

## REMEDIAL MEASURES FOR ENVIRONMENTAL PROBLEMS IN NEW OFFICES

Hal Levin

University of California, Berkeley

The purpose of this paper is to describe the environmental conditions in newly-constructed or -remodeled offices and to suggest remedial measures to reduce the discomfort and health problems typically experienced by many office workers. Although many of these problems can be avoided if they are addressed during design or construction, often they are not. This brief paper can assist building operators, office managers and workers confronted by office environmental problems to address them when they arise.

The discomfort, irritation and health problems experienced by office workers after moving into a new building include headaches, nausea, dizziness, lethargy, itchiness or reddening of the eyes and skin, throat irritation, and general "flu-like" symptoms. (Note: New building or new office as used in this paper also refers to newly remodelled or refurnished offices.) These complaints are typically dubbed "building sickness", a well-documented syndrome associated with the occupancy of newly-constructed or -remodelled buildings. They are particularly common in sealed, mechanically-ventilated buildings. They tend to diminish in a matter of months for most occupants, although a small percentage of individuals with allergies or with sensitivities to certain chemicals may continue to have difficulty for a much longer time.

The air quality inside newly-constructed offices suffers from the presence of chemicals (from building materials, carpet and carpet adhesives, and paints) detectable by their strong odor and from dust particles (from construction in adjacent spaces). These chemicals have been detected in the air of many new and remodelled buildings and in laboratory tests of building materials and furnishings. Over 800 chemicals have been identified so far. They include skin and mucous membrane irritants; respiratory, nervous and digestive system toxins; and many known or suspected human carcinogens.

Most of the environmental problems experienced by office workers can be expected to decrease in time without remedial measures. However, in some cases the substantial negative impacts on the productivity, welfare and health of the workers and their employer organizations require that the process be accelerated. It is possible to accelerate the improvements by significantly reducing the levels of airborne contaminants through modified operation of the HVAC (Heating, Ventilating and Air Conditioning) system.

It is not uncommon to find poorly adjusted ventilation systems in new buildings. Among the resulting problems are insufficient volumes of air, poor distribution of the air supply within the space, both horizontally and vertically, and insufficient amounts of outside air to dilute the concentrations of toxic and irritating substances in the air. Adjustment of the mechanical system and changes in operating protocols can relieve most or all of the symptoms experienced by office workers.

Each of the measures described below will improve indoor air quality and may be employed separately. The use of all of them will provide the maximum relief available in the shortest possible time. They are not necessarily listed in order of importance or feasibility.

1. Air temperature: Cooler air temperatures will reduce the rate of chemical emissions from the materials and will improve the mixing of the supplied air within the occupied space. Supply air temperature is controlled by the thermostats located in the office space (one per zone).

RECOMMENDATION: Maintain thermostat temperatures as cool as possible. Employees should bring sweaters, coats or other clothing to maintain thermal comfort while utilizing the coolest acceptable supply air temperature. The exact temperature which will be tolerated by occupants will vary depending upon individual preference, activity level, health status, location within the building, presence of smoking, outside air humidity and other weather factors. It could be under or close to 70 degrees most of the time.

2. Composition of supply air: Operation of the HVAC system with maximum outside air volumes and no recirculation of return air will limit many airborne pollutant concentrations to approximately one-half the levels under normal operation with 20% outside air and recirculation of return air.

RECOMMENDATION: Request that the building engineer operate the supply fans in the All Outside Air mode (no recirculation). This should be done at least during occupancy hours and preferably whenever the system is operating. This protocol should be continued until the indoor air quality becomes acceptable.

3. HVAC hours of operation: Longer hours of operation of HVAC system operation will further reduce airborne pollutant concentrations and accelerate the removal of volatile chemicals from building materials and furnishings. Lower airborne chemical concentrations result in increased emission rates and reduce their retention indoors through the absorption or adsorption of pollutants by materials.

RECOMMENDATION: Request that the building engineer operate the HVAC system serving offices on a 24-hour, 7-days-per-week basis until indoor air quality becomes acceptable.

4. "Bake-off" procedures: Heating building air while exhausting return air during unoccupied hours will further accelerate the improvement in indoor air quality. This has the effect of "baking off" the chemicals from building materials. It can be done for an entire weekend if the building is unoccupied during that time. However, cooling with full ventilation should occur for at least two hours prior to re-occupancy in order to remove the excess airborne chemical concentration resulting from the "bake-off".

