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MANAGING INDOOR AIR QUALITY

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Synthesis of the overall framework for property managers to manage indoor air quality was led by D.W. Patton, Director, Property Management Policies, Public Works Canada. Development of the comprehensive indoor air quality inspection protocol and technical descriptions in the manual were spearheaded jointly by F. Vaculik, Senior Maintenance Engineer (Mechanical), Public Works Canada and by C.Y. Shaw, Senior Research Officer, National Research Council, in consultation with G.K.U. Yuill, Consultant. The inspection protocol was validated in four buildings by Public Works Canada's property managers.

The draft manuscript was reviewed and revised by H.F. Hull, former property management executive. Editorial services were provided by Corporate Communications Branch, Public Works Canada.

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INTRODUCTION

This document provides property managers and building operators with a proven approach, related working tools and basic technical information for effectively managing and solving problems related to indoor air quality (IAQ) in office buildings.

The primary focus is on indoor air quality and the directly related issues of ventilation, temperature and humidity. Other environmental factors such as noise, lighting and space layout are covered briefly. Attention is drawn particularly to Section 4, which outlines proactive management through prevention and Section 5, which describes how to manage complaints and reported problems.

Experience has shown clearly that the effectiveness of IAQ management and problem-solving depends on open, frank communications with the building's occupants and other parties involved. To assist the property manager, Section 6 proposes a communication strategy for indoor air quality issues.

BACKGROUND

2.0 BACKGROUND

2.1 Managing the Indoor Environment — The Challenge

The indoor air quality issue has come to the fore, in part, because of an increase in environmental awareness and general expectations of today's building occupant. Employee representative associations have also helped increase the focus on all aspects of the working environment, including air quality.

At the same time, the property manager's and building operator's task of providing a productive working environment has become increasingly complex due to greater use of synthetic materials in construction and furnishings; tighter building construction; and more sophisticated heating, ventilation, cooling and control systems. Ironically, the very complexity of the environmental control problem often results in a diminished ability of occupants to directly influence the environment which surrounds them. In some cases, this can contribute to the frustration of tenants and perhaps even suspicion regarding environmental quality.

2.2 Defining Indoor Air Quality

Indoor air quality is generally described in terms of two main parameters.

- The first factor is the level of various pollutants found in the air. These pollutants can range from carbon dioxide, which we all exhale, to low levels of other organic and inorganic chemicals such as formaldehyde. Some pollutants are generated by building activities, materials, equipment and occupants. Others may be present in the outside air entering the building.
- The second factor is the amount of outdoor air being provided in the building. Obviously, these two parameters are linked: the more outdoor air supplied, the greater the dilution of air pollutants in the building.

Other factors in the indoor air quality equation are air temperature and relative humidity.

Indoor air quality can be defined strictly from a health and safety viewpoint as do standards for pollutants from the US Occupational Safety and Health Association (OSHA) and from the American Conference of Governmental Industrial Hygienists (ACGIH). In office buildings, however, it is more appropriate to look beyond basic health and safety to employee comfort and productivity. Standards developed by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) reflect this approach. ASHRAE's Standard 62-1989 is widely accepted in the industry. It sets out the following air quality recommendations:

a. carbon dioxide — 1000 parts per million (ppm); and
b. outdoor air supply — 10 litres per second per person in office workstations.

ASHRAE recognizes that it is not always possible to satisfy everyone. The above standard is intended to result in about 80% of building occupants being fully satisfied with the air quality and the remainder being somewhat less than completely satisfied.

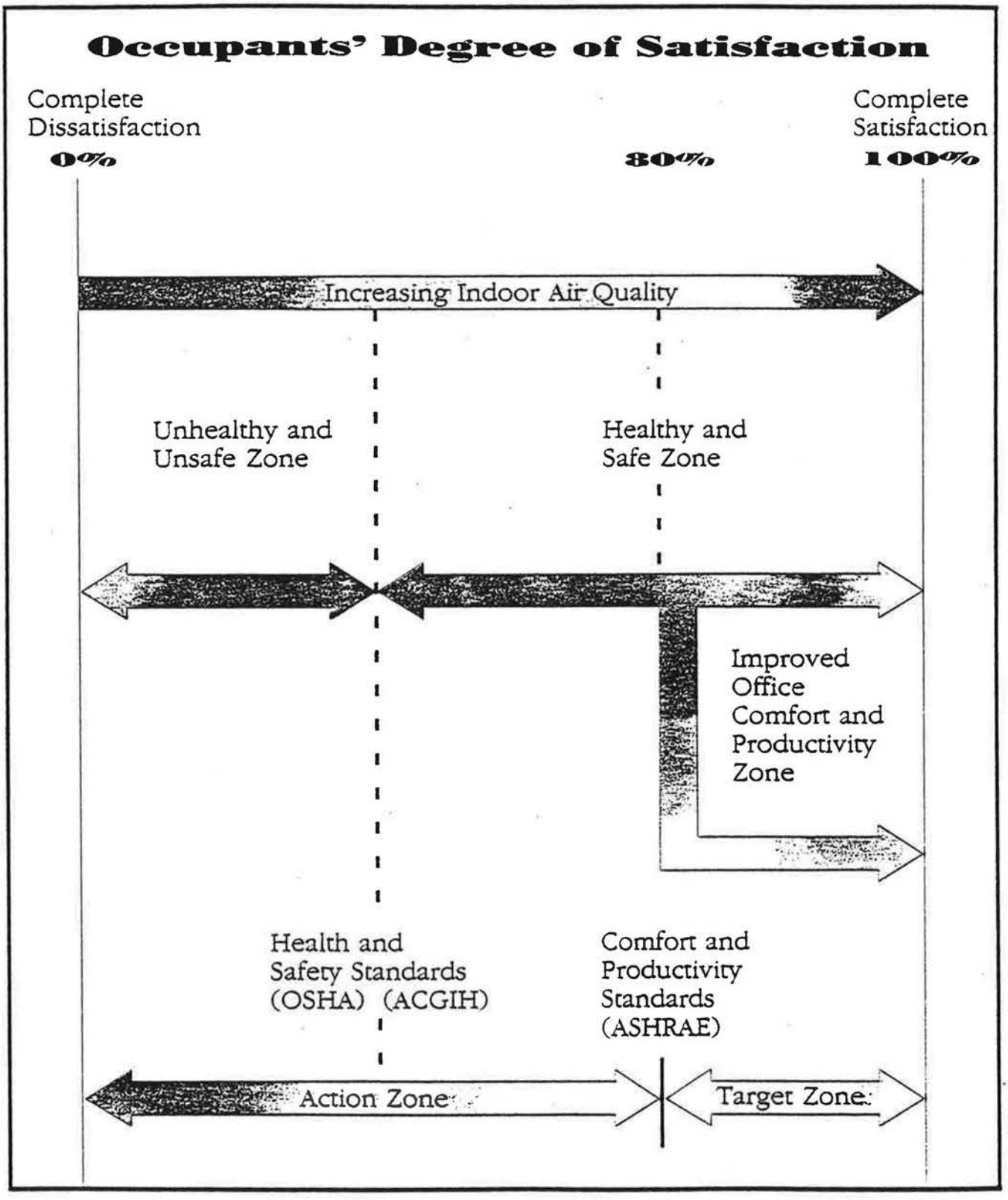
The continuum of occupant satisfaction in Figure 1 depicts indoor air quality standards in terms of both health and safety and comfort and productivity.

Experience has shown that the majority of working environment complaints relate to thermal comfort. Thermal comfort is achieved when a person's body heat is dissipated at the same rate that it is being generated. Each individual's thermal comfort is affected by environmental and personal factors, which include the following:

- temperature;
- relative humidity;
- air motion;
- activity level;

FIGURE 1

Conceptual Relationship Between Health and Safety, and Comfort and Productivity Standards for Indoor AIR QUALITY AND CLIENT SATISFACTION



- clothing; and
- state of health.

