FBI

FEDERAL BUILDINGS INITIATIVE

HEALTH AND SAFETY GUIDELINES

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1

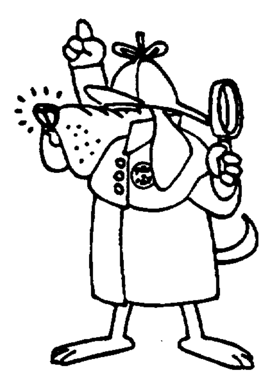
PURPOSE

The Federal Buildings Initiative (FBI) is a new Green Plan program delivered by Energy, Mines and Resources Canada. It provides federal property managers with the information they need to implement energy reduction programs, while relieving potential fears of building occupants. Experience has shown that complete energy management programs usually improve the indoor conditions. These improvements occur because the optimization of energy use first requires old building faults to be corrected.

In the past, energy reduction programs have often contributed to real and perceived difficulties in indoor air quality. Eagerness to achieve energy savings or incomplete building engineering have compromised working conditions in some buildings. The industry has learned the do's and don't's of good energy management from poorly conceived or executed energy conservation projects. And such projects have also made workers keenly aware of possible risks to the working environment from energy conservation.

These Guidelines are intended for use by federal facility managers, energy management firms, energy auditors, engineers and contractors undertaking energy management projects under FBI. The Guidelines' specific purposes are to provide direction for:

- the health and safety as well as the comfort and related productivity issues of an energy management project;
- appropriate actions to ensure that common energy management activities do not contravene relevant health and safety **regulations** for federal agencies;
- particular actions to optimize comfort and productivity for each common type of energy management activity;
- strategy to communicate with occupants about indoor air quality (IAQ) issues surrounding the energy management project in their building.



Although the document is entitled *Health and Safety Guidelines,* it encompasses the more prevalent issues of occupant comfort and productivity. In most federal indoor environments, concern for comfort and productivity is far more prevalent than health or safety matters. Occasionally comfort concerns reach extreme proportions and become health or safety issues. Therefore, this document addresses indoor air quality issues that affect comfort and productivity, long before they can become health and safety problems. Health and safety concerns should be referred to Health and Welfare Canada.

The term 'Indoor air quality', as used in this document, is meant to include the following factors as they affect federal workers inside buildings: temperature, humidity, indoor air velocity, airborne chemicals and particulate matter, radiation, sound level, light level and glare.

These Guidelines can help facility managers define suitable constraints for energy management activities to protect the working environment. Facility managers can also use the Guidelines to alert energy auditors, engineers, contractors, and energy management firms to issues they must address for the health, safety, comfort and productivity of federal workers.

These Guidelines only apply to federally owned buildings. Leased buildings must also comply with municipal or provincial codes and regulations not covered in this publication. It is intended to include them in later editions of these Guidelines.

This document is **not** a primer for facility managers on indoor air quality management. Nor does it define a procedure for dealing with air quality complaints. Other helpful publications on such matters are suggested.

2

INTRODUCTION

The Health and Safety Guidelines were prepared by Cowan Quality Buildings in Toronto, under the direction of the FBI Health and Safety Committee, chaired by the Treasury Board Secretariat. The Committee included representatives from Health and Welfare Canada, Public Works Canada Realty Branch, Public Works Canada Accommodation Branch, and Energy Mines and Resources Canada.

The Guidelines begin with a review of Target Space Conditions in Section 3. In Section 3.1, consideration is given to conditions **required** by Collective Agreements between employees and the Crown. Section 3.2 covers evolving industry practices aimed at achieving recommended conditions.

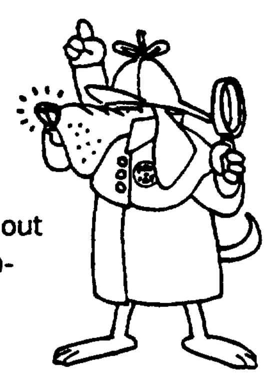
Section 4 outlines the general approaches for maintaining these target space conditions in an energy management program.

Section 5 covers the IAQ risks applicable to the most common energy management measures. Appropriate techniques for removing the IAQ hazards are presented with each measure.

Section 6 deals with common measures which normally have positive or neutral IAQ impact.

Section 7 presents the common IAQ risks arising while building changes are under way. Regulations and good practices for reducing the impact of construction are presented.

Section 8 outlines General Procedures, beyond the design of individual measures, to minimize the chances of IAQ problems at a later date. Good IAQ management requires thorough procedures and the cooperation of both occupants and all parties involved in modifying the building.



Section 9 outlines the roles and responsibilities of all parties involved in an energy management project.

Section 10 suggests ways of communicating with occupants about the IAQ aspects of energy management programs, in order to maintain their involvement and cooperation.

These Guidelines are written for the non-technical reader with a minimum of technical terms. Section 11 contains a Glossary defining the necessary technical terms.

Section 12 lists useful IAQ-related documents and regulations, along with directions on how to get a copy of each.

FBI 3

TARGET SPACE CONDITIONS

Any energy management program in a federally-owned building must be constrained by the needs of the occupants, which are outlined below. They are separated into **regulations** that are mandatory (Section 3.1) and **good practices** that should be implemented where reasonably practicable (Section 3.2). Useful reading materials on the evolving science of IAQ management are listed in Section 3.3.

3.1 REGULATIONS AND STANDARDS

The requirements to be met in federal buildings are prescribed in Part II of the *Canada Labour Code* and *Canada Occupational Safety and Health Regulations*[1]. Federally-owned buildings are excluded from any other municipal or provincial legislation on indoor conditions, except those stipulated in the National Building Code.

The *National Building Code of Canada*[2] is silent on IAQ matters, referring to the "good practice" described by:

- the handbooks and standards of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE),
- the digest of the Heating Refrigerating and Air Conditioning Institute (HRAI),
- the manuals of the Hydronics Institute,
- the manuals of the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), and
- the Industrial Ventilation Manual of the American Conference of Governmental Industrial Hygienists (ACGIH).

Major renovations of the HVAC systems in a building should meet the requirements outlined in the most recent version of these documents.

The requirements of *Occupational Safety and Health*, (Volume #12) of the *Treasury Board Manual*[3] **must be respected.** They are referenced in the Collective Agreements between the Public Service unions and the Federal

Government represented by the Treasury Board of Canada. These requirements must, as a *minimum*, meet the requirements of Part II of the Canada Labour Code and COSH Regulations. Good practices described in Section 3.2 of this document should be implemented where reasonably practicable.

The Treasury Board Manual declares a policy objective "To promote a safe and healthy workplace for Public Service employees." All IAQ relevant requirements of Volume 12 are summarized below. For full details of the requirements, the current version of the referenced chapters should be examined.

In order to meet the minimum requirements of the Canada Labour Code and Regulations, the corresponding regulations should be consulted.

Chapter 2-17 Use and Occupancy of Buildings Directive - 17.3 Environmental Conditions

Section 17.3.1 requires that in office buildings, indoor conditions conform to ASHRAE Standards 55-1981[4] and 62-1981[5], "to the extent practicable."

ASHRAE Standard 55-1981 contains complex definitions of the comfort range for 80% of the occupants of a space, based on temperature, humidity, surface temperatures, air velocity, activity level and clothing level.

Sections 17.3.2 and 17.3.3 have simplified these complex requirements to the more measurable temperature and humidity for office accommodation. These Sections define the comfort range as 20°C - 26°C **during "working hours"**. The temperature is measured at desk top level at the locations where employees perform most of their normal duties. Beyond the comfortable range is the 'uncomfortable range', reaching to 17°C and 29°C. Short term accidental extensions into the uncomfortable range are allowed, but cannot be planned except for weather extremes. These variances cannot exceed three hours per day or 120 hours per year.

In the uncomfortable range, corrective action **may** be required of the employer. Such action could include increased frequency of rest periods, and temporary relocation of employees. Beyond the 17°C and 29°C limits, and for a Humidex of 40 or greater[a], employees must be relocated or released from work, as these uncomfortable conditions have a clear productivity impact. **No energy management activity should be contemplated which allows temperatures in office spaces during working hours to go beyond the 20°C - 26°C range.**

ASHRAE Standard 55-1981 stipulates a number of other comfort parameters which can be individually measured. (Refer to the standard for definition of measurement methods.)