RECOMMENDATION: During a weekend, especially three-day (holiday) weekends, set thermostats at 78 - 85 degrees. Maintain minimum

ventilation during the first 12 hours while heating to raise temperatures, then slowly elevate ventilation rate while maintaining higher temperatures. Increase ventilation to maximum levels 12 hours prior to re-occupancy. Decrease heat, as required, in advance of re-occupancy so that workers experience air temperatures below 72 degrees when they return.

5. Subjective evaluation of air quality: Air quality improves with time as materials age and emit the majority of their noxious fumes. Tests conducted by me and others (but not yet published) indicate that six to twelve weeks aging and exposure to the environment will result in the emission of 95% of the volatile organic chemicals from many building materials. Some means of assessing air quality in order to curtail use of the special protocols recommended in items 1 - 4 above is required. This can be done by monitoring involving the collection and analysis of air samples or by the use of subjective evaluation by panels of occupants. Due to the very high cost of monitoring and the well-established nature of the indoor air pollution problem in newly-remodelled buildings, subjective evaluation is desirable.

RECOMMENDATION: Select at least two individuals from each ventilation zone to comprise an "air quality panel". Ask each panel member to fill out an air quality evaluation form (see attachment) each time he/she enters or leaves the building. This data can form the basis for monitoring reduced use of the HVAC system special protocols described in items #1 - 4 above. Qualified persons should process, analyze and interpret the data collected by this process.

6. Shading for sun control: The sunlight entering through unshaded south- and west-facing windows directly heats the materials it strikes. Thus, while air temperature may be acceptable, heating of carpet increases carpet and carpet adhesive emissions as well as those from other materials.

RECOMMENDATIONS: Blinds, curtains or other devices should be installed immediately to reduce the direct heating of building materials and furnishings by sunlight.

7. Weekend and holiday occupancy: Occupancy of offices during evenings, weekends and holidays is not uncommon among some workers. HVAC systems are not normally run in office buildings during the weekend. The HVAC system is usually controlled by time clocks and can be preset to operate at any time.

RECOMMENDATION: An agreement should be developed with building management so that any employee who works in the building may initiate a special protocol during any evening, weekend or holiday by calling a designated building management phone number. A reasonable charge for the extra hours should be part of the lease or rental agreement.

8. Individual occupant actions: Individual physiology, biochemical balance and response to inhaled chemicals varies significantly among people. Allergic and chemically sensitive individuals clearly respond more strongly to indoor air pollutants. The healthiest individual can become chemically sensitized or suffer immune system changes as a result

of exposures to chemicals found in building air. Serious long-term health impairment can result from exposure to high concentrations of some indoor air pollutants.

RECOMMENDATION: Management and supervisory personnel should encourage individuals who strongly feel the effects of occupancy of their offices to take frequent "fresh air" breaks during the work day. Some of these individuals might be able to do some of their work at home or at another location such as a public or university library. Until the air quality improves, health problems should be considered carefully and receive immediate and proper medical evaluation and treatment. While office workers should be informed that their symptoms are "normal" responses to indoor air pollution, they should not be led to believe that the problems are trivial.

9. Construction dust: Construction results in the creation of airborne dust and increased airborne levels of many construction solvents. Installation of carpeting and furnishings also results in elevated levels of solvents and other volatile chemicals including many very toxic substances. Non recirculation of return air will reduce the chemical and dust burden significantly.

RECOMMENDATION: Request building management to instruct its employees or those of its contractors to install vapor and dust barriers between work areas and the hallways. Moisture can be used on some materials to minimize airborne dust. Return air registers within the construction zones should be sealed to prevent contamination of the HVAC system. Temporary exhaust systems capable of removing air from construction zones should be employed during construction. These can be installed in window openings or ducted to the outside through stairwells, skylights, exit doors or other paths to the outside. Care should be taken that exhaust air is not re-entrained in supply air and delivered back into the building.

10. Environmental monitoring: Air quality monitoring can determine the levels of airborne chemicals with reasonable reliability. The cost of such monitoring is substantial. The results are fairly predictable in most new offices. Thorough ventilation system evaluation is also valuable in assessing indoor pollution problems. While not as costly as air quality monitoring, it is time-consuming and requires substantial cooperation of building management.

RECOMMENDATION: Unless legal or insurance requirements dictate that they be used sooner, employ air quality monitoring or ventilation system evaluation only after attempting to control the problems by the means outlined above. If the above measures do not provide satisfactory relief, then ventilation system evaluation and environmental monitoring should be conducted.