Given the differences in seasonal clothing, the ASHRAE Standard 55-1981 recognizes two comfort zones — one for winter and the other for summer. The temperature and relative humidity (R.H.) ranges satisfying the majority (80%) of healthy people are 20-27°C with 20-70% R.H. To determine if specific combinations of temperature and relative humidity in these ranges lie within the seasonal comfort zone, property managers should consult the ASHRAE Standard.

2.3 Achieving Air Quality in the Workplace

The challenge of maintaining air quality standards must be approached within a broader context. One of the key responsibilities of any property management organization is to provide the occupants of its building with a productive working environment which meets all targets specified by the building owner or asset manager. Normally, these environmental targets are based on industry-accepted standards such as those established by the ASHRAE.

A good building environment does not just happen. It is the product of a well-structured professional approach over the entire life cycle of a facility. This approach includes the following:

- good design in accordance with accepted standards;
- formal commissioning to ensure the building systems are functioning as intended;
- special ventilation strategies during the first year of operations while new building materials are off-gassing and while systems are being fine-tuned;
- an active preventive maintenance program;
- regular periodic inspections by the property manager;
- investigation of any environmental problems or complaints;
- testing and special in-depth investigation by consultants (in-house or external) where problems persist;
- open communication, including a service-call system for tenants; and
- meetings with tenants and their safety and health committees and consultation with health and other regulatory officials as required.

2.4 Role of the Property Manager

In existing buildings, managing good air quality requires a well-coordinated effort by the building management team, operators, maintenance support and technical staff, spearheaded by the property manager.

To play this leading role, the property manager must be conversant with indoor environmental standards, knowledgeable about the indoor air quality issue and familiar with potential air contaminant sources and the environmental systems in his/her buildings. The property manager should ensure a preventive approach is adopted towards indoor air quality problems through a preventive maintenance program and by regular personal building performance checks. Finally, the property manager must be able to handle occupants' complaints about indoor air quality, investigate the causes and coordinate any corrective action.

The property manager's fundamental responsibility with respect to indoor air quality is to ensure each building is operated to meet established environmental standards.

To proactively and successfully manage indoor air quality, property managers must understand

the role of the various parties involved in the indoor air quality issue. Included would be the building owner, health authority, regulatory agency and the tenant. For federal government accommodation, the responsibilities of each of the parties is set out in Annex 7.1.

A note of caution — tenants will sometimes indicate that the building environment is causing symptoms of ill health in employees. The property manager is not a health professional and should, therefore, avoid becoming involved in requests for assessment and analysis of suspected threats to health. These should be referred, in consultation with the tenant, to the responsible health authority (Health and Welfare Canada in the case of Federal Government employees). The property manager should work hand in hand with the responsible health official to ensure the operation of the building is not contributing to any health problems.

A RECOMMENDED MANAGEMENT FRAMEWORK

3.0 A RECOMMENDED MANAGEMENT FRAMEWORK

Sections 4, 5 and 6 of this manual together with Annexes 7.2 to 7.7 furnish property managers with a proven approach and the essential tools for managing indoor air quality in their buildings. This management framework and the related tools are also illustrated in Figures 2 and 3.

3.1 Prevention of IAQ Problems

1. Once a property manager is committed to the proactive management of indoor air quality, the first step is to become knowledgeable about the elements of the IAQ issue, including the following:

   - the basic concepts of the operation of typical heating, ventilation and air conditioning systems used in buildings (Annex 7.9);
   - the definition of indoor air quality (Section 2.2); and
   - the common causes and solutions to indoor air quality problems (Sections 4 and 5 and Annex 7.8).

   This information allows the property manager to professionally deal with environmental problems and intelligently address these matters with specialists, tenants and union representatives. (It is noted that employee associations are generally very well informed on indoor air quality issues.)

2. The next step is to prevent environmental problems by periodically inspecting the building systems and assessing operating activities which could affect the indoor air quality. The detailed inspection checklist in Annex 7.2 is designed for use on the property manager's first IAQ inspection of a facility. A simplified protocol for annual follow-up inspections is provided in Annex 7.3. These IAQ inspections can be completed in conjunction with normal building performance reviews and will assist the property manager in early identification of potential environmental problems.

3. The third step is to address and correct any deficiencies found during the preventive inspection. Recommended follow-up actions are indicated for each item on the inspection checklist in Annex 7.2.

3.2 Proactive Management of IAQ Complaints and Problems

1. If a tenant is not satisfied with the indoor air quality in a building, the next step is to document and analyze the actual complaints. To this end, a suggested framework is provided in Annexes 7.4 and 7.5. This will help the property manager distinguish between routine minor local incidents and significant general complaints which require thorough follow-up investigation.

2. In the case of significant general IAQ complaints, the property manager should personally carry out an investigation in consultation with the building operator. This is categorized as a Level 1 investigation. The detailed air quality investigation checklist in Annex 7.2 will assist the property manager in investigating both zone and building-wide IAQ complaints and in taking the appropriate action to correct any problems identified.

3. If the results of the Level 1 investigation are inconclusive, the next step is to initiate follow-up IAQ investigations by technical specialists, at a progressively increasing level of expertise as required (i.e., Level 2 and Level 3 investigations). Guidance on initiating these technical investigations is provided in Section 5.

4. The next two steps involve taking remedial actions to correct problems identified during IAQ investigations and then verifying their effectiveness. A recommended approach to addressing identified deficiencies is included in Section 5.

5. Dialogue with all parties involved should take place throughout all the stages described above. A recommended communication strategy is presented in Section 6. This will help the property manager establish open frank communication, maintain credibility and promote effective client and tenant relations, while addressing indoor air quality issues.

