



## Indoor Air Quality (IAQ) Tailoring Lease Specifications

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Office space lease, proposal or work agreement language is one method by which tenants and building owners can address Indoor Air Quality (IAQ) prior to finalizing an occupancy agreement. Tenants influence overall air quality with space design changes and by introducing air contaminants through their activities. Owners influence air quality through design, maintenance and operation of a building and its heating, ventilating and air conditioning (HVAC) systems.

This paper suggests contract language to be negotiated between the two parties which addresses quantity of ventilation air delivered to occupied spaces, contaminants generated, maintenance practices, evaluations of air quality, design limits and operation of ventilation systems. Examples of specific provisions and instructions are presented.

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# S-852

last updated

May 2011

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## Introduction

Conditions of inadequate Indoor Air Quality (IAQ) can arise from deficiencies in the design, the installation or the operation of a building and its heating, ventilating and air conditioning (HVAC) systems or simply from overwhelming the design capacities of the system. Lease requirements to assist in protecting IAQ will differ for an initial tenant occupying a new building, as compared with a tenant occupying space with an established prior history. This second case is considered the more typical situation.

Both tenant activities and owners influence indoor air quality. While many of the clauses suggested in this document address the issue from the perspective of the tenant, similar clauses can be suggested from the perspective of the landlord. In particular, it may be desirable for the owner to clearly communicate the design capacities of the HVAC system to the tenant.

## Outside Air Distribution

The delivery of sufficient quantities of outdoor air to a building's occupied spaces can be considered the most important requirement for achieving good IAQ. In the results reported by the National Institute for Occupational Safety and Health (NIOSH) summarizing their investigations of inadequate IAQ, 50 percent of the cases have been attributed to the delivery of insufficient quantities of outdoor air for ventilation.

Different types of heating, ventilating and air conditioning (HVAC) systems are available for providing this crucial requirement. There are decentralizing systems such as perimeter fan/coil units where each through-the-wall unit brings in some outdoor air and heats or cools it as necessary. This approach, however, is not practical for buildings with large interior areas. For these buildings there are the two basic types of centralized systems; constant air volume (CAV) or variable air volume (VAV). In CAV systems, local thermal control is achieved by varying the temperature of the delivered air. In VAV systems, local thermal control is achieved by varying the quantity of cooling air delivered, and possibly the delivery temperature.

For all of these system types, the quantity of ventilation air can vary as a function of the specifics of the system. There are some systems that are designed to only deliver a constant minimum quantity of outdoor air (OA).

These systems are not optimum from an IAQ point of view. More advantageous are systems with so called "economizer cycles" which are designed to bring in larger and larger quantities of OA when the outdoor conditions are favorable for the use of OA for "free cooling." These economizer systems, however, go to their minimum OA settings when the outdoor air temperature gets above the maximum delivery temperature for cooling or when it approaches or is below freezing outdoors. More advantageous in some situations, where an analysis of life-cycle costs demonstrates a favorable return on investment, are systems with the ability to recover heat or cooling from the building exhaust system so that even during unfavorable outdoor air temperatures, sufficient quantities of outdoor air can be provided without significant energy penalties.

Therefore, it may be specified that:

**Clause #1:** Prior to occupancy, testing shall be performed by a qualified registered professional engineer or certified industrial hygienist to confirm that the ventilation system, in its minimum outdoor air setting, is delivering the quantities of outdoor air to representative occupied spaces, as called for in this lease agreement. This certification testing shall be by the Tracer Dilution Method as specified in the American Society for Testing and Materials (ASTM) Standard Test Method E74-83.

Spaces with intermittent or variable occupancy may lag or should lead the hours of occupancy in accordance with the provisions of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.1. Certain assumptions may have to be made of occupancy levels, especially if reference to ASHRAE 62.1-2004 is made since this Standard references outside air on a cubic feet per minute (CFM) per person basis.