- air velocities should remain below 0.15 m/s in winter and 0.25 m/s in summer.
- the maximum temperature stratification in the space is allowed to be 3°C, between the 0.1m and 1.7m levels above the floor.

a A Humidex chart in the appendix to Chapter 2-17 defines a Humidex of 40 or greater as:
- 95% Relative Humidity or higher, at 27°C
- 85% Relative Humidity or higher, at 28°C
- 75% Relative Humidity or higher, at 29°C

- minimum floor temperature is set at 18°C.
- radiant temperature differences from floor to ceiling shall not exceed 5°C; 10°C horizontally.
- the rate at which space temperatures may vary is specified. The maximum cycling rate is 2.2°C/hour, if the peak variation is more than 1.1°C. General temperature drift should be held to within 0.6°C/hour.

In non-office accommodation, ASHRAE Standard 55-1981 defines methods of correcting the comfort range for the clothing and activity levels of occupants.

ASHRAE Standard 62-1981 specifies that good quality outdoor air[a] be supplied to office space at a fixed rate of 2.5 l/s/person, if there is no smoking in the space. If there is any smoking within the area served by the intake air system, the intake rate increases in offices to 10 l/s/person[b]. Special air cleaning may allow the intake rate to be reduced, but never below 2.5 l/s/person. Night shutdown of outdoor air intake is permitted for spaces that are not occupied at night, as long as the start-up time respects the contaminant generation rate over night and the intake rate during fan operation[c].

Proof of compliance with this Standard begins with verification of outdoor air quality. Proximity of the intake dampers to pollution sources would pose the most likely difficulty. In communities of concern, Environment Canada may have data to help assess ambient outdoor air quality.

Proof of compliance also requires measurement of the outdoor air intake flow rate, to be performed with the intake damper in its minimum position and no direct wind blowing on the intake damper.

In variable volume systems, where air flow varies with space requirements, extreme care must be taken during the intake air flow test to ensure that intake plenum pressures created by supply and return fans are the highest normally achieved. This condition will often occur when variable volume control devices around the building are in their minimum flow positions. However, other conditions may also create this condition, depending on the control strategies governing damper and fan operations. The intake flow measurement in variable volume

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a ASHRAE Standard 62-1981 defines good outdoor air as air meeting acceptable levels of 34 different elements. Key elements are sulphur dioxide, particulates, carbonmonoxide, ozone, nitrogen dioxide, and lead. Refer to the ASHRAE Standard for details of levels. In downtown or industrial areas these levels may warrant careful scrutiny. Where outdoor air does not meet the requirements, air cleaning is required.

b The Standard offers an alternate compliance path known as the Air Quality Procedure. This procedure is more difficult to design and verify performance than the procedure described above. Therefore the Air Quality Procedure is rarely employed.
The Air Quality Procedure requires that indoor air meet acceptable levels of 34 different elements. Key elements are sulphur dioxide, particulates, carbon monoxide, ozone, nitrogen dioxide, and lead. Refer to the ASHRAE Standard for details of levels. The Standard also refers to the evolving nature of the science of acceptable levels. It references other documents for guidance if other materials are thought to be in the air. It encourages vigilance regarding "reduced ventilation." In addition, the Procedure requires that odour conditions be rated as acceptable by impartial observers.

c Refer to the Standard for a detailed set of requirements. For example: when contaminants are generated overnight in office space where day-time occupant density is 10 m^2/person, the pre-occupancy ventilation period must be 6 hours, at an equivalent 5 l/s/person rate, or 3 hours at 10 l/s/person. Where occupants are the only source of pollution, as in 'clean' office space without new fabrics or materials, fan start-up may lag behind occupancy if the previous day's contaminants are dissipated overnight.

systems requires careful planning if it is only to be performed once. Continuous flow measuring equipment, permanently installed in the air intake, is the best way to ensure intake air flow remains proper in variable volume systems.

Compliance also requires measurement of the flow at all supply air diffusers to verify uniform distribution of outdoor air to all work places. The maximum occupancy in each zone must also be known to allow verification of the amount of outdoor air per person.

All air flow measurements should be performed by trained air flow measurement specialists.

Chapter 2-17 Use and Occupancy of Buildings Directive – 17.15 Illumination

Section 17.15 requires that light levels meet the *Canada Occupational Safety and Health Regulations Part VI*[6]. The light levels are determined by taking the average of four readings at different locations representative of the lighting at the task position. The lowest of the four readings shall not be less than one third of the average at most task positions and one tenth for parking, lobbies, atria and VDT work areas.

Levels required at common locations are summarized below. They are normally minimum levels except as noted and are stated in lux. Refer to the Regulations for the full list of areas.

Reflections on VDT screens must be reduced so that employees can read text on every part of the screen. Emergency lighting must maintain an average of 10 lux in exits, corridors, principal routes to exits on open floors and areas where employees normally congregate. For buildings whose construction began after October 31st 1990, the minimum emergency lighting level at any point must be 0.25 lux.

■ ***Offices:***	***Lux***
Drafting and very difficult visual tasks	1,000
General office	500
Conference, reception, switchboard, storage	300
Corridors and stairs used frequently	100
Corridors and stairs used infrequently	50
Emergency stairs	30
■ ***Laboratories:***	
Instrument reading hazardous to health and safety	750
Handling hazardous substances	500
Lab work requiring close prolonged attention	500
Other lab work	300
■ ***VDT Work:***	
Exclusively data entry or retrieval	750 max
Intermittent data entry or retrieval	500 max
Document reading - minimum level on the document	500

- *Other Indoor Areas:*

Loading docks	150
Frequent checking/sorting of packages	250
Infrequent checking/sorting of packages	75
Hazardous substance processed or manufactured	500
Elevators used frequently	100
Elevators used infrequently	50
Pedestrian service corridors & aisles used frequently	50
Pedestrian service corridors & aisles used infrequently	30
Pedestrian & equipment service corridors & aisles	50
Pedestrian & equipment service corridors & aisles-main intersections	100
First aid rooms (non-treatment)	500
Food preparation areas	500
Boiler rooms	200
Mechanical rooms	50
Covered parking	50
Lobbies and atria	100

- *Building Exterior:*

Entrances and exits used frequently	100
Entrances and exits used infrequently	50
Pedestrian walkways	10
Pedestrian walkways at vehicular intersections	30
Open parking	10

Chapter 5-1 Safety Guide for Laboratory Operations

Various special design considerations for laboratory facilities are listed. Key ones are summarized below. Individual custodian departments may have their own additional requirements which must be considered.

Section 2.2.8.4: The average fume hood face velocity is 0.4 - 0.5 m/s., which is usually measured with a typical operating sash opening of 30 cm. Test procedures are specified.

Section 2.3.15: Requires the application of labels on equipment carrying hazardous substances through mechanical spaces.

Section 2.3.16: Isolation techniques for biological laboratories are provided. The key requirement is to maintain proper space pressurization and control of recirculation to avoid spread of biological matter. Requirements are also sited for avoiding air leakage through light fixtures, around pipes, ducts and conduits. Paints and finishes must be resistant to washdown or steam decontamination. Face velocity of partial barrier hoods must be at least 0.5 m/s.

Section 2.3.17: Animal facilities should have exhaust air intake near floor level.

It should be noted that ventilation is required for storage spaces for: cryogenics (Section 3.1.3.2.); compressed gases (3.2.5.4.); flammable storage (3.5.2.); and toxic hazards (3.5.6.). Special laboratory equipment also requires special ventilation for: chromatography (3.4.5.); fraction collectors (3.4.7.); ovens (3.4.10.); mercury diffusion pumps (3.4.12.); and environmental chambers (3.6.2.7.).

The Regulations noted above stipulate constraints to deal with extreme conditions. Comfort and productivity have already deteriorated substantially by the time any of these limits are reached. Therefore, other accepted good practices should be followed to make the space as comfortable as practical. These practices are discussed in Section 3.2, below.

3.2 GOOD PRACTICES

Optimizing space comfort goes beyond the simple constraints defined in the regulations outlined in Section 3.1. The science of ensuring space comfort is not yet well developed, but some key design criteria for good IAQ maintenance are listed here. These good practices should be followed where reasonably practicable. Reference documents are listed for details.

Outdoor Air Intake

ASHRAE Standard 62-1981, referenced in the *Treasury Board Manual*, Chapter 2-17, has been superseded by Standard 62-1989 which contains a more stringent intake requirement for 10 l/s/person, regardless of occupant smoking or air cleaning. The newer standard also requires the supply of this outdoor air to the occupant level to be within six feet of floor level.