FIGURE 2

THE PROPERTY MANAGER'S ACTION PLAN

for Effective Prevention of Indoor Air Quality Problems

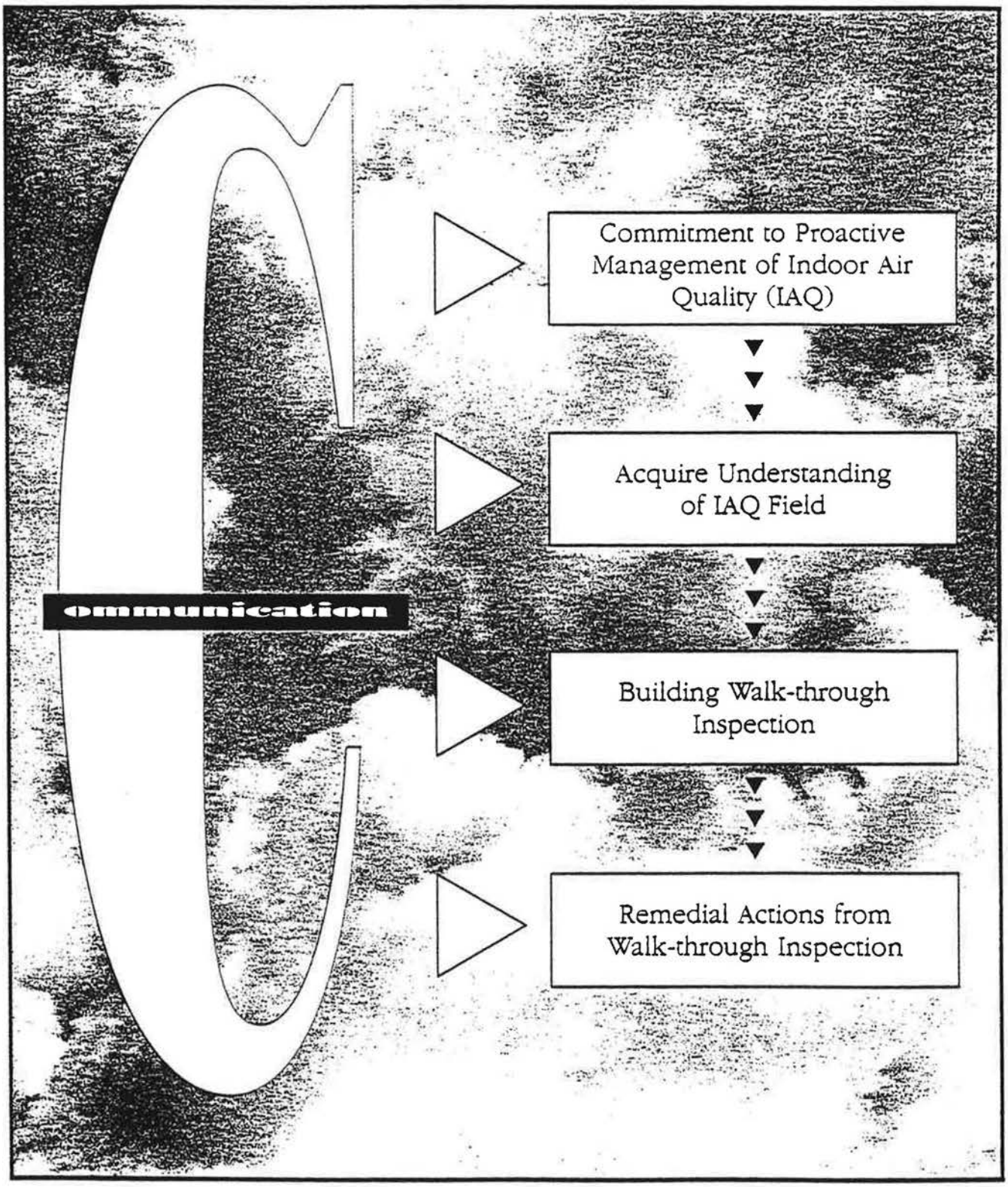
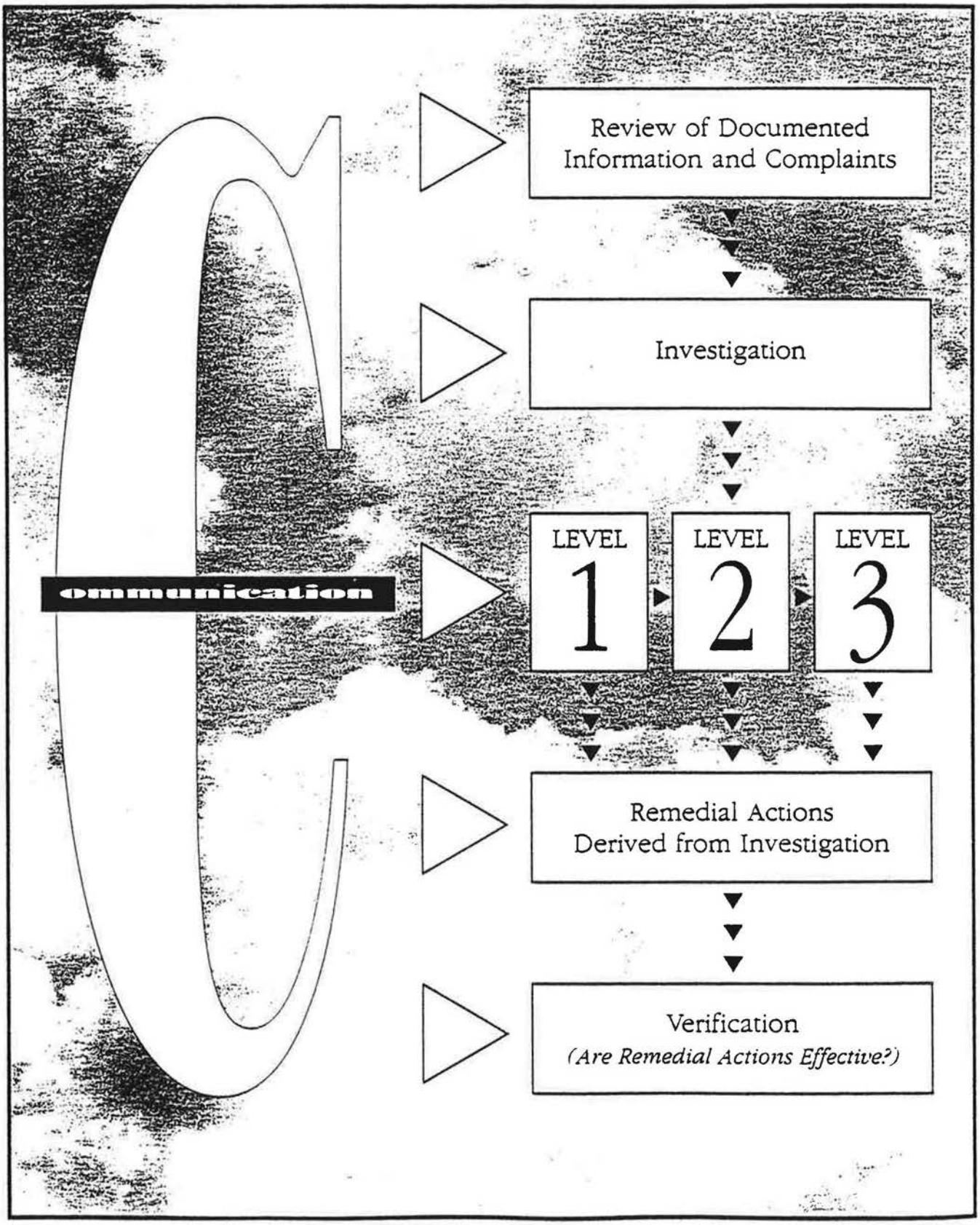


FIGURE 3

THE PROPERTY MANAGER'S ACTION PLAN

for Effective Management of IAQ Complaints and Problems



PREVENTION OF AIR QUALITY PROBLEMS

4.0 PREVENTION OF AIR QUALITY PROBLEMS

4.1 Building Walk-through Inspection

The key to proactive environmental management is a regular, periodic walk-through of the building, with an assessment of the building systems and operating activities (such as the inventory of chemicals used for cleaning, plant maintenance, etc.). Such walk-throughs allow potential environmental problems to be identified and corrective actions taken before occupants experience discomfort and concern.

If property managers wait until occupant complaints begin before initiating a walk-through inspection, they are forced into a reactive and typically difficult game of "catch-up ball."

The property manager's first inspection of a building should be done using the detailed checklist in Annex 7.2. This will serve to thoroughly familiarize the manager with the HVAC system and any potential problem areas which may affect indoor air quality. For follow-up inspections, it is suggested the property manager use the abbreviated checklists in Annex 7.3. The questions on both checklists require simple "yes or no" responses. A "yes" response indicates that a potential problem could exist and that follow-up attention is required.

Following is an overview of the step-by-step procedures for using the checklists in Annexes 7.2 and 7.3.

1. Weather Information

Record the local weather conditions at the time of inspection by contacting in-house technical staff or the local Environment Canada weather office. Weather has an effect on natural and mechanical ventilation that can sometimes account for any unusual occurrences during a walk-through inspection.

2. Outdoor Air Contaminant Sources

Inspect for external air contaminant sources that could cause air quality problems inside the building. The checklist focuses on the common potential outdoor contaminant sources and how outdoor contaminants might enter the building. It also addresses the location of air inlets and building entrances in relation to air exhaust outlets, traffic, chimneys and other sources of industrial pollution.

3. Indoor Air Contaminant Sources and Other Building Environmental Problems

Inspect for air contaminant sources inside the building and for other building environmental problems including noise, lighting and temperature. (These other environmental problems are sometimes perceived by occupants as causes for air quality complaints.) The checklist covers a range of potential air-quality-related problems such as mold, excessive dust, odours, stuffiness, use of chemicals, obstructions to good air flow and improper installation of equipment. The inspection includes the mechanical equipment areas, office space, special purpose space and parking areas.

4. Potential Problems Within Building Mechanical Systems

Inspect for potential problems related to the operation and maintenance of the building's mechanical systems such as those related to the operation of outdoor air dampers, air mixing dampers, exhaust and other controls; cleaning of air filters and spray coils; and ventilation strategy.

Improper functioning of special ventilation systems serving installations such as laboratories, kitchens and garages, as well as smoke-control systems to protect paths of egress from a building fire may adversely

affect the performance of the general and other local ventilation systems. These special systems must be regularly maintained and related code requirements observed.

