacco smoke is visible and if it accumulates, it is an indicator that there is a ventilation problem in the building. For these reasons smoking bans may not be the quick and easy solution they appear to be. If bad ventilation traps smoke, it its simultaneously trapping all other pollutants and these affect the health and productivity of all employees.

Before changing anything else, the building manager should ensure that the ventilating system is clean, equipped with good filters and that it is also well maintained and bringing in adequate amounts of outside air to dilute all internally generated pollutants. Regular inspections of the system will help ensure this is the case, and only after this step should consideration be given to the need for a further policy on indoor pollutants including tobacco smoke.

DESIGNATED SMOKING AREAS

Where courtesy options fail and there is a need to physically separate smokers from non-smokers, a common politically practical solution is the use of designated smoking areas. These can often balance the objections of non- smokers with the smokers' wishes. Designated smoking areas can be as small as one person's office, or as large as an entire floor, but they should take into account the ventilation system in use. With some thoughtfulness in the selection of smoking areas with respect to the ventilating system, this policy of designating smoking areas can work very satisfactorily, and our findings show that in most buildings tobacco smoke leakage from a smoking area to a non-smoking area is negligible.

DESIGN FLAWS

Occasionally, problems with designated smoking areas have been found in indoor air quality investigations due to careless

Airborne Particulate Concentrations
(Respirable Suspended Particulates RSP $\mu g/m^3$)

Repace and Lowrey's Theoretical Values	200	◄ Model Used in Risk Assessment Studies
WHO - Consensus of Concern for Tobacco Smoke Particles	150	◄ "Concentration of Concern"
	100	◄ "Limited or No Concern"
Actual Values Measured in U.S. Offices by HBI	46	◄ Average of 331 Smoking Offices
	20	◄ Average of 254 Non-Smoking Offices

WHO = World Health Organization.

design. Portions of cafeteria areas are often designated as smoking areas by management, sometimes positioning smokers away from the exhaust system causing smoke to drift across non-smoking areas. Another possible pitfall of the designated smoking area concept as a whole is that, in a large building served by many air handling units, one smoking area concentrates all the smokers into an area served by only one unit. The capacity of this unit to dilute this more concentrated smoke load is now often exceeded, delivering more, not less, tobacco smoke to non-smokers also served by this unit. It is better to have a large number of smaller smoking areas than one crowded and smoky room.

A frequent mistake found during building studies is the use of local fans to exhaust air from a room used for smoking directly into the ceiling void (the space between the false ceiling and the concrete slab which divides the floors). This ceiling void is often used as part of the return air system, in which case it should be under negative pressure with respect to the rooms below. An exhaust fan blowing directly into the ceiling void will pressurize that part of the void, thereby disrupting the normal air flow in that area. This condition will usually deposit the tobacco smoke into an adjacent office, often occupied by a non-smoker who is mystified as to how his or her office becomes smoke filled. Such an exhaust fan should be equipped with ductwork leading either to the building's main return system or preferably to the exhaust system.

SMOKING LOUNGES

In the designation of specific smoking lounges, attention should be given to the feasibility of equipping these lounges with exhaust ventilation to the exterior of the building. Consultation with the landlord or the landlord's air quality consultants can help identify the feasibility of designating dedicated smoking areas. The advantage of local exhaust ventilation is clear — no re-entrainment of tobacco smoke into the return system of the building and a minimum of overall air movement is required.

Furthermore, with the correct selection of the designated smoking areas coupled with optimized exhaust ventilation rates, no further outside air intake to the building is required since the use of "transfer" air from areas adjacent to the smoking room is a practical option that meets ASHRAE requirements. Such a practice utilizes the use of negative air pressure in the smoking rooms with respect to the adjacent rooms. This technique has the advantage of not only minimizing make-up air ventilation costs, but also precludes any possibility of smoke leakage from the smoking areas to the non-smoking areas.

AIR CLEANING EQUIPMENT

Equipment marketed specifically for removal of tobacco smoke components from room air include electrostatic precipitators, activated charcoal filters and HEPA (High Efficiency Particulate Air) filter units. All three have their place in removing the finer, so-called respirable dust and activated charcoal specifically is used for removing some of the gases from the air. However, the role of these units should be considered supplementary to adequate ventilation. They should not be used instead of adequate ventilation.

In addition, the use of the various air cleaning devices should be carefully optimized to provide peak performance. Undersizing such units can quickly cause overloaded conditions and the overall performance falls precipitously. Furthermore, the servicing of these units involving replacement of filter pads and chemical or charcoal adsorbents, plus the frequent cleaning of the electrodes in the case of electrostatic precipitators, is of paramount importance to the continued efficiency of each system.

POLICY OPTIONS

The emotional question concerning smoking policies is not simply going to disappear. In addition, the multiplicity of existing regulations means that policies that work in one area will not necessarily be acceptable in another.

Some managers have already acted to ban smoking completely. Others rely solely on courtesy which can frequently accommodate smokers and non-smokers. This would be especially true in buildings that are well ventilated as evidenced by the ASHRAE observation that offices receiving a minimum of 20 cfm/person (10 l/s) of outside air, a minimum requirement for a healthy office, can cope adequately with a moderate amount of smoking.

Employers who choose to restrict smoking to designated areas will, however, be encouraged by the news that ventilation engineering can adequately cope with removing smoke from dedicated smoking rooms or lounges. Also, such a practice is not necessarily expensive. In fact, when handled properly, a smart manager can turn a potential problem into an asset.

A property manager who works for the Turco Development Company, a St. Louis based commercial real estate development and management firm, is an example of one who has actively tackled the smoking problem. Wendy Merciante, Turco Development's vice president and director of asset management, states: "The goal of an asset management firm is to maintain a building's profitability and leasability while constantly working to increase the property value for the building owner. We see tenant lounges as a method of resolving the smoking problem and achieving our goals. We've found that many non-smoking firms view the lounges as a building amenity. Ideally, we would like to provide additional space for private employee lounges, but we felt we could not afford to wait for that trend to develop. We wanted to respond in a prompt, positive manner to the problem. That's why tenant lounges will now be as much a part of every new Turco building as an elevator."