Provision for further increases in outdoor air intake rates is appropriate during times of high internal contaminant generation. The need for extra ventilation can be caused by space renovations or spills. It is unlikely an energy management program can enhance system capabilities in this regard. However, no steps should be taken which would unduly impede existing capabilities to temporarily increase outdoor air rates. For example, if outdoor air intake rates can be reduced while still meeting standards, the size of the intake openings should be modified with sheet metal rather than bricks.

Minimum Air Circulation

IAQ specialists have found that odours persist and air cleaning is poor if space air supply rates drop below about 3.5 $l/s/m^2$. The only public reference on this matter sets a lower level of 3 $l/s/m^2$. The source is the *Design Guidelines for Energy Conservation in Ontario Government Buildings*[7].

Minimum Humidity

Comfort and health are improved by maintaining a humidity level above 25%[a], but not all buildings can withstand this level without forming condensation on cold surfaces. This should be avoided as it can cause structural damage in unseen locations and promote the growth of microorganisms. Microbial contamination can cause a rapid deterioration of indoor air quality. Therefore the maintenance of acceptable minimum winter humidity levels must be tempered by the structural capabilities of each building. It may be possible to maintain higher levels of indoor humidity as the outdoor temperature rises.

Temperature Range

The *Treasury Board Manual* defines an acceptable temperature range from 20°C - 26°C, although the ASHRAE Comfort Standard (55-1981) suggests a maximum range of 4°C in any season. (See Section 3.1) The wider Treasury Board range reflects the high end of the summer clothing comfort zone and the low end of the winter clothing comfort zone.

Therefore, it is recommended that in any one day, the temperature range not exceed 4°C, as occupants cannot change clothing midday.

Temperature Stratification

Complaints about cold floors become frequent if temperature variations between the floor and the 1.1 m level exceed 1.0°C. This recommendation is in addition to the requirements of ASHRAE Standard 55-1981 mentioned in Section 3.1, above.

Lighting

Beyond the Canada Occupational Safety and Health Regulations Part VI summarized in Section 3.1, above, light levels for other areas are contained in the *Illumination Engineering Society of North America Handbook, Reference Volume*[8]. This document also contains recommendations on other lighting factors such as illuminance, reflectance, luminance ratios, colour rendition and glare management. These should be considered to ensure that any lighting redesign maintains a visually comfortable space. A loss of visual comfort can lead to complaints about the indoor environment.

The visual comfort of a space is affected by fixture design and layout. Manufacturers publish Visual Comfort Probability (VCP) data on their fixtures as a measure of discomfort glare. This data reports the percentage of occupants who will find the direct fixture glare acceptable. Target VCP should be 70, 80 in VDT areas. (With indirect lighting and parabolic cell lenses, VCP cannot be used.)

In addition to the regulations outlined in Section 3.1, it is recommended that light level at any point in a work area not fall below 80% of the average light level of the area.

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a Refer to ASHRAE Standard 55-1981

Another important comfort matter to consider when altering light levels is to keep the light level in task areas no more than 3 times that of the surrounding space.

Good summaries of lighting design parameters to maintain good visual comfort are contained in *CSA Standard Z412-M89 Office Ergonomics*[9] and *Office Lighting* by Public Works Canada[10].

Sound

Background sound levels should meet noise criteria as listed in the *CSA Standard Z412-M89 Office Ergonomics*[9]. The design goals (in Decibels) in Room Criteria units are:

Executive offices and conference rooms	25-30
Private offices	30-35
Open plan offices	35-40
Computer/business machines and public circulation	40-45

For other types of space the *ASHRAE 1991 HVAC Applications Handbook*[11] lists Room Criteria (in Decibels) such as:

Hospital wards	30-35
School lecture and class rooms	25-30
Apartments	30-35

Domestic Hot Water Temperature

Most drinking water supplies contain a variety of microorganisms in small quantities. When they have a chance to multiply and enter the human body in large quantities via the lungs, they can be hazardous to human health. These microorganisms can enter the lungs by inhaling the vapour from showers, spray nozzles, or tap aerators. They multiply rapidly between 30-50°C, and are killed off at or above 60°C.

The length of time that water is in the 30-50°C range should therefore be kept to a minimum. The *ASHRAE Applications Handbook, 1991*,[12] provides background and references on this topic.

Design Documentation

In order to avoid the overloading of a particular space, it is important that any new design criteria for the HVAC systems be clearly documented. This documentation should be readily available to the health and safety committees of the occupant department(s). It should include the design occupant density and types of activity allowed for, as well as the assumed occupancy period. ASHRAE Standard 62-1989 recommends such documentation.

Operations and Maintenance Procedures

Equipment must remain in proper working order and be operated in a way that will not compromise indoor air quality. Any new operating and maintenance procedures required by the energy management program should be clearly written down. The procedures must be in a form that is easily understood by operations staff, and maintenance staff or contractors. Staff should be trained in these new procedures.

Procedures should define operating principles, set points, operating schedules, inspection points, inspection frequencies, expected range for each inspection point, periodic performance testing procedures, troubleshooting suggestions for typical problems and maintenance schedules including control re-calibration.

Documentation and training may already be in place for building operations and maintenance. The energy management program documentation and training can be fitted into this overall building program. If documentation or good staff training is not available before the program begins, the program should include training and documentation beyond the particular measures being implemented. This extra effort should aim to ensure that there is sufficient understanding of the impact of new procedures on existing, undocumented procedures.

3.3 OTHER READING

Other documents with current information on the evolving science of indoor air quality are:

Making Your Workplace Work: A Tenant's Guide To PWC Buildings, prepared by Public Works Canada, Accommodation Branch, May 1990.

Managing Indoor Air Quality, a document for property managers and operators prepared by Public Works Canada and the National Research Council. Available through the National Research Council of Canada, Publication Sales, Montreal Road, Building M-20, Ottawa, K1A 0R6. Prepayment required – call Edgar L'Ecuyer (613) 993-2463.

Controlling Indoor Air Quality, Ventilation Engineering Guide, a document for plant engineering and maintenance engineers prepared by Public Works Canada and the National Research Council. Available through the National Research Council of Canada, Publication Sales, Montreal Road, Building M-20, Ottawa, K1A 0R6. Prepayment required - call Edgar L'Ecuyer (613) 993-2463.

Strategy For Studying Air Quality In Office Buildings, prepared for building owners and operators by IRSST Laboratory Division, 1989. Available from IRSST, 505 de Maisonneuve Blvd. West, Montreal, H3A 3C2. Phone (514) 288-1551.

Building Air Quality, A Guide for Building Owners and Facility Managers, prepared by the US Environmental Protection Agency and others, December 1991. Available from the US Government Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington, DC, USA 20402-9328. Reference ISBN 0-16-035919-8.

4

GENERAL TECHNIQUES FOR MAINTAINING SPACE CONDITIONS

The general techniques for maintaining indoor air quality through an energy management program are summarized below:

Adequate Air Circulation Rate

To flush the space of undesirable odours and filter the air of dirt, air should be circulated at the minimum rates given in Section 3.2.

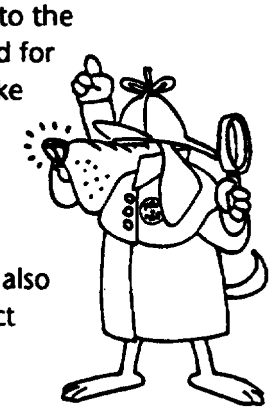
This circulation must continue throughout the occupancy period. Any curtailment of circulation during the occupied period infringes upon ASHRAE Standard 62-1981. It also creates two problems:

- air exchange and cleaning stops, allowing odours to build up, particularly in areas with marginal circulation.
- occupants will usually notice the stopping and starting of air flow, and may prompt them to complain of about lack of air movement.

Good Air Distribution Patterns

To ensure air is properly distributed throughout the occupied space, diffuser design must be consistent with the location of occupant installed walls, partitions and furniture. The size, type and location of diffusers should be reviewed.

The key parameter is to maintain direct delivery of outdoor air to the breathing zone. Any outdoor air bypassing the people it is intended for is of no value in meeting the ASHRAE Standard, as outdoor air intake must be increased to compensate for any such short-circuiting.



Any change to the volume of air supplied through the ducts may also require redesign of the diffusers to ensure proper diffusion of air in the space.

A change from the original design supply air temperature may also require a diffuser redesign. Changes in supply air temperature affect the natural buoyancy of the air and the ease with which it circulates throughout the space.

Proper Outdoor Air Intake

The amount of outdoor air drawn into the building must always meet the minimum design level, as outlined in Section 3.1, or as suggested in Section 3.2. The intake level must consider the number of persons in the space and the amount of supply air which short-circuits directly to return air openings.