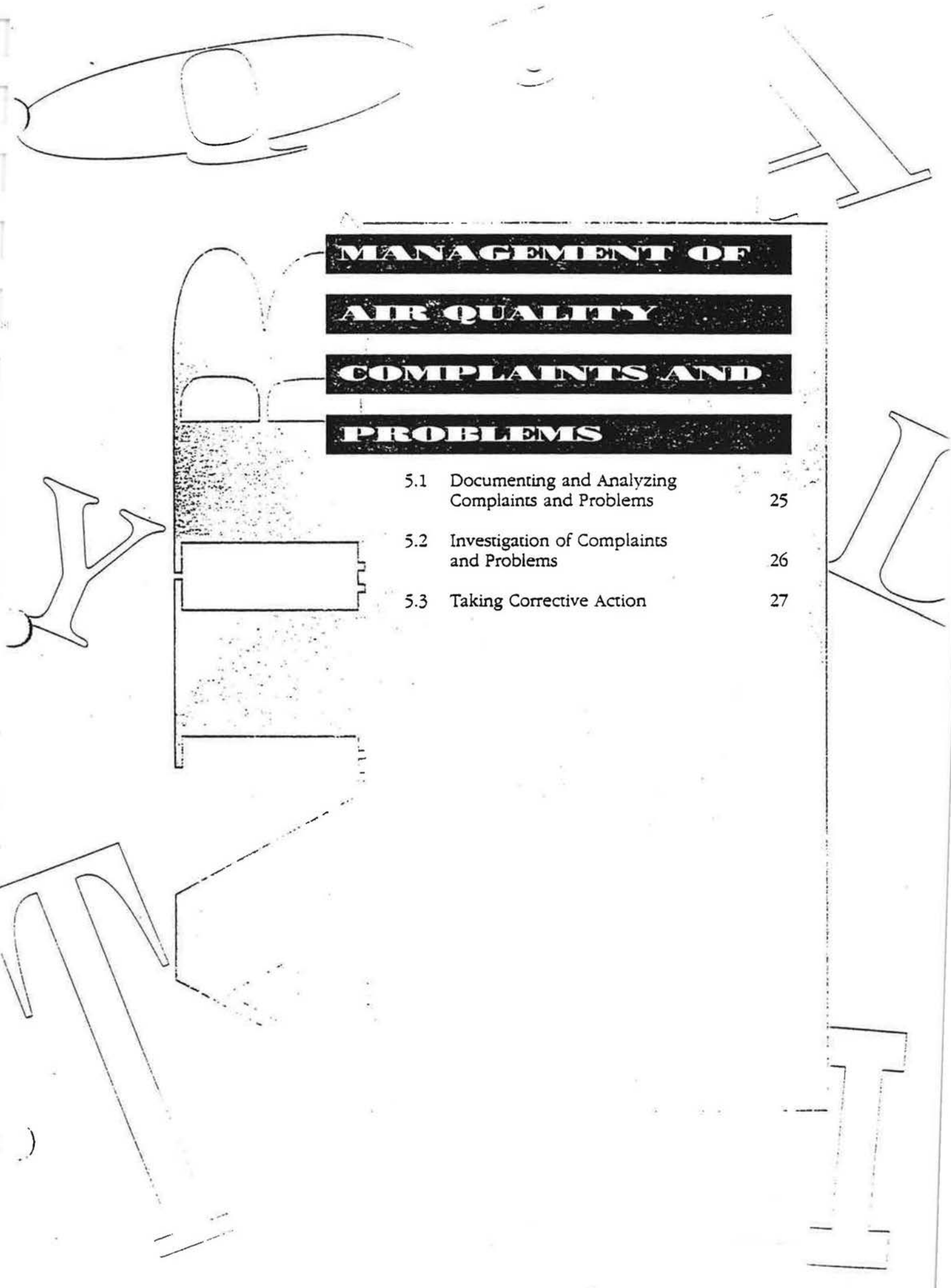
5. Communication with Occupants During Walk-through Inspection

Communication between inspection personnel and building occupants is something that cannot and should not be avoided. Occupants should be made aware that the inspection is of a preventive nature and that any necessary corrective measures will be undertaken without delay.

Frequent building walk-throughs will help ensure problems are identified before occupants experience symptoms stemming from the deficiencies. They also provide an opportunity for property managers to encourage occupants to take steps themselves to ensure good air quality; for example, by not blocking ventilation ducts. Ideally, a walk-through inspection should be conducted every three months (one inspection per season). At a minimum, a walk-through inspection should be conducted once a year. It can be combined with other visits or inspections such as overall building condition or building performance reviews.

4.2 Taking Corrective Action

Prompt action should be taken to address any deficiencies or concerns identified during the walk-through inspection. Recommended action steps are indicated on the checklist.



MANAGEMENT OF AIR QUALITY COMPLAINTS AND PROBLEMS

5.0 MANAGEMENT OF AIR QUALITY COMPLAINTS AND PROBLEMS

5.1 Documenting and Analyzing Complaints and Problems

The first task in any air quality investigation is to determine the magnitude and distribution of the problem. In practice, the most common indicator of an air quality problem is complaints from building occupants. Such complaints can provide valuable information for estimating both the magnitude and distribution of an air quality problem, so it is important to document all of them. Annex 7.4 Information Form — Occupant Environment Complaint Register can be used for documenting individual complaints and Annex 7.5 Information Form — Summary of Occupant Environment Complaints can be employed for summarizing the complaint patterns.

A note of caution — sometimes it is difficult to get an overall picture of the problem by referring only to the Occupant Environment Complaint Register. Complaints may not always get through the occupying agency's own administrative process and therefore may not reach the property manager. Dissatisfaction with the building environment may, in reality, be much more widespread than indicated by a formal Occupant Environment Complaint Register.

The analysis of complaint patterns is crucial as it often suggests the causes. Hours of effort can be saved by focussing first on the most probable causes before launching a complete building-wide investigation. Complaint patterns generally fall into one of the following three categories:

1. One complaint originating from a small area with several occupants
   This could be caused by a localized problem; for example, blocked air register or diffuser, thermostat requiring adjustment or calibration, disconnected flexible air duct, malfunctioning VAV-box, misdirected air flow from diffuser or too much heat-generating equipment in the area.
2. A few complaints originating from a zone (i.e., an area served by a separate ventilation unit)
   This could be attributable to a problem in that particular zone. The HVAC system should then be checked for problems in the zone (e.g., dirty filters, blocked fresh air supply, special equipment, potential contaminant sources, etc.).
3. Several complaints originating from throughout the entire building
   If the problem is building-wide, there is a good chance it may be related to the central ventilation equipment. The investigation, therefore, should focus first on the central equipment before moving on to other parts of the HVAC system. For example:

   - check the outdoor air intake dampers to ensure that they are functioning properly;
   - check for blockage at the outdoor air intake and at filters in the outdoor air supply duct;
   - check for contaminant sources in the vicinity of the outdoor air intake; and
   - check for contaminant sources within the building such as new carpets or new equipment.

In analyzing complaint patterns, particular attention should be paid to the time symptoms occur and the locations of complainants. Investigation of the complaints should be planned around these times and locations to determine if there is a connection between the time and location of complaints and other building activities such as cleaning, maintenance and renovation projects.

Past investigation of indoor air quality problems in several hundreds of buildings have identified the following most common causes, in order of frequency:

- inadequate ventilation;
- contamination from inside the building;
- contamination from outside the building;
- microbiological contamination;
- contamination from the building fabric; and
- other.

The property manager should keep this list in mind when analyzing and investigating specific air quality problems. There is often not one single cause but rather a combination of causes, so the property manager should not arbitrarily discontinue the investigation when one deficiency is found.

5.2 Investigation of Complaints and Problems

General Approach

If complaints persist or if they are widespread, affecting more than one HVAC zone, the property manager should initiate a full investigation. The three levels of investigation recommended below are complementary, combining the property manager's professional skills with the technical expertise of engineering support staff and indoor air quality specialists, as required. These investigations should be undertaken progressively, moving from Level 1 to Levels 2 and 3 only if needed. As most IAQ problems can be initially identified with a Level 1 investigation, the property manager should not normally launch a Level 2 or 3 investigation without first having undertaken a Level 1.