11. Environmental lighting: Questions are frequently raised regarding fluorescent lighting and the possible connection to health problems. Individual reactions to fluorescent lighting vary considerably. Problems can involve a) incorrect lighting levels, b) ultraviolet radiation, c) flicker, and d) release of PCBs.



a) Proper illumination is a critical part of a comfortable and stress-free environments. Too little or too much light can cause eye strain, headaches, discomfort and stress. The typical, generalized office lighting scheme of evenly-spaced, overhead fixtures is sometimes adequate but often is not. Overhead lighting in data or word processing and other VDT-based work station areas should be eliminated to reduce glare which results in eye strain and possible secondary effects related to posture, headaches, and fatigue.

Individual workers' requirements and preference will vary with the type of work performed, vision, and preference. Individuals should be given as much control as possible over the illumination at their work station. A qualified lighting consultant should be retained to develop a lighting plan tailored to the type of work and equipment, general office environment, and individual preferences of each organization.

b) Fluorescent light fixtures which do not employ plastic lenses and which utilize certain newer, energy-efficient fluorescent lamps (tubes) may deliver substantially higher levels of ultraviolet radiation than older fixtures and lamps. Insufficient research has been done on the health effects of this radiation. Experimentally, levels have been measured which exceed the NIOSH\* recommended maximum exposure levels. Concerned employers can either replace the lamps or install plastic difusers.

c) The potential interaction between the flicker frequency of VDTs and that of overhead lighting can result in a secondary pulse known as the "beat effect". It is a recently discovered phenomenon which will vary according to the type of equipment and lighting used. The biological effects are not yet known.

d) Concern about possible PCB contamination from fluorescent light fixtures merits investigation in buildings constructed prior to 1978. Most fluorescent light fixtures installed prior to that time contain PCBs. PCB-containing transformer were not manufactured after that time. Older transformers usually do contain PCBs. They may leak as they age, and they occasionally explode. Research shows that it takes approximately three months for airborne concentrations to return to normal after such explosions. Newer transformers are clearly labelled to indicate that they do not contain PCBs.

**RECOMMENDATION:** Eliminate overhead fixtures in VDT-based work station areas and provide two adjustable desk lamps for each work station. Where possible, worker-controlled task lighting should be provided at each work station. Retain a qualified consultant to design suitable lighting for each situation. Replace older fluorescent fixture transformers which contain PCBs. Get qualified assistance in the event of a leak or explosion involving PCBs.

---

NIOSH (National Institute of Occupational Safety and Health) publishes recommended maximum exposure levels based on health data. The Ultraviolet (UV) exposure recommendation was intended for workers exposed to UV from sunlight.

DRAFT \_\_\_\_\_

-6-

12. Computer-based work stations. Electronic office equipment requires special furnishings designed for their use. Particular attention should be paid to user-adjustable furnishings and lighting. Individual comfort is essential to minimize posture stress. All workers should be encouraged to adjust the position, angle, height and brightness to match their own needs.

Attachment

**DRAFT**

AIR QUALITY EVALUATION FORM

NAME: \_\_\_\_\_ HVAC ZONE: \_\_\_\_\_

DAY OF WEEK/DATE: \_\_\_\_\_ / \_\_\_\_\_ TIME: \_\_\_\_\_

PLEASE RATE EACH OF THE CHARACTERISTICS OF THE AIR QUALITY BY CIRCLING THE APPROPRIATE INDICATOR BELOW:

	EXCELLENT	ABOVE AVERAGE	AVERAGE	BELOW AVERAGE	UNACCEPTABLE
TEMPERATURE:	1	2	3	4	5
HUMIDITY:	1	2	3	4	5
ODOR:	1	2	3	4	5
AIR MOVEMENT:	1	2	3	4	5

BEFORE LEAVING FOR LUNCH OR AT THE END OF THE DAY, RATE YOUR REACTIONS TO BEING IN THE OFFICE BY CIRCLING THE TERM WHICH BEST DESCRIBES YOUR SYMPTOMS, IF ANY.

	NONE	SLIGHT	MODERATE	ACUTE	EXTREME
HEADACHE, DIZZINESS	1	2	3	4	5
SKIN/EYE IRRITATION (ITCHING, REDNESS)	1	2	3	4	5
DIGESTIVE PROBLEMS (NAUSEA, ELIMINATION)	1	2	3	4	5
UPPER RESPIRATORY (CONGESTION, THROAT IRRITATION, COUGH)	1	2	3	4	5
LOWER RESPIRATORY (CHEST TIGHTNESS, BREATHING DIFFICULTY)	1	2	3	4	5
GENERAL FEELINGS OF TIREDNESS, LETHARGY, BAD MOOD	1	2	3	4	5

PLEASE NOTE ANY OTHER SYMPTOMS OR OBSERVATIONS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_