Many modern buildings have a fixed outdoor air intake capacity which matches the standards at the time of design. As these standards have changed significantly in the last 20 years, some buildings may have intake rates much lower than the latest standards. In some situations it may be possible to increase the outdoor air intake rate, increasing the fresh air flushing rate while possibly allowing better energy performance.

Where the building is designed to use large amounts of outdoor air for cooling, the minimum design level is almost always exceeded. The minimum intake quantity is reached only when outdoor air would either overcool or overheat the building, usually in extreme winter and most summer conditions. For these types of buildings, the minimum intake volume must be regularly checked. It is controlled by dampers and control equipment which can drift out of calibration.

Rebalance Air Supplies

The cooling supply capacity in a space must be adjusted after any change in cooling load. The most common major cooling load in commercial space is the lighting, followed by office equipment. Solar and body heat are usually of less concern.

Any reduction in lighting electrical load requires a redesign of the air supply volume to each space. Existing air supplies are often out of date with current occupancy, or have changed from design. A lighting power change must therefore include a complete recalculation of the air requirements of each space. The design location and performance of diffusers must be checked to verify that they provide proper room air circulation under the new cooling load. Outdoor air intake design and performance must also be checked to verify that minimum intake volumes still meet standards.

Maintain Air Pressure Separation

A special aspect of air balance is the maintenance of negative pressure in areas where pollutants are generated. By maintaining relatively negative pressure in a 'dirty' area such as a parking garage or laboratory, air is drawn into the zone rather expelled. When adjusting supply air volumes, return or exhaust air volumes must also be adjusted to maintain proper space pressurization.

Natural winter infiltration on lower floors and exfiltration on upper floors can complicate proper pressure separations in winter. Basement garage air is naturally driven upwards in a multiple floor building during cold months. Extra fan pressure must be added to overcome these forces.

Temperature Range

The space temperature and humidity must be maintained within the range shown in Section 3.1. People can tolerate a range of temperatures and humidities as they normally dress differently in warm and cold weather. With winter clothing and indoor temperatures near the top of the range, however, the number of complaints will be pronounced. The suggested reduced range in Section 3.2 should be respected for any single day.

In addition, each person's comfort range is different and as space temperatures approach either the upper or lower limit of the range, the number of complaints will increase. Action is only required from building management when the conditions exceed one of the limits, but it is good practice to maintain a cushion between the action limits and the normal operating range.

Light Levels

Task illumination levels should remain within the levels shown in Section 3.1. The ratio of task to adjacent ambient levels should also remain within the range shown in Section 3.2.

When planning an energy management program remember that light output deteriorates as lamps age. And as fixtures get dirty, their light delivery declines. Average light levels also drop as some lamps burn out until relamping is performed. A common cost effective means of avoiding these situations is to relamp and clean all fixtures on a group basis, rather than on a burnout basis.

Domestic Hot Water Temperature

Most domestic hot water systems deliver water at temperatures in the 30-50°C range, which corresponds to the rapid reproduction range for microorganisms. System retrofits should ensure that the water temperature in the tank is maintained at 60°C to kill off any bacteria growth. This requirement only applies to the tank and not the entire piping system.

5

SPECIFIC ENERGY MANAGEMENT IAQ RISKS AND PREVENTION TECHNIQUES

Well engineered energy management programs should have a positive impact on space conditions because mechanical system malfunctions must be removed, allowing energy efficiency levels to be achieved through fine tuning.

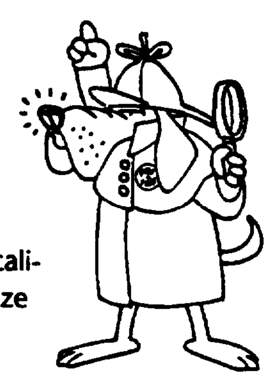
But some energy management retrofits can have a negative impact on indoor air quality. The following sections identify the key engineering elements which must be respected to avoid IAQ problems. Where there is a direct danger of not meeting specific **required** standards as listed in Section 3.1, the issues are **bolded**. Other techniques are suggested to help meet the suggested good practices listed in Section 3.2.

Section 6 lists some energy retrofit strategies which normally have neutral or positive IAQ impact.

5.1 SPACE TEMPERATURE ADJUSTMENTS

Space temperatures may be lowered in winter or raised in summer, but **must not go below 20°C, or above 26°C** as outlined in Section 3.1.

The standards permit unintentional space temperatures beyond these limits for brief three hour periods, to allow for normal equipment problems. However, space thermostats **must not be set at these limits** as normal thermostat operation allows temperatures to wander from the setpoint. Therefore revised thermostat settings **must be above 20°C and below 26°C.**



Property managers may want an even narrower range of thermostat settings to allow for:

- thermostat drift. This phenomenon arises because many controls and sensors lose accuracy over time and need recalibration. As a result some cushion is appropriate to minimize the frequency of complaints. Digital control equipment with thermistor type sensors are least prone to drift and require no cushion.

- human comfort has a wide range, as discussed in Section 4. The 20-26°C range should satisfy most people. However near the edges of this range, the clothing worn by occupants and the history of complaining may prompt more complaints than if temperatures remain mid-range.

The seasonal adjustment of setpoints should be done when most occupants have switched clothing seasonally, as they adjust to changing outdoor conditions.

Some energy management programs may include conscious **temperature float**. This concept allows space temperatures to climb throughout the day. This technique presses both the lower and the upper ends of the acceptable range, whereas a single setpoint only involves one limit. It **may also endanger the recommended maximum temperature drift of 0.6°C/hour**. It is recommended that any planned daily range be within the limits suggested in Section 3.2.

5.1.1 Setback and Setup

Energy management programs which allow space temperatures to drop, or climb, at night can reduce the comfort of late night occupants. The needs of these occupants must be discussed with the particular employer.

The HVAC systems must have **enough capacity to restore space temperature** before "working hours" (Section 3.1). This capacity is most critical on Monday mornings when the building and contents have had an extended time to stabilize at setback conditions. Some modern buildings with low heat losses and small heating plants have difficulty in recovering from setback conditions. In these buildings, setback is not practical in extreme outdoor conditions. The capacity to recover from setback should be carefully verified by engineering assessment of the HVAC system design. Cold Monday morning testing may also be necessary to prove warm-up capability in situations where design performance is not certain.

5.2 FAN OPERATING PERIOD CONTROL

The night shutoff of fans must **meet the outdoor air needs of late night occupants**, as outlined in Section 3.1 and agreed with the particular employer. This includes both the agreed "working hours" and engineering assessment of whether acceptable conditions are maintained by the natural outdoor air leakage into the space (under the Air Quality Procedure of ASHRAE Standard 62-1981). Overnight testing in warm weather may be required if fans are to be shut off while some occupants are still present.

The extent of solvent use for building cleaning must be considered when assessing the ventilation needs of late night occupants. During the period of solvent use, fan operation may be required to maintain adequate air quality for persons in small rooms.

The time for restarting the fans in the morning must **ensure that space conditions are adequate at the beginning of the agreed "working hours".** The length of the pre-occupancy fan operation is outlined in ASHRAE Standard 62-1981, and summarized in Section 3.1, Page 6, footnote c. The key factors to consider in determining fan start time are:

- internal pollution generation overnight (from equipment or new furnishings)
- overnight infiltration of contaminated air (eg: from underground parking garage)
- length of fan operation after the preceding occupancy period
- the outdoor air intake rate during fan operation
- the occupant density (occupants per 100 m^2)

These factors must be evaluated for each fan system.

Temperature setback and setup procedures must not simply restore fan operation based on the 'optimized' start time needed to recover space temperature before occupancy. There should be a minimum fan operating period before occupancy to allow for the above factors. The choice between longer evening fan operation and earlier morning restart should be influenced by the number of occupants present outside of normal "working hours."

Some energy management programs reduce air circulation rates by turning fans off for a portion of each hour. **The hourly cycling of fans means that the building is operating under ASHRAE's Air Quality Procedure, rather than its Ventilation Rate Procedure (see Section 3.1.).** The hourly cycling of fans may endanger IAQ, since it is difficult to prove compliance with the Air Quality Procedure, especially for short periods. It also shortens fan belt and motor life and is not as energy efficient as the more desirable technique of slowing the fans down.

Any change to the operating periods of fans must ensure that **required laboratory ventilation is maintained** as noted in Section 3.1.