Level 1 Investigation

The Level 1 IAQ investigation is a visual survey designed to be carried out personally by the property manager accompanied, where possible, by the building operator or technical support staff. The detailed checklist protocol in Annex 7.2 guides the property manager through a complete HVAC system inspection. This may not be necessary if the complaints are limited to one zone. Questions related to zone problems are designated with a "z" to assist in zeroing in quickly on the most likely causes.

The purpose of the inspection is, of course, to identify likely causes of the IAQ complaints and equally important, to demonstrate to the occupants that the complaints are being regarded seriously. As previously noted, the Level 1 investigation should, in most cases, be able to pinpoint the cause(s) of the complaints.

Level 2 Investigation

A Level 2 technical investigation should be initiated if the property manager does not identify the problem during the Level 1 inspection. In addition, a Level 2 investigation can be undertaken to confirm potential or suspected causes identified during the Level 1 investigation.

The Level 2 investigation is normally performed by trained, in-house technical support staff. The first step is to review the Level 1 investigation results to determine where to focus the more detailed technical assessment. Typically, the next step in a Level 2 inspection is to ensure that occupants in complaint areas are receiving their required amount of fresh outdoor air. A ventilation assessment should be made at all locations where complaints occur.

An assessment of the operational performance of the ventilation system can be done by measuring CO_2 levels and correlating the readings to overall ventilation rates. These measurements should be carried out when there is speculation that the building or an area of the building is under-ventilated. A follow-up assessment should also be made to verify the effectiveness of changes made to the ventilation system.

Smoke pencils are useful for sensing airflows, determining the direction of airflows and identifying stagnant areas in the occupied space. Evaluations are made by releasing the smoke tracer from the pencil and observing its movement.

The Level 2 investigation may involve a technical review of the HVAC system's operating and maintenance procedures and an engineering evaluation of the existing system including the design criteria.

Level 3 Investigation

A Level 3 IAQ specialist investigation should be initiated in those rare instances where no causes have been found during the Level 1 and 2 investigations and the complaints persist. A Level 3 investigation may also be used to confirm a suspected problem identified in Levels 1 and 2.

The Level 3 investigation should be focussed on specific tasks by the property manager and technical support advisors, based on the results of the Level 1 and 2 investigations. The Level 3 investigator could, for example, be directed to measure for specific air contaminants, such as formaldehyde. In other situations, the IAQ specialist may be tasked to accurately measure building air change rates, to track interior air flows or to determine if exhaust air is short-circuiting into fresh air intakes, using, for example, tracer gases.

Health and Safety Investigation

The three levels of investigation described above are intended to address complaints related to the comfort and productivity of the building's occupants. If they indicate there are health and safety concerns, the responsible tenant official should be advised to call in the health and safety authority having jurisdiction. The property manager should not wait for the results of the health authority's investigation. On the contrary, the property manager should proceed in parallel to initiate Level 1 and subsequently, if necessary, Level 2 and 3 investigations. to confirm whether or not the building ventilation systems may be contributing to the health complaints. The property manager should establish a close liaison with the health authority during a health and safety investigation.

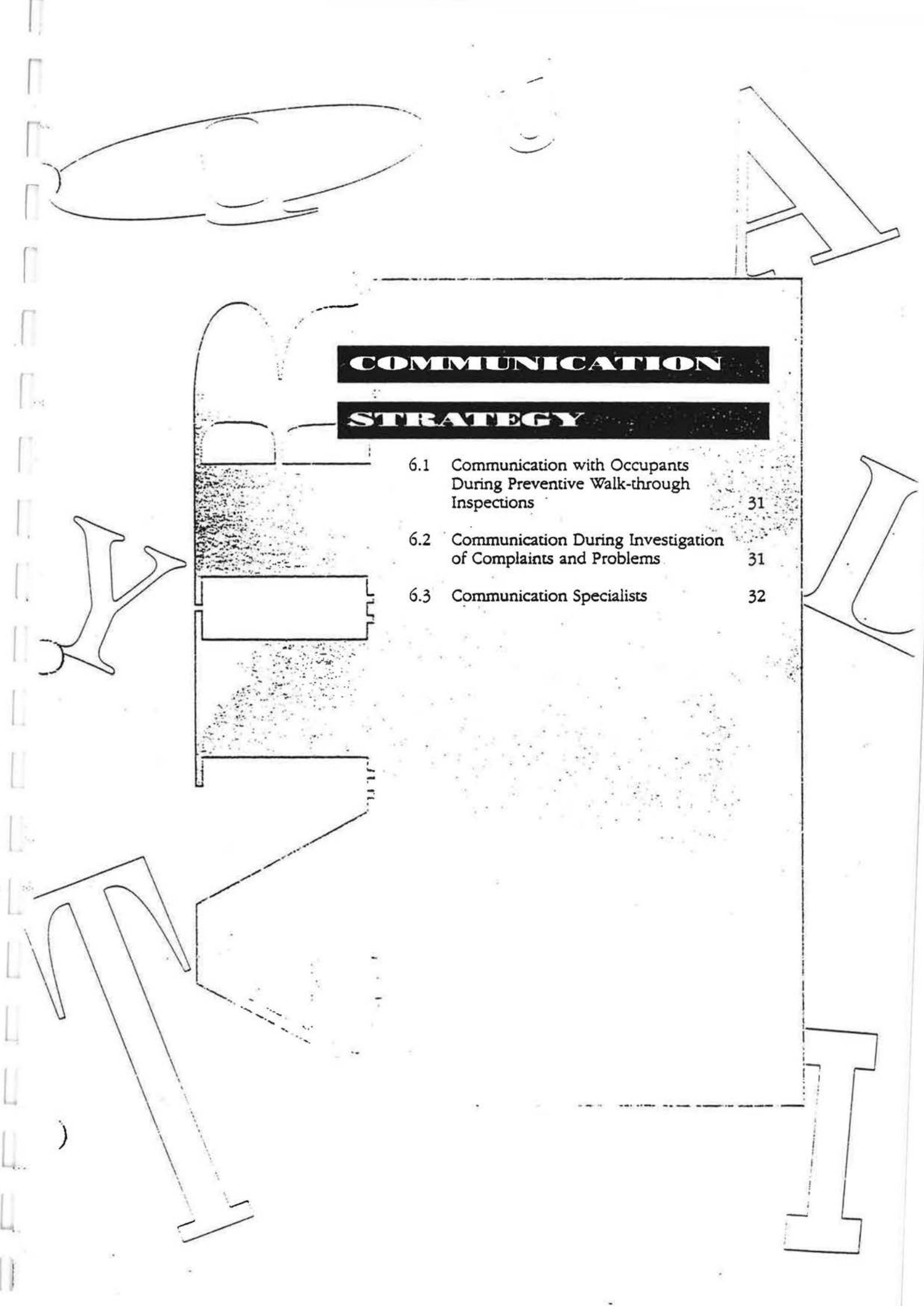
5.3 Taking Corrective Action

Once the source of a problem is identified, corrective measures should be taken promptly. Corrective action should normally be graduated. Start off with obvious adjustments and verify their effectiveness by measuring the overall ventilation rates; for example, by measuring carbon dioxide concentrations. If the obvious adjustments are unsuccessful, then move to the more involved and expensive recommended system changes as required.

Some of the technically-simple, typical corrective actions that may be required to address ventilation problems include the following:

- adjusting the minimum setting of the outdoor air damper;
- rebalancing the air distribution;
- unblocking of air openings on the window sill;
- relocation of diffusers or return air openings;
- alteration of partition layouts;
- alteration of partition heights;
- adjustment of VAV boxes;
- re-balancing outdoor air supply (in buildings with a fixed outdoor air system, i.e., compartmental system); or perhaps
- installation of a ceiling or desk fan.

In some cases, special ventilation strategies may be advisable. In new buildings, for example, carpets, acoustical screens and other materials emit or off-gas trace amounts of chemicals such as formaldehyde. As this off-gassing continues 24 hours per day for the first year or two, small amounts of these air contaminants accumulate during silent hours. One strategy is to preventilate by turning on HVAC systems before the beginning of each day. This same strategy could be employed during renovations or even painting. The most effective ventilation strategy is to locate sources of air contaminants, such as copy machines, together in one room where they can be handled by a local ventilation system. However, this is not always practical.