In this wording, it is the delivery of the outdoor air to the occupied spaces that is stressed, because the quantity of OA entering the HVAC from the outdoors typically does not actually get delivered to the building occupants due to leakage from the supply ductwork and other distribution inefficiencies. Also, it is the minimum outdoor air quantities that are specified because many types of ventilation systems can vary the quantity of outdoor air being drawn into them.

The potential challenge in this situation is that buildings built for a nonspecific tenant will vary in the point in construction where the initial tenant begins to have input into the decision-making process.

One of the problems associated with lease arrangements is that "spec" building, i.e., buildings built on speculation, with no specific tenants under agreement, are typically built with an eye towards minimizing the "first costs" of construction. In this situation, the builder has little incentive to perform "life cycle" costing in his decisions. Unfortunately, this means that the building systems are less likely to include heat recovery for the ventilation system.

This may be unfortunate because in many climates with low density occupancy, the use of heat recovery equipment can assist in guaranteeing both the adequate IAQ will be provided throughout the year and that energy costs will be minimized.

**Clause #2:** Preference in awarding lease agreements will go to proposals for space in buildings that have the capacity to vary the quantity of indoor air up to 100 percent of the total supply air. Further preference should go to buildings where life-cycle cost analyses, including energy, demonstrate the advantages of heat and/or moisture recovery ventilation systems.

An alternative approach would be to have the evaluation process for potential lease spaces to include a ranking where the ventilation system is given points according to its type. Under this scheme, the most points would go to buildings with 100 percent outside air capability and bonus points for heat and/or moisture recovery systems, if supported by life-cycle cost analyses. The least points would go to buildings with merely constant minimum OA systems. A possible rank ordering of the various options for providing outdoor air are presented in the following chart:

1. Buildings with full economizer capability (100 percent outdoor air) and heat and/or moisture recovery where economically justified by life-cycle analysis (including energy).
2. Buildings with constant volume or variable air volume HVAC systems with full economizer capability (100 percent outdoor air).
3. Buildings with constant volume or variable air volume HVAC systems with partial economizer capability (50 percent outdoor air).
4. Buildings with variable air volume HVAC systems with separate dedicated constant volume outdoor air fans to operate under minimum outdoor air conditions.
5. Buildings with variable air volume HVAC systems with the ability to proportional increase the amount of outdoor air entering as the total air volume decreases.
6. Buildings where the amount of outdoor air is limited to one constant minimum value.

Other possibilities for lease language include incorporation by reference to various standards. As an example for the State of Maine, an act to require state-leased buildings to meet certain air quality standards includes the following statements:

“Application of minimum air ventilation standards: Beginning September 1, 1988, to apply the ASHRAE Indoor Air Quality and Ventilation Standards by the American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. or more

stringent standards to buildings occupied by state employees during normal working hours. These standards shall be applied ... to buildings for which the State enters into new leases following the date in this subsection." ASHRAE Standard 55-2004 provides information describing acceptable operative temperature and humidity, therefore reference to this Standard provides for the specification of temperature and humidity conditions.

Another documentation of the performance capability of the HVAC system, in addition to that specified in Clause #1, is measurement of the total air handling volume, the amount of indoor air entering the HVAC system and the distribution of conditioned air to the occupied spaces.

**Clause #3:** Prior to occupancy, a validated report detailing the measurement and verification of air volume testing, adjusting and balancing shall be provided.

This could be performed by a contractor certified National Environmental Balancing Bureau (NEBB) or by a building representative. For spaces which have been previously occupied, building maintenance personnel are likely to conduct balancing.

### **Air Contaminant Sources**

The major factors that affect the potential of materials to contribute air contaminants, principally volatile organic chemicals (VOCs) can be summarized as follows:

1. The quantity and distribution of the material in the building (i.e. floor coverings, work surfaces and interior partitions which are all significant because of the large extent of their use).
2. The specific chemical composition of the products.
3. The stability of the chemical substances involved.
4. The toxic or irritation potential of the major chemical constituents involved.