5.2.1 Occupancy Sensor Control of Fans

Occupancy sensors are only useful to turn on fan systems when the first occupant arrives if:

- there is adequate flushing of the space at the end of the preceding occupancy period,
- there is no pollutant generation in the space during the unoccupied period, and
- the **temperature control standards for the space are met during the occupancy period.** This requirement may mean that only interior spaces suffering no heat loss can rely on occupancy sensors for morning startup.

Such sensors may still be used to shut off fans at the end of the occupied period.

5.2.2 Exhaust Fan Operation

The night shutdown of exhaust fans is acceptable unless special exhaust fans are required to control pollutant sources. An example is a fan for a laboratory fume hood or cabinet exhaust.

Where exhaust fans are used to maintain potentially polluted areas under negative pressure, they should not be shut down at night until the pollutant source is removed. An example is a parking garage, where multiple carbon monoxide sensors can be used to shut exhaust fans off after car exhaust is removed. Such sensors need careful routine maintenance and calibration.

For an exhaust fan that is shut down at night, there must be a backdraft damper near the discharge, if it is near potential pollutant sources. Examples of pollutant sources are chimneys, plumbing vents and garage exhausts.

5.3 VAV RETROFITS

Variable air volume (VAV) retrofits use a space thermostat signal to control the amount of air supplied to a space. As thermostats only sense temperature, not air quality, VAV retrofits **may endanger requirements of the ASHRAE Standard 62.** VAV retrofits pose two primary risks to IAQ:

- The throttling of air circulation in the space may reduce the effectiveness of the diffusion system to deliver outdoor air to the occupant level. Reductions in total air flow **may reduce the amount of outdoor air supplied to the space below the level required** in Section 3.1.
- The throttling of the supply fan may reduce the amount of outdoor air brought through the intake dampers.

The first risk can be avoided through:

- maintaining a minimum total flow to each zone to ensure:
  - adequate total circulation of air, see Section 3.2., and
  - adequate outdoor air quantities are still delivered, though total flow is reduced.

  The use of VAV boxes containing small fans is a good way to ensure that space air circulation is always above the recommended minimum. However, they do nothing to ensure that enough outdoor air is delivered to each zone. Supply air connections to fan-powered VAV boxes must still include suitable minimum flow settings.
- reviewing diffuser design to ensure ventilation effectiveness is maintained as flow rates drop. It is also important to ensure that the diffusers distribute air around the space properly at the minimum air flow rate , rather than 'dumping' air straight down. 'Dumping' can cause cold draft problems for persons sitting under diffusers. For this reason, diffusers that supply air at constant velocity are preferred for VAV applications.

The second risk is best avoided by adding equipment to continuously measure intake air flow. With reduced total air flow, the strict maintenance of proper outdoor air intake volumes may also require heating the mixture of intake and return air.

VAV retrofits also endanger:

- good space cleansing because circulation rates are low. This risk is minimized by maintaining the minimum air circulation rate outlined in Section 3.2.
- space sound levels because the throttling of air flow creates noise. This problem can be avoided by the proper use of sound absorbing equipment.
- building pressurization control. The dynamic variation of supply and return fan flows may lead to fluctuations in building pressure. These fluctuations arise because pressure measurement locations and control points cannot easily be found that are appropriate for all simultaneous conditions of wind and internal air flow variation. Building pressure control difficulties can induce problems such as underground parking garage air leaking into a building, or difficult entrance and elevator door operation.

  These difficulties can be managed by adding equipment to continuously measure intake air, to provide the required pressurization air, as in constant volume systems. (This control method is also mentioned above for ensuring proper outdoor air intake for the occupants.)
- the ability to **restore space temperature in the morning.** This problem will arise when the building is heated solely by coils in the ducts. When perimeter zone thermostats call for heat from these coils, they normally also restrict the supply of cool air to a minimum, to reduce simultaneous heating and cooling. With restricted air flow, heating capacity is restricted, impairing the building's ability to warm itself up on cold mornings.

  As a result occupants may find cold space after a cold night, and setback strategies may have to be abandoned. This can be avoided if a special warm-up control sequence is included to fully open the zone dampers so they deliver warm-up heat.
- microbial growth on bag type filters. Filters that are inflated by the air flow may no longer be fully inflated when the fan flow is reduced. As a result the filters sag, allowing the row of filters closest to the floor to make contact with condensation from an adjacent cooling coil. The filter fabric can become soaked and form a home for bacterial or fungal growth. This problem only arises where filters droop into the condensate pan. Minor filter modifications can usually solve this problem.

5.4 MISCELLANEOUS AIR SYSTEM RISKS

5.4.1 Air Handler Heat Recovery

The addition of heat recovery to an air handler poses a few possible IAQ risks, depending on the form of heat recovery employed.

All heat recovery coils restrict air flow, **possibly endangering temperature control and outdoor air supply**. The restriction can be overcome by increasing fan power.

'Heat wheel' type recovery devices risk transferring some pollutants in the exhaust air stream to the intake air stream. Proper design and installation of the wheel can reduce this risk. Where even minor cross contamination from exhaust to supply is unacceptable, either the 'glycol run around loop' or the 'heat pipe' style of heat recovery equipment should be used.

The supply and exhaust louvres on the outside of the building are usually close together when a 'heat wheel' or 'heat pipe' is used. To avoid re-entrainment of exhaust air into the intake, the two louvres should be separated and directed away from each other as much as possible.

The warm exhaust side of the heat recovery system has the potential of forming condensation as it is cooled by the intake air side. This condensation must be drained away properly to avoid soaking duct or ceiling materials. In the coldest conditions this condensation may freeze, blocking exhaust flow. Controls must be able to detect and automatically defrost the systems so air flow is not disrupted.

5.4.2 Recirculation

The recirculation of exhaust air is an acceptable energy management technique as long as:

- the exhaust air is clean, or there is adequate filtering of the air stream. The nature of the filtration depends on the gases, microorganisms, or particulates recirculated from the exhaust air.
- the exhaust is recirculated back to the general area from which it came. Recirculation to different zones will spread any regular or spill-related odours from one part of the building to another.

Additional filtration will increase airflow resistance, requiring adjustment of fan performance.

5.4.3 Fan Capacity Change

When adjusting the speed of any supply fan, **the associated return or exhaust fan must also be adjusted to maintain proper pressure balance within the space.** This requirement is particularly important for air systems serving laboratory spaces or similar spaces where pressure differentials are used to isolate zones.

No supply or return fan adjustments should be made without checking the air distribution through the ducts. This distribution check must include a random measurement of the flow through at least 20% of the outlets.

When adjusting fan performance, the total air circulation rate should be kept above the level suggested in Section 3.2.

The diffuser system design should be reviewed to be sure any new air flow rate will provide effective ventilation. This review should include the location, number, size and type of diffusers.

The following air handling unit elements may also need adjustment to ensure their proper operation after changing fan capacity:

- outdoor air intake volumes, **at minimum damper position**
- intake, exhaust and return dampers, **to ensure proper pressures are maintained at the intake plenum.** The dampers may need to be reduced in size if a significant reduction in air flow has been made.
- filter capacity, if the inflated bag style of filter is used. At reduced flows, the bags may not fully inflate. In this situation those at the bottom of the air handler may droop into condensation on the floor near the cooling coil. Soaked filter media become good breeding grounds for any microorganisms in the area. It would be logical to blank off the bottom row of filters.
- humidifier design. Though there may be the same need for humidity, a change in flow may cause humidifiers to be less effective in fully vaporizing water. As a result, there may be more soaking of air handler elements immediately downstream from the humidifiers. Soaked elements can lead to IAQ problems from mould and fungi growth. Humidifier capacity can be altered by changing the number or size of water outlets.

5.4.4 Supply Air Temperature Adjustment

To better match cooling supply to demand, many energy management measures automatically adjust the temperature of supply air. The key risk with this strategy is that the generally warmer supply air may not circulate in the space as well as the more dense cool air. This could result in lowering the ventilation effectiveness, delivering less of the outdoor air to the occupants. The diffuser size and type must be reviewed.

Supply air temperature adjustments may be combined with a shutoff of zone reheat coils. With such shutoff there is a loss of individual control for each zone. **Temperatures in some zones may not stay within the required range (Section 3.1)**. This loss of zone control can be avoided with intelligent control which monitors the cooling requirement in all zones before changing supply air temperature. This control would adjust the supply temperature to meet the needs of the warmest space and is best achieved with digital controls.