COMMUNICATION STRATEGY

6.0 COMMUNICATION STRATEGY

6.1 Communication with Occupants During Preventive Walk-through Inspections

Communication between inspection personnel and building occupants is essential and must not be avoided. It is an opportunity for property managers to demonstrate their resolve in providing a satisfactory work environment.

Here are a few points regarding communication with occupants during the walk-through inspection.

- Explain to occupants that the routine inspection is being conducted to ensure that operations and maintenance of the building and its mechanical systems are providing the appropriate level of environmental comfort. This will assure occupants that the quality of their work environment is of concern to you. In turn, occupants may contribute by pointing out potential problem areas that go unnoticed in the walk-through inspection; for example, an area they feel is inadequately cleaned or ventilated. Taking immediate action in these particular areas will definitely be noticed by occupants and will enhance working relationships as well as improve the working environment.
- Another sound approach is to explain that the inspection will ensure the building is being operated to industry-accepted standards. It is suggested that property managers *not* state that the routine inspection is being conducted to identify potential air contaminant sources that may cause air quality problems. Terminology such as "air pollutant," "air contaminant" or "air contaminant source" tends to be alarmist. Air contaminants are present in all indoor air, usually in concentrations far below generally accepted guidelines. The danger of making specific reference to air contaminant levels is that it may lead some skeptical occupants to advance the somewhat academic argument that there are known safe levels of pollutants.
- It is not recommended that occupants be directly questioned on their impression of the air quality in the building. Direct questioning should generally be left to qualified professionals who specialize in developing objective survey protocols.

6.2 Communication During Investigation of Complaints and Problems

During investigation of complaints and problems and follow-up remedial measures, the property manager should keep all interested parties informed, including occupants, unions, clients and health and safety committees. Otherwise, physical air quality improvements may go largely unnoticed and unappreciated, and complaints may persist. The means of communication used will depend on the size of the building and the number of occupants affected. Communications should involve:

- assurances that the occupants' working environment is a primary concern and that any problems will be corrected;
- information about remedial measures, possibly providing verification that remedial measures are successful;
- opportunities for occupants or occupants' representatives to see the remedial work being carried out or to witness measurements of air quality; and
- follow-up communication to ensure that occupants and particularly the complainants have noticed a beneficial change in their work environment.

6.3 Communication Specialists

Communications on indoor air quality problems are sensitive, and the property manager should not hesitate to obtain the support of communication specialists. When large numbers of occupants in a building become very concerned about the indoor environment, an overall communication strategy should be developed.

ANNEXES

ANNEX 7.1

7.1 Parties Involved in the Indoor Air Quality Issue, for Federal Employees

Labour Canada

Labour Canada is the regulatory agency of the Federal Government with respect to the occupational health and safety of federally-regulated employees including members of the Public Service. Environmental conditions essential to the health and safety of employees are defined and enforced through the application of the Canada Occupational Safety and Health Regulations (COSHR) issued pursuant to Part II of the Canada Labour Code.

Treasury Board

Treasury Board's Occupational Safety and Health Standards are contained in Volume XII of the Personnel Management Manual and are considered to be part of Public Service collective agreements. As the employer, with respect to the Federal Public Service, the Treasury Board goes beyond strictly health and safety considerations by adopting environmental targets that promote employee productivity.

Health and Welfare Canada

Health and Welfare Canada sets the health and safety standards which are then enforced by Labour Canada. Health and Welfare Canada also provides professional advice to the Treasury Board with respect to environmental targets that promote employee productivity. It is also responsible for monitoring departmental compliance and promoting the implementation of these standards.

Public Works Canada

Public Works Canada plays complementary roles in the provision of accommodation which conforms to health and safety and productivity requirements. These roles reflect the responsibility of the Department as a custodian of the government inventory of general purpose buildings, as the government's design and construction agency, and as a realty management agency providing property management, operation, maintenance and repair services.

Building Occupants

Building occupants play a key role in establishing a productive work environment. Alterations to office layout, changes in occupancy levels and the introduction of new processes and equipment must all be assessed with respect to their impact on the working environment. Such changes must be discussed with the property manager so that building systems can be adjusted to reflect the changes in occupant activities.

In addition, good housekeeping practices are required by building occupants to prevent unnecessary interference with the operation of building systems.

ANNEX 7.2

7.2 Detailed Indoor Air Quality Inspection Checklist

This checklist is to be used for first preventive inspection and subsequently, for Level 1 investigation of tenant complaints.

The initial walk-through inspection will be the most time-consuming as it involves assembling data on the chemicals being used in the building and on building characteristics. This data will be recorded on Information Forms, Annex 7.6 Inventory of Chemicals used in Cleaning, Maintenance, Operations and Pest Control and Annex 7.7 Building Characteristics. This initial inspection may reveal some potential indoor air quality deficiencies that should be corrected. At the same time, this thorough inspection presents an opportunity for property managers to update their knowledge of the particular air control systems involved and the current building operations.

The inspection checklist provides a walk-through guide for the inspection, identifies where attention is required and the degree of urgency to be given each corrective action. Each question on the checklist is to be answered by a "tick" in the "Yes" or "No" columns. In cases where occupant complaints are limited to one ventilation zone, the property manager should initially focus on those questions designated with the zone indicator "z".

Action symbols are used throughout the checklist to indicate the urgency of action to be taken. When the answer to the question is "No" this indicates that a satisfactory condition exists and no remedial action is required at this time. Precautionary measures may, however, be indicated for follow-up consideration. When the answer to the question is "Yes" some form of remedial action is likely needed. The urgency is indicated by "x" for immediate attention and "o" for precautionary action. Questions that do not have indicator symbols are included in the checklist to provide information that may be useful in troubleshooting potential problems.

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION

To be used for First Preventive Maintenance Inspection and Subsequently for Level I Investigation of Client Complaints

Inspection Conducted by:	Weather Conditions at Time of Inspection:
Date: Time:	Outdoor Temperature _____ Wind Speed _____ km/hr Relative Humidity _____ Wind Direction _____ General Synopsis (sunny, cloudy, rain, etc.) _____

A	Inspection for potential problems and contaminant sources outside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	FRESH AIR INLETS					
1	How many fresh air inlets are there to the building? ☐					
2	Are any inlets located near parking or major vehicle traffic routes? *(*Arrange for a measurement of the carbon monoxide concentration at the fresh air inlet during the peak vehicular traffic time. Determine if the carbon monoxide concentration is below accepted guidelines for ambient air quality.)*		x			
3	Are any inlets located near cooling towers? *(*Obtain a second opinion from qualified personnel regarding the proximity of cooling towers to fresh air inlets. Relocation of one or the other may be necessary.)*		x			
4	Are there any signs of blockage to the fresh air inlets (leaves, snow, etc.)? *(*Instruct maintenance personnel to unblock fresh air inlets. Ensure that they will remain free of blockage.)*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

A	Inspection for potential problems and contaminant sources outside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
5	Is there any vegetation near fresh air inlets? *(*Have nearby vegetation that is a source of pollens and spores removed, if possible.)* If yes, identify the type of vegetation. _____ _____ _____		o			
6	Are there other potential sources of air contaminants in the vicinity of the building (chimneys and stacks, industrial plants, dry cleaners, etc.)? If yes, what are they? _____ _____ _____ _____ *(*Judge whether or not exhausts from nearby buildings or facilities are close enough to contaminate the fresh air supply for the building. If suspect, have qualified personnel make the assessment. This may involve a visual inspection or the use of a tracer gas to track airflow.)*		o			
7	Has the exterior of the building in the vicinity of the fresh air inlets been painted recently? *(*If air quality complaints coincide with painting in the vicinity of the fresh air inlets, inform occupants that the problem is only temporary.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