Standards do not yet exist to provide a yardstick for specifying limits in new materials. This is a new area and more information is becoming available slowly. Currently information is available from manufacturer's Material Safety Data Sheets (MSDSs) which list hazardous substances contained in the products they cover.

However, although MSDSs are available for most building products, their usefulness in this application is debatable due to "trade secrets" exemptions in the reporting requirements. The Environmental Protection Agency (EPA) is now developing a database on building material emission rates. In the absence of specific standards

in this area, no lease clauses can be defined at this time. It appears that the most efficient way to obtain "clean" products is to place as much responsibility as possible on the product manufacturer to control emissions and to provide data.

In the interim, specifications can be suggested that can be used to direct potential vendors to provide appropriate products. Certain materials are more important sources of VOCs than others. These materials include carpets, adhesives, caulks, sealants, paints, insulations and office work station furnishings. Since the selection of interior furnishings is typically not within the scope of leases, readers are directed to a chapter by Hal Levin<sup>2</sup> for a more detailed discussion of this issue.

Responsibility for the selection of materials often rests with both the tenant and the building owner.

What is in the domain of both construction activities and lease specifications are requirements to maintain maximum ventilation. Therefore, the following requirements may be considered:

**Clause #4:** During the installation of materials (in either the tenant's space or areas served by the tenant's HVAC system) with the potential to emit VOCs (including carpets, adhesives, caulks, sealants, paints, insulations and office work station partitions), the HVAC system shall be operated with no recirculation or air (weather permitting). This can be achieved either with 100 percent outside air or by using only the supply air fans and ducts; exhaust is to be provided through windows (if operable). This reduces contamination of return air ducts, plenums, and insulation materials. If operable windows are not present, temporary openings shall be provided by the removal of window glass. Consideration shall be given to the use of exhaust fans to pull exhaust air from deep interior locations. Stair towers and other paths to the exterior are useful for exhausting air from the building during temporary ventilation. Any temporary systems must comply with applicable life and safety codes. This construction related ventilation shall be operated for 24 hours a day and shall persist for one week after the installation of the carpets or other remodeling activity.

For addressing issues pertaining to cigarette smoke:

**Clause #5:** Air exhausted from areas designated to permit smoking shall be discharged directly to the outdoors via a separate exhaust system at a minimum rate of 50 cfm/smoker.

In no cases shall the air exhausted from smoking rooms or other locations with identifiable sources of air contaminants be permitted to be recirculated back into the building.

Other clauses could address the potential for biological contamination sources, for example, through the confirmation of the operation of drain pans and drainage piping.

**Clause #6:** All air conditioning (AC) drain pans shall be certified to drain completely under all opening conditions.

## **Maintenance and Operation**

Other building and HVAC parameters that can effect IAQ and could be addressed in contract language include the operating schedules for the HVAC equipment, the maintenance schedules for this equipment and requirements for rebalancing, filter maintenance activities, the need for someone to take responsibility for the operation of the HVAC system and the need to include provisions for providing local exhaust "spot" ventilation on equipment or processes reasonably expected to produce point sources of indoor air pollution such as high volume copying machines.

In order to prevent the infiltration of unconditioned (e.g. unfiltered) outdoor air through penetrations in the building's envelope, a performance standard for building pressurization is possible. IAQ complaints and temperature control problems have been traced to the entry of dust laden and/or dry air infiltrating into the perimeter areas of buildings.

**Clause #7:** The landlord is responsible for operating the building HVAC systems so that the occupied areas of the building are maintained at a slight positive pressure typically (0.01-0.05 of water column) with respect to the outdoors.