By raising the temperature of supply air, mechanical cooling equipment dehumidifies less. As a result, space humidity levels will be higher during humid outdoor conditions **endangering the Humidex standards** outlined in Section 3.1 This risk can be offset by subcooling the air to dehumidify it, and heating it back up to suit the space needs. This process requires little additional energy, as only few hours of reheat coil operation are normally required in most Canadian climates.

With higher supply air temperatures, the systems using outside air for cooling will bring in less outdoor air. Though the controls should still ensure intake volumes never go below the minimum setting, there will be a reduction in the year round average outdoor air intake rate.

5.4.5 Add Economizer

Mechanical cooling energy can be reduced through the addition of intake or 'economizer' dampers which use outdoor air for cooling in winter, spring, and fall. This will improve indoor air quality as the amount of outdoor air in the space increases substantially at most times of the year.

These 'economizer' additions must include **minimum intake air volume controls.**

It is also important that the **outdoor air quality meets the standards defined in ASHRAE Standard 62-89.** Though some outdoor air had been brought in before the addition of economizer dampers, the large increase may require a change to the unit's filtration.

5.4.6 Demand Controlled Ventilation

The amount of outdoor air intake is sometimes lowered when occupancy drops. This adjustment should **never allow intake rates to drop below those mentioned in Section 3.1.**, or ideally below rates outlined in Section 3.2.

Occupant counting and air flow measuring equipment should be used to verify that the correct amount of outdoor air is being supplied for the number of persons in the space at any point in time. **CO_2 based control is not recommended** for adjusting outdoor air intake because of the difficulty of proving compliance with the ASHRAE Standard for outdoor air intake[a].

PRACTICAL COMPLICATIONS

When making automatic adjustment to intake quantities, care must be taken in the design to ensure proper building pressure. Often the intake air required under normal occupancy roughly matches the toilet exhaust volume which must remain constant. If the intake is reduced at times of low occupancy, while the toilet exhaust fans continue to run normally, there will be more infiltration. Infiltration air can cause drafts and make some door operation very heavy, as well as nullifying energy savings.

a CO_2 based control, though widely used, assumes that CO_2 levels in return air are a complete indication of whether enough outdoor air is being supplied. CO_2 based control is not a direct control of outdoor air intake to ensure it meets the current occupancy level. Instead it is an indirect measure which has a poor correlation with the actual occupancy at any hour.

The ASHRAE Standard does not confirm CO_2 control as a means of proving compliance with its requirements. Therefore CO_2 based controls schemes must be examined on their individual technical merit without any ASHRAE guidance.

This retrofit must also recognize that each zone must be supplied with the correct amount of outdoor air, regardless of the average occupancy in all zones. Occupant counting must therefore be performed for each zone, restricting the application of this measure to air handling systems that only serve one or two zones. An auditorium is a good application for demand controlled ventilation, as long as occupant counting equipment is used rather than CO_2 sensing equipment.

5.4.7
New Duct or Pipe Routes

When new ducts or pipes are added to a building, they often must pass through walls or floors. Walls and floors act as barriers to the migration of pollutants and their penetration may allow pollutant migration if the openings are not resealed around the new service.

5.5 CENTRAL PLANT

5.5.1
Radiation Water Temperature Reset

The automatic reduction of radiation water temperature is a common energy management technique. However it risks **aggravating perennial cold areas** because heating capacity is reduced when water temperature is reduced. This potential problem can be addressed by balancing water flow through radiation pipe branches in problem areas. Occasionally extra radiation capacity may be needed in perennially cold areas, to allow water temperature to be reduced throughout the whole building.

The reduction of radiation water temperature in warmer weather may make recovery from night setback temperature more difficult. The **risk of cold indoor conditions at the beginning of occupancy** can be removed by allowing radiation water temperature to rise during the warm-up cycle.

5.5.2
Chilled Water Temperature Reset

Chiller energy can be reduced by raising discharge water temperature. This is often done in response to load or outdoor temperature. Caution is required to ensure that the ability to dehumidify is not impaired, since warmer chilled water will not allow cooling coils to condense moisture out of the air. Without full dehumidification capacity, **indoor Humidex standards may be endangered.** This risk can be avoided by using outdoor humidity levels in the control logic for adjusting chilled water temperature.

5.5.3
Humidifier Replacement

Humidifiers should only use potable water, free of hazardous additives.

Central humidifiers vary widely in their energy intensity. One of the lowest energy-consuming types is also the **least desirable** from an IAQ point of view. This is the water spray type, which recirculates water from a pan through spray nozzles. This type of system requires extensive routine maintenance to keep the pan free of microorganism contamination and to keep any downstream elements free of lime deposits and microorganism growth. Treatment with biocides is often performed but requires careful attention to be sure it is effective and not overused. The use of any biocide must be carefully considered as it adds chemicals to the air stream.

Another low-energy form of humidification that avoids potential IAQ risk is the atomizing, or fogger style. These systems require the use of softened water and does not deliver water minerals through the duct system.

5.5.4
Domestic Hot Water Replacement

Temperature reduction is often used to reduce heat losses from domestic hot water piping systems, temperature. To minimize the time that water is in the critical 30-50°C range, tanks should remain at 60°C. A makeup water blending valve should be added to the tank discharge line to reduce distribution pipe temperature. The blending valve should be automatically controlled allowing high temperature water to periodically enter the piping system to reduce bacteria growth in the piping.

5.6 LIGHTING

5.6.1
Fixture Changes

Lighting changes may be made to reduce light levels and/or increase efficiency. All changes must **adhere to the light level regulations outlined in Section 3.1.** Future deterioration of light levels should be considered in designing new light levels (see Section 4).

It is important that occupants feel visually comfortable after any lighting retrofit. The many factors influencing this comfort are outlined in Section 3.2.

To maintain proper IAQ during lighting changes, it is important to adjust the cooling capacity, air circulation and air intake systems to reflect the reduction in cooling load. Without such adjustments **space temperature control may be lost.** In VAV systems, **outdoor air supply to the space may be endangered,** as well as the air circulation and cleaning rate.

If any removed lighting ballasts contain PCB's, special disposal restrictions may apply. The Environment Canada publication *Identification of Lamp Ballasts Containing PCB's*[13] will assist in determining whether this is an issue. *Guidelines For Management of Wastes Containing PCB's*[14], a publication of the Canadian Council of Ministers of the Environment, provides guidance on treatment of such ballasts.

5.6.2 Lighting Control

Controls may turn lights off when there is adequate daylight or a lack of occupants in an area. When lights are turned off, the cooling load in the space is reduced and the zone may be overcooled. If the cooling supply is not simultaneously throttled, **the space temperature will drop.**

This risk can be avoided by automatically shutting off the cooling supply when the lights are shut off. A thermostat or direct linkage to the lighting control may be used.

5.7 ENVELOPE

5.7.1 Window Film

The addition of window film reduces solar heat gains. HVAC equipment capacty in the space may need to be reduced to **provide proper temperature control.**

5.7.2 Building Skin Heat Loss Reduction

There are many methods of reducing heat losses to the outside through the building skin. The IAQ impact of the basic measures is discussed below.

- *Caulking/Weatherstripping*
  Sealing the building fabric reduces the amount of infiltration of outside air into the space. This reduction in outside air **may require an increase in the outdoor air intake through the fan system to meet the requirements of Section 3.1.** It may also require the addition of outdoor air supply ducts to zones that formerly received all of their outside air from leakage.
- *Reglazing*
  The replacement of windows has the same potential IAQ effect as caulking and weatherstripping. However, it may also allow indoor humidity levels to increase in cold months. This increase may be desirable.
- *Insulation*
  The addition of insulation has no IAQ impact unless the vapour barrier is installed incorrectly, allowing condensation to form and soak building materials. Soaked materials can become homes for bacterial growth, even after the area has dried.

5.8 ELECTRICAL DEMAND CONTROL

Most strategies to control peak electrical demand in large buildings have no IAQ impact. However, the shutoff of fans during occupied periods is sometimes used for electrical demand control. This **violates standards for supplying fresh air to occupants,** as fans should never be shut off during occupied periods (see Section 5.2).

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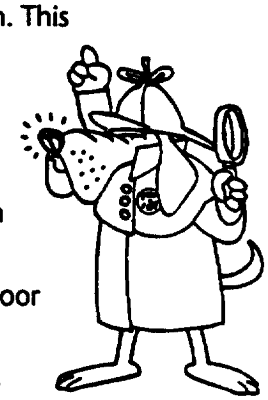
ENERGY MANAGEMENT MEASURES WITH POSITIVE OR NEUTRAL IAQ IMPACT

Some of the most common energy management measures that usually have no IAQ impact are listed below. This list may not be all inclusive, as there is an unlimited number of energy management concepts.