A	Inspection for potential problems and contaminant sources outside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
8	Has the roof been repaired recently? *(*If air quality complaints coincide with roof repair in proximity to the fresh air inlets, inform occupants that the problem is only temporary.)*		o			
9	Have nearby traffic routes or the parking lot been repaired recently? *(*If air quality complaints coincide with traffic route or parking lot repair, inform occupants that the problem is only temporary.)*		o			
10	Are there exhaust outlets within 2 m of fresh air inlets? *(*Arrange for qualified personnel to examine the existing design and, if necessary, make recommendations for relocation or construction.)*		x			
	ENTRANCES					
11	Are there major vehicle traffic routes or parking areas in the vicinity of occupant entrances? *(*Arrange for the measurement of the carbon monoxide concentration at the occupant entrance during the peak vehicular traffic time. Determine if the carbon monoxide concentration is below the accepted guidelines for ambient air quality.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

A	Inspection for potential problems and contaminant sources outside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
12	Can inward airflow be sensed at occupant entrances? *(*Arrange for the measurement of the carbon monoxide concentration at the occupant entrance during the peak vehicular traffic time. Determine if the carbon monoxide concentration is below the accepted guidelines for ambient air quality.)*		o			
13	Are there major vehicle routes or parking areas in the vicinity of freight entrances? *(*Arrange for the measurement of the carbon monoxide concentration at the freight entrance during the peak vehicular traffic time. Determine if the carbon monoxide concentration is below the accepted guidelines for ambient air quality.)*		o			
14	Are vehicle engines running when materials are unloaded or loaded? *(*Prohibit engines from idling when parked in the immediate vicinity of freight entrances unless there are specific devices for removing their exhaust. The use of signs may be necessary.)*		o			
15	Do vehicles with refrigeration systems still running stop at freight entrances? *(*If there are vehicles that cannot be turned off, for example, a vehicle with a refrigeration system requiring the engine to run the compressor, ensure that their exhaust does not enter the building at*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

A	Inspection for potential problems and contaminant sources outside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	these entrances. Request that exhaust is ducted away from the air intakes and entrances.)					
16	Can inward airflow be sensed outside freight entrances? *(*Prohibit engines from idling when parked in the immediate vicinity of freight entrances unless there are specific devices for removing their exhaust. The use of signs may be necessary.)*		o			
17	Can inward airflow be sensed at outside garage entrances? *(*If there are vehicles that cannot be turned off, ensure that their exhaust does not enter the building at these entrances. Request that exhaust is ducted away from the air intakes and entrances.)*					
	AIR OUTLETS					
18	How many exhaust air outlets are there from the building? _____					
19	Do any of the exhaust air outlets face in the direction of fresh air inlets? *(*Have qualified personnel check that the distance between the exhaust outlets and fresh air inlets is sufficient for avoiding air quality problems caused by short-circuiting of exhaust air. Determine if reorientation of the exhaust air outlets is necessary.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	MECHANICAL EQUIPMENT ROOM					
20	Do the floors and walls appear to need cleaning? *(*Arrange for the cleaning of the floors and/or walls. Ensure that cleaning and maintenance staff include this measure as part of their routine work.)* How often are they cleaned? ☐		x			
21	Is there any stagnant water on the floor? *(*Arrange for the removal of the stagnant water. Determine the source of the water and correct the problem.)*		x			
22	Are there any wet spots on the walls or floors (especially in corners)? *(*Take measures to dry wet areas and repair those areas that have been water damaged. Determine the source of water and correct the problem.)*		x			
23	Is there any mould on the walls or floor? *(*Arrange for the cleaning and removal of mould from the walls or floor. Repair the areas that have been damaged.)*		x			
24	Is there any paint peeling on the walls or floor? *(*Paint peeling in localized areas sometimes indicates that the surfaces have become wet. Determine the source of water and correct the problem.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
25	Is the mechanical room used as a storage space?					
	OFFICE SPACE					
26	Are there dust marks on or around ceiling diffusers and return air grilles? *(*This occurence is not uncommon. Check that filters in the HVAC system are cleaned or replaced on a regular basis.)*		o			
27	Does the floor area appear to need cleaning? *(*Arrange for cleaning staff to clean or vacuum the floors. Have floor cleaning conducted more frequently if this problem continues.)* How often is the floor vacuumed? _____		x			
28	Is there any dust visible on window sills, drapes or bookshelves? *(*Arrange for cleaning staff to clean these areas. Check that filters are properly maintained. Have cleaning staff clean these areas more frequently if the problem continues.)*		x			
29 (Z)	Is there any condensation on windows or window sills? *(*Excessive condensation on windows or window sills is sometimes an indicator of high humidity, possibly due to lack of ventilation. Have humidity levels measured.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
30	Is there any wall staining in the vicinity of windows or window sills? *(*Wall staining in the vicinity of windows or sills indicates that there was once condensation on the window or window sills. Have the stains repaired and check for condensation on the windows and window sills on cold days).*		o			
31	Are there any other stains or residues left behind from underdiluted industrial cleanser or improper usage of cleaners? *(*Ensure that cleaning staff are using cleaning agents correctly.)*		x			
32 (Z)	Are there any noticeable odours? *(*If occupants have complained of odours, ask them where they believe the odours originate. Ensure that the occupied space is cleaned properly. Have maintenance staff check the functioning of the intake dampers. Check that floor drain traps are not dry; fill if necessary. Check and remove obvious sources external to the building, if possible.)*		x			
33 (Z)	Does the space seem dry? *(*Arrange for qualified personnel to conduct a humidity measurement. Have maintenance staff check if humidifiers are functioning properly.)*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
34 (Z)	Does the space seem stuffy? *(*Have maintenance personnel check for airflow or air motion at the supply air grilles. If air circulation seems insufficient, arrange for qualified personnel to estimate the overall ventilation rate using the CO_2 method.)*		x			
35 (Z)	Are there any noticeable drafts? *(*Have maintenance personnel locate the source(s) of drafts. Have qualified personnel correct the problem.)*		x			
36 (Z)	Does air motion appear restricted at diffusers and grilles? *(*Check for blockage at affected diffusers or grilles. If air motion cannot be sensed at all diffusers and grilles, check for blockage in the main air supply.)*		x			
37 (Z)	Have any registers or grilles been blocked off by occupants deliberately? *(*Have the blocked registers or grilles unblocked. Determine the reason for deliberate blockage by questioning occupants. Relocate grilles or adjust the damper settings.)*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
38 (Z)	Have books or other items been placed on top of ventilation grilles? *(*Remove books or other items from the top of ventilation grilles and inform occupants that blocking off these grilles can decrease the comfort of their work environment. If the problem continues, it may be necessary to install grilles that are sloped.)*		x			
39 (Z)	Is there furniture or are there other obstructions blocking ventilation grilles? *(*Have occupants move their furniture and other obstructions away from ventilation grilles. Inform them that blocking off ventilation grilles can decrease the comfort of their work environment. Relocate the grilles or adjust the damper settings.)*		x			
40 (Z)	Are there any high partitions in the office space (over 1.8 m)? *(*High partitions can affect air circulation in the office space. They may require lowering if occupants in localized areas complain of poor air quality.)*		o			
41 (Z)	Do office partitions touch the floor or are they less than 15 cm above the floor? *(*Have office partitions raised at least 15 cm above the floor.)*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
42 (Z)	Are there any photocopier machines in the office space? *(*Photocopier machines are a source of ozone and some volatile organic compounds. Not all photocopiers need to be directly vented to the outdoors. If there are complaints of poor air quality from occupants who work in the vicinity of photocopier machines, arrange for qualified personnel to measure for associated air contaminants in their locale.)* Are they wet or dry machines? _____ Are they vented to the outdoors? _____		o			
43 (Z)	Are there any facsimile machines, laser printers or other equipment? What are they? _____ *(*Facsimile machines, laser printers and other office equipment are sources of volatile organic compounds. However, it is not likely that their fumes need to be vented directly to the outdoors. If there are complaints of poor air quality from occupants who work in the vicinity of this type of equipment, arrange for qualified personnel to measure for associated air contaminants in their locale.)*		o			
44 (Z)	Are there any video display terminals? How many? ☐					