Once the building is occupied, periodic IAQ evaluations shall be conducted by a ventilation/IAQ engineer or certified industrial hygienist to confirm that the initial satisfactory performance of the ventilation system is being maintained. This evaluation can be performed on a once or twice a year schedule or can wait until there is a specific request of the tenant due to employee complaints. In either event, the following clause wording may be considered:

**Clause #8:** In the event that IAQ complaints for more than two weeks, the landlord will be responsible for the cost of hiring a ventilation/IAQ engineer or certified industrial hygienist to evaluate the cause or causes of those complaints. The responsibility for paying for the remedies, however, shall be negotiable depending on the specific reasons for the degradation of indoor air quality.

Typical protocol for the performance of an IAQ investigation would include an initial walk-through evaluation, personal interviews with the building occupants, environmental monitoring and follow-up site visits. In the initial assessment the

complaints are documented, the building and its systems are characterized, followed by an inspection of these systems, with specific attention to the ventilation system. This walk-through also includes a survey of office areas for potential sources of indoor air contaminants. This initial phase is followed up with environmental measurements, based on the findings of the initial walk-through, and concludes with recommendations for the correction and prevention of indoor air quality problems. For a more detailed discussion of this IAQ investigation, readers are directed to a chapter by Patricia Quinlan, et. al.<sup>3</sup>

## **HVAC System Capacities**

Based on the experience of the authors and other researchers, it is not uncommon to find that the cause of complaints of poor air quality is simply overloading the HVAC system capacities for which the building has been designed. Many buildings, including owner-occupied buildings, are designed for a given maximum loading based upon the number of persons per square meter (foot) and a maximum quantity of watts per square meter (foot). Exceeding the design capacities is likely to cause temperature control problems (overheating) or indoor air quality problems (not enough ventilation air). These conditions are likely to occur during periods of operation at or near design conditions. Another example would be when a tenant has chosen a high occupant density or installed significant amounts of computer equipment or other heat producing equipment.

The owner may notify the tenant of the design limits of the space, i.e. the maximum number of persons per square meter, or the quantity of watts per square meter.

**Clause #9:** The space provided for the tenant has been designed to be capable of providing adequate ventilation air to meet ASHRAE Std. 62.1-2004. Guidelines for office type environments specify a maximum density of seven people per 90 square meters (1000 sq. feet), a maximum of one personal computer per person and a maximum of 21 watts per square meter (2 watts per square foot). If tenant needs exceed the office HVAC design capacities, it is the responsibility of the tenant to notify the owner such that appropriate action can be undertaken. The cost of the installation of additional cooling or ventilation capacity if needed can be negotiated.

Another mechanism which could reduce the likelihood of both overheating and air quality problems is to identify equipment known to cause problems.

**Clause #10:** The space provided for the tenant has been designed to be capable of providing adequate ventilation air to meet ASHRAE Std. 62.1-2004. Installation of large or high use photocopying machines, kitchen/vending equipment, or several large computer work stations will exceed the HVAC design capacity and may

necessitate the installation of a direct coupled exhaust or additional cooling capacity. If tenant needs exceed the office HVAC design capacities, it is the responsibility of the tenant to notify the owner such that appropriate action can be undertaken. The cost of the installation of additional cooling or ventilation (exhaust) capacity if needed may be negotiated.

## **Conclusion**

In discussing issues of contract language, it is important to recognize that both tenant and building owner activities affect air quality. While many of the proposed clauses presented address the issue from the perspective of the tenant, similar clauses can be suggested from the perspective of the landlord.

Addressing these issues prior to contracting for a particular leased space provides both building owner and tenant with resources for addressing issues of poor air quality which arise in many occupied office buildings.

## **References**

- <sup>1</sup> Work performed under contract to the U.S. Environmental Protection Agency, Region X.
- <sup>2</sup> Levin, H. (1989) Building Materials and Indoor Air Quality, Occupational Medicine: State of the Art Reviews - Vol. 4, No. 4: 667-693
- <sup>3</sup> Quinlan, P, et. al. Protocol for the Comprehensive Evaluation of Building Illness, Occupational Medicine: State of the Art Reviews - Vol. 4, No. 4: 771-797.