- de-stratification fans in high ceiling areas
- automatic gas pilot lights
- boiler heat recovery and burner improvement
- cooling tower water temperature reset
- pump shutoff or variable pumping
- steam pressure change
- high efficiency motor replacement
- outdoor heating and lighting control
- cogeneration
- thermal storage

Some measures will have a positive impact:

- outside air economizer modification to reduce cooling compressor use. This measure substantially increases outdoor air intake.
- balancing air supply systems to match current space configuration. This measure removes the many imbalance problems which gradually creep into any building as occupants move equipment and HVAC systems are adjusted in a haphazard fashion to maintain comfort.
- training building operators on the key engineering aspects of their systems so they understand how to operate them in both a healthy and efficient fashion.
- reglazing a building with glass with lower heat loss, to allow indoor humidity levels to be increased in cold months.
- solar film on windows to reduce radiant heat and the discomforts created by local or general temperature variations within the building.
- thermal cool storage involving ice may allow lower than normal supply air temperatures. These temperatures will allow lower summer building humidities and higher indoor temperatures without endangering the Humidex standards.



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CONSTRUCTION ACTIVITY IMPACT ON OCCUPANTS

Energy management retrofit construction can impact on space conditions but it must not unduly interfere with the productivity of the occupants. Some special considerations may be needed such as restriction of construction periods to after "working hours". It is important that disruptions during the construction period do not aggravate occupants so that they turn against the project before it has a chance to prove itself.

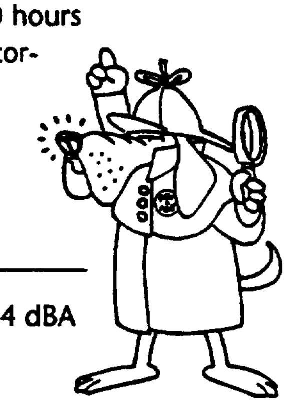
7.1 REGULATIONS AND STANDARDS

The *Treasury Board Manual*[3] contains regulations and standards which must be followed.

Chapter 2-17 Use and Occupancy of Buildings Directive

This chapter contains many traditional health and safety related procedures for construction around existing occupants. They are not particularly related to IAQ but worth recognition by all engineering and construction staff involved in the energy management project.

In Section 17.3.2 concerns temperatures that go beyond the comfort range of 20-26°C for a maximum of three hours per day, totalling 120 hours per year. During these periods, employers may choose to take corrective action, such as allowing more frequent rest periods or moving staff. Conditions should never go below 17°C or above a Humidex of 40 (See footnote a, page 5). Employees must be moved or released from work under such conditions.



Chapter 2-12 Noise Control and Hearing Conservation

If an employee's daily eight-hour noise exposure level reaches 84 dBA or higher, the following action is required:

- post a copy of the investigation report;
- provide the employee with written information and instruction on the hazards of exposure to high sound levels; and
- implement hearing level tests.

If space sound levels are expected to reach 84 dBA or higher for a period that is likely to endanger the employee's hearing, special investigation and reporting is required.

Controls shall be applied, as far as is reasonably practical, to all work so that sound levels never exceed 87 dBA, even if hearing protection is used.

7.2 GOOD PRACTICES

In addition to the above construction period regulations and standards, the following recommendations should be considered in the design and construction of retrofits:

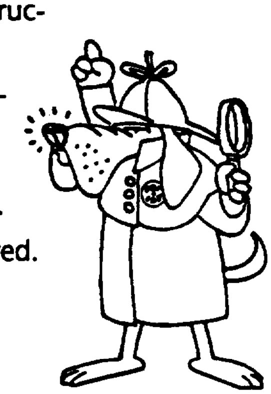
- Occupants should be forewarned the day before space temperature control may be temporarily lost, so they can dress accordingly. They should also be informed when the period has passed.
- Construction-related noise may be considered disruptive by occupants if it raises the average sound level more than 15 dBA above the target levels outlined in Section 3.2.
- Areas where dirt or fumes are generated should be operated under negative pressure relative to adjacent untouched areas. This strategy is implemented by throttling supply air to a zone, while holding return air constant. Air from contaminated zones should be exhausted when possible, rather than recirculated. Special temporary window-mounted exhaust fans can perform this exhausting, and selected windows may need to be removed.
- Air handling systems serving dirty construction areas should:
  - be operated continuously
  - have filters changed frequently, or extra filtration added temporarily
  - have their outside air intake rate increased where possible
- Where window or duct caulking is to be applied:
  - caulking should be used with the least toxic volatile solvent
  - follow the above noted ventilation and pressurization schemes
  - if possible, work should be performed in spring or fall when the outdoor air intake rate is high in buildings capable of 100% outdoor air intake.
- Where painting is to be performed:
  - water-based paint should be used wherever possible
  - ventilate the area for several days before occupant return, or increase outdoor air intake rate for several days after the work.

8

GENERAL PROCEDURES

In addition to proper design and construction methods, good general procedures must be followed to ensure that indoor air quality is protected in the long run. Though the timing of some of the following general procedures overlap, they are presented in their normal sequence.

- Occupant density and type, along with the working hours, must be defined for all parts of the building. These definitions should be in written form.
- The engineer must document any changes to building systems capabilities.
- The property manager should check all proposed retrofits against the concerns raised in Sections 5 and 6, above. The property manager should review construction methods proposed in light of Section 7, above.
- The timing of construction and the nature of disturbances to the occupants should be discussed with the occupant employers well before the work begins. Detailed communication should be maintained throughout the construction period. It is advisable to keep the safety and health committee informed of all activities. Accommodation should be made for any employee with a known pre-existing health problem which may be aggravated by the work.
- If the energy retrofit is being included with a major space refit, provision should be made to over-ventilate the space or place construction zones under negative pressure during the refit.
- A commissioning plan must be developed and implemented for each measure. The plan should ensure that key design parameters are met, to ensure compliance with the regulations and recommendations of these Guidelines.
- Operating and maintenance instructions should be prepared. Building staff and service contractors should be trained in these procedures.



- Early complaints from occupants must be promptly addressed as they can rapidly erode good occupant relations. Early complaints may take time to resolve while debugging systems or tracking down problems. This fact should not get in the way of at least acknowledging the occupant's concern.

  Often, minor adjustments to solve early complaints can protect the entire project from becoming a major occupant relations problem. For example the restoration of light levels in a few isolated areas can avoid widespread complaints, without requiring similar changes throughout.

  The key defence against complaints is always proper design and commissioning to ensure that standards are met. However, some complaints are still likely to surface as not everyone is comfortable with conditions laid down in the various regulations and standards. By quickly addressing any such concerns, bad rumours can be stopped.
- Inform occupants of changes at every step along the way. They should hear of the positive impacts on their environment, before implementation and after. Detailed construction plans should be discussed with occupants who might be disturbed during construction. Section 10, below, reviews appropriate communication strategies.

9

RESPONSIBILITIES

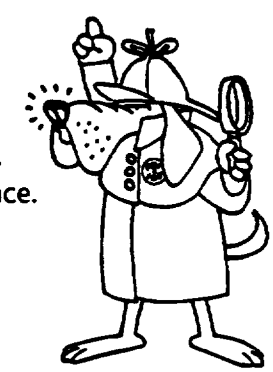
All persons involved in an energy management program should be aware of IAQ issues. This awareness must begin with the planning of energy saving opportunities by the first energy auditor involved with the building. IAQ awareness in energy retrofits must continue through the design and construction phases and into the commissioning phase. It also needs to continue through ongoing operations, where those doing servicing and adjustments must be alert to IAQ strategies.

The persons who must be alert to the IAQ risks of the energy management program are:

- property manager
- occupant employer
- occupant employee
- operator
- energy auditor
- engineer
- construction contractors
- service contractors

Where an energy management firm is involved, it may play the role of energy auditor, engineer, construction contractor, and service contractor.

The typical responsibilities of each party are outlined below. Many of these responsibilities are normal good practice. However, they warrant repeating due to their importance to IAQ maintenance.



PROPERTY MANAGER

Ensure that the occupant employer has approved the definition of "working hours" and the outdoor air needs of after hours workers. The employer must also approve any proposed change in space temperature.

All occupant department regulations and standards regarding facilities with laboratories should be delivered to any energy management firm, energy auditor, engineer, construction contractor, or service contractor.

If an energy management firm is involved, verify that their contract includes:

- reference to these Guidelines.
- definition of "working hours".
- definition of acceptable space conditions, outlined in Sections 3 and 7.
- property manager approval of retrofit concepts and details before implementation.
- owner remedies for deficient space conditions, including damages associated with conditions requiring that employees be given rests, moved, or released from work.
- training of operating staff as required.
- drafting of appropriate key phrases to describe the IAQ aspects of the project for occupant communications.
- documentation of any new design parameters for the HVAC system.

The model Request For Proposal and Energy Management Contract from the FBI program covers these details. These details should not be diluted in negotiation.

If no energy management firm is involved, ensure that:

- the energy auditor, engineer, and construction contractors have a copy of these Guidelines. Require that each party notes any expected areas of variance from the Guidelines.
- persons inspecting construction and persons responsible for operations are aware of the Guidelines.
- the engineer develops a commissioning procedure.
- the engineer approves the commissioning report.
- the engineer provides documentation of any new design parameters for the HVAC system.
- the engineer provides written operating and maintenance instructions on the energy management measures, noting any IAQ-sensitive aspects.
- operating staff are fully trained on the IAQ implications of their building operations.
- the engineer conducts specific training on the IAQ-sensitive aspects of the energy retrofits performed on the building.

- service contractors receive a copy of the operating and maintenance instructions prepared by the engineer.
- the engineer drafts appropriate key phrases to describe the IAQ aspects of the project for the occupant communications.
- all operating problems are reviewed with the engineer.

Become familiar with procedures for updating mechanical systems when an occupant makes minor or major changes within his space.

Make revised HVAC design parameters available to occupant department health and safety committees on request.

Provide appropriate communications with occupants before and after retrofit.

OCCUPANT EMPLOYER

- In consultation with the property manager, set appropriate "working hours" and approve outdoor air needs of after hours workers.
- Approve any proposed space temperature changes.
- Communicate with occupant employees before and after retrofit.
- Notify the Property Manager of any changes in building use or the introduction of any pollutants.

OCCUPANT EMPLOYEE

- Follow normal reporting channels within the department for any discomforts created by the retrofits. If uncertain of these channels, contact the facility or property manager or the occupational safety and health committee for the facility.

OPERATOR

- Follow operating instructions supplied by the engineer. Report any difficulties with these instructions to the Property Manager.

ENERGY AUDITOR

- Review these Guidelines.
- Report any possible variance from the Guidelines as a result of the proposed energy management plans.

ENGINEER

- Review these Guidelines.
- Report any expected variance from the Guidelines as a result of the energy management retrofit.
- Document any new design criteria for the HVAC System resulting from the energy management program.
- Write operating and maintenance instructions for the energy management measures. Note the specific duties associated with IAQ management. Develop a commissioning procedure to test the achievement of those design parameters which reasonably ensure compliance with the regulations and recommendations of Section 3. Include the full reporting of results in the procedures.
- Approve a commissioning report as outlined above.
- Provide specific operator training on the IAQ sensitive aspects of the specific energy retrofits performed on the building.
- Draft appropriate key phrases to describe the IAQ aspects of the project for the occupants.

CONSTRUCTION CONTRACTORS

- Review Section 7 of these Guidelines.
- Include in any quotation the expected variances from Section 7 of these Guidelines.
- Assist with or conduct, as the contract requires, the commissioning procedures developed by the engineer. Seek the engineer's approval of the results.
- Note construction variances from design, for the engineer.

SERVICE CONTRACTORS

- Review the operating and maintenance instructions for the energy management measures.

10

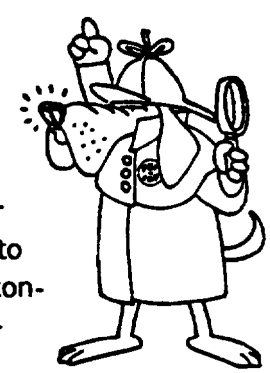
COMMUNICATING WITH OCCUPANTS

In the past, energy reduction programs have contributed to real and perceived difficulties in indoor air quality. As a result, these programs now evoke poor IAQ images amongst the general public, regardless of reality. As misperceptions can easily spread amongst occupants, it is appropriate to supply complete and correct information about intended energy management work. This communication starts before work begins, whether or not it is expected to affect IAQ.

Refer to Energy Mines and Resources' publication *FBI Employee Information*[15] for a complete guide to informing building occupants about energy management projects. This binder contains example posters, brochures, articles and memos for facility managers to describe the program and its expected impact on the working environment.

During project planning, the energy auditor and engineer should be discrete about their discussions near occupants. Discussions, if any, with occupants should focus on listening to any problems they wish to report. Discussion of plans should be restricted to terms such as 'building updating', 'recommissioning', and 'debugging'.

Once plans are firmed up, a pre-retrofit communication with occupants should highlight the planned improvements to space comfort. Even the simple act of commissioning to prove achievement of key design parameters is good news to occupants. Energy savings are less interesting to occupants than the impact on their space. Any use of new technologies to gain efficiency and improve space quality, such as T-8 lighting, should also be highlighted.



Before construction crews enter the building, the occupants affected by the work should be told of the nature and timing of the work. Depending on the sensitivity of the particular individuals, it may be appropriate to reassure them of the intent to stay within the regulations and standards in Section 7 for space conditions during the construction period. If construction period disturbances will likely mean a temporary loss of space temperature control, occupants should be notified at least one day in advance so they can dress appropriately. Employees with medical conditions which could be aggravated should notify their supervisor.

Following commissioning of the work, occupants should be told of the successful verification of parameters affecting IAQ.

All of these communications are aimed at providing factual information that reinforces benefits for the occupants. Any improvements to conditions must be highlighted. Where conditions favouring IAQ are lowered, it should be pointed out that the building continues to live within modern IAQ Guidelines, while being energy efficient.

FBI

11

GLOSSARY

Breathing Zone – The breathing zone is the region from the floor to a plane six feet above the floor.

dBA – Decibels (dB), measured on the 'A' weighted scale. A measure of sound level, adjusted to the 'A' scale to simulate the human ear's sensitivity to different frequencies.

De-stratification – Warm air rises to the ceiling, with cooler air staying near the floor. This condition is called stratification. De-stratification fans mounted at the ceiling stir the air, driving warm air down to floor level.

Face Velocity – The effectiveness with which a fume hood or cabinet can contain all fumes generated within it depends on the velocity of air entering it. This velocity is termed face velocity.

$l/s/m^2$ – Litres of air per second per square meter of floor space.

l/s/person – Litres of air per second per person in the space. A measure of the amount of air supplied per occupant. Outdoor air intake rates are usually reported on a per person basis because people are usually the only reason for bringing outdoor air into a space.

Negative Pressure – The condition in a space when more air is withdrawn from the space than is supplied to it.

Room Criteria – A number representing the human ear's response to sound levels over a broad spectrum of frequencies.

Ventilation Effectiveness – The ability of an air distribution system in any space to deliver outdoor (ventilation) air directly to the breathing zone. Any supply air not reaching this zone before returning to the return air stream detracts from ventilation effectiveness.

12

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2. *National Building Code of Canada*
Available from the National Research Council of Canada, Publication Sales,
Montreal Road, Building M-20, Ottawa, K1A 0R6
3 *Occupational Safety and Health* volume (#12) of the *Treasury Board Manual.*
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K1A 0S9. Phone (819) 956-4802, Fax (819) 994-1498
4. *ASHRAE Standard 55-1981, Thermal Environmental Conditions for Human Occupancy*
Available through ASHRAE, The American Society of Heating Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, Georgia, USA 30329. Phone (404) 636-8400. Most technical libraries should also carry a copy of this document.
5. *ASHRAE Standard 62-1981 Ventilation for Acceptable Indoor Air Quality.* This document has been superseded by *ASHRAE Standard 62-1989* with the same title. Standard 62-1989 is available through ASHRAE, The American Society of Heating Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, Georgia, USA30329. Phone (404) 636-8400. Most technical libraries should also carry a copy of this document. Some libraries or private collections may still have the 1981 standard as referenced.
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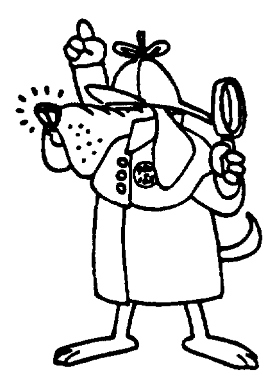

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15. *FBI Employee Information* prepared by Energy Mines and Resources, Energy Ventures Division, (To be published in 1993).
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