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
45 (Z)	Does the office space seem to be too hot or too cold? If yes, which? *(*Check that the thermostats are set correctly. Measure the temperature in the occupied space. Also measure the temperature of the air immediately next to the thermostat and compare with the reading on the thermostat. A difference indicates that the thermostat needs to be recalibrated.)*		x			
46	Are many occupants wearing sweaters or heavy clothing? *(*Chances are that the occupied space is too cold. Refer to action number 45 of this guide.)*		o			
47	Are any thermostats located where they may be exposed to drafts? *(*Have affected thermostats relocated or eliminate drafts.)*		x			
48	Are any thermostats blocked by furniture or other obstructions? *(*Have furniture or other obstructions removed. Inform the affected occupants that this measure is necessary for properly controlling the thermal comfort of their work environment.)*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
49	Are any thermostats located where they may be exposed to direct sunlight? *(*Have the affected thermostats relocated or shade them from direct sunlight.)*		x			
50 (Z)	Can occupants adjust the temperature settings on the thermostats? *(*In areas where temperature of several workstations is controlled by one thermostat, do occupants adjust the thermostat often?)* Typically, how many workstations have temperature control by one thermostat? ☐					
51	Is there a thermostat in each office?					
52 (Z)	Have thermostats been calibrated? When was the last time? _____ What are the settings on the thermostats? _____ *(*If there are complaints of the occupied space being too hot or too cold and the thermostats appear to be set correctly, recalibrate the thermostats.)*		o			
53	Are drapes left open during periods of sun and closed at other times?					
54	Can occupants operate the drapes?					

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
55	Do occupants complain of inadequate lighting at workstations? *(*Check that existing lighting is functioning properly. Arrange for the installation of additional lighting if necessary.)*		x			
56 (Z)	Is the lighting level adjustable? If yes, how is it controlled? _____ _____ _____					
57	Is there sunlight creating glare? *(*Provide shading where there is sunlight creating glare, perhaps drapes. If there are drapes already installed but left open, ensure that there is adequate lighting when they are closed.)*		x			
58	Is there task lamping?					
59	Is background noise of ventilation system easily heard? *(*If background noise of ventilation system seems objectionable, arrange for qualified personnel to conduct sound level measurements.)*		o			
60	Do noises from occupant activities (typing, photocopying, conversations and traffic) seem loud enough to affect ones concentration? *(*Noises of this type are beyond the control of the property manager. However*		o			

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	they are worth noting. An occupant's lack of concentration that is sometimes attributed to poor air quality may really be due to noise.)					
61	Are workstations in open areas?					
62	Do occupants complain of noise? *(*If the noise is caused by the ventilation system, have qualified personnel conduct sound level measurements. If the noise is caused by occupant activities, layout changes in the office space may be necessary. When layout changes are made, measure ventilation rates at various workstations using the CO_2 method to ensure that occupants are still receiving their required amounts of ventilation air.)*		o			
63	Make general notes regarding occupant density in the office space (approximate occupant-to-space rating; is furniture layout congested or uncrowded; type of partitioning, etc.) _____ _____ _____ _____ _____					
	SPECIAL PURPOSE SPACES Repeat 64 to 71 for each special purpose space. (Photocopy these questions as required.)					
64	Indicate the type of special purpose space. _____ _____					

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
65	Are there commercial establishments in the same building? If yes, what are they? _____ _____ _____ _____ _____					
66	Is there a special ventilation system in this space? If yes, give a brief description of the system. _____ _____ _____ _____ _____					
67	Are there noticeable odours in this space? Does the space seem stuffy? *(*If occupants have complained of odours, ask them where they believe the odours originate. Ensure that the occupied space is cleaned properly. Have maintenance staff check the functioning of the intake dampers. Determine if odours are from outside the building or inside the building by sensing if there are odours at the fresh air intake.* *If the space seems stuffy, have maintenance personnel check for airflow or air motion at the supply air grilles. If air circulation seems insufficient, arrange for qualified personnel to estimate the overall ventilation rate using the CO_2 method.)*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
68	Does the air seem dry in this space? *(*Arrange for qualified personnel to conduct a humidity measurement. Have maintenance staff check if humidifiers are functioning properly.)*		x			
69	Do occupants complain of inadequate lighting? *(*Check that existing lighting is functioning properly. Arrange for the installation of additional lighting if necessary.)*		x			
70	Are there objectionable noises in this space (noises which are not typical of the special purpose space and may be objectionable to occupants)? *(*If there are objectionable noises that are not due to normal occupant activities, arrange for qualified personnel to conduct sound level measurements.)* If yes, what are they? _____ _____		o			
71 (Z)	Are chemicals or solvents being handled or stored in this space? If yes, what are they? _____ _____ *(*Ensure that the chemicals or solvents stored in this space are tightly sealed. Determine the suitability of the space for this type of storage. It may be desirable to store these chemicals and solvents in an appropriate storage area.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	PARKING					
72	Is there indoor parking attached to the building? _____ If yes, complete 73 to 84.					
73	Are there any enclosed vestibules attached to entrance doors, stairs and elevators? *(*Arrange for qualified personnel to measure the carbon monoxide concentration at entrance doors to the building during the peak traffic time. Elevated or slightly elevated concentrations indicate that some vehicular emissions are entering the building at these points.)* If yes, are they pressurized?		o			
74	Are there any odours entering the building that are believed to have originated from the garage? *(*Immediately arrange for qualified personnel to measure the carbon monoxide concentration in the occupied space, in the garage and in access ways between the garage and occupied space.)*		x			
75	Can airflow from the garage to the building be sensed at garage access doorways or elevators? *(*Arrange for qualified personnel to measure the carbon monoxide concentration at access routes during the peak*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	traffic time. Contact an HVAC specialist to determine a means for preventing this airflow.)					
76	Should garage cleaning be improved? How often is the garage cleaned and what does cleaning involve? _____ _____ _____ *(*Have appropriate cleaning staff clean the garage area. Ensure that the garage is cleaned on a regular basis.)*		x			
77	Are any areas of the garage used for storage? If yes, what materials or items are stored? _____ _____ _____ _____ _____					
78	Is the garage missing carbon monoxide sensors? *(*Consider the option of having them installed.)*		o			
79	Has the time since the last calibration exceeded three months? *(*Measurement and sensing instrumentation usually have a recommended frequency for which they are to be calibrated. Calibrate the carbon monoxide sensors as recommended.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Inspection for potential problems and contaminants in the occupied areas of the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
80	Have the carbon monoxide detectors triggered the alarm system since they were last inspected or calibrated? If yes, when? _____ *("Try to determine the cause of the alarm by communicating with building operations and maintenance staff. Arrange for qualified personnel to measure the carbon monoxide concentration in the garage during the peak traffic time. If the levels are acceptable, recalibrate the carbon monoxide sensors.)*		x			
81	How many vehicles can the garage accommodate? _____					
82	Does most vehicle traffic in and out of the garage occur in the morning when the office opens, at lunch hour and in the afternoon when the office closes? If no, record when vehicles come and go. _____					
83	Do vehicles have to stop momentarily after entering the garage or before leaving the garage for example, to pay for parking? If yes, specify after entering, before leaving or both. _____ _____ _____					
84	How many vehicles with engines running are waiting to exit during the peak period? _____					

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

C	Inspection for potential problems within the building mechanical systems	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
85	Is there a preventive maintenance program in place?					
	FRESH AIR INTAKES					
86 (Z)	Are there any obstructions in the fresh air intakes (eg. newspapers, etc.?) *(* Remove obstructions. Check if the design or orientation of the fresh air inlets is such that blockage will occur again.)*		x			
87	Are there signs of water staining or mould? *(* Water stains and mould indicate that very moist air is entering the building. The source of the problem could be a nearby cooling tower. Remove mould and water stains. Arrange for qualified personnel to determine the source of moist air if it is not obvious.)*		x			
88 (Z)	Is there indication that the outdoor air dampers on the air handling units are not functioning properly? *(* Arrange to have the dampers serviced. Ensure that operations and maintenance staff are preventively maintaining them.)* If there is a minimum setting on the outdoor air dampers, what is it? _____ _____		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

C	Inspection for potential problems within the building mechanical systems	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	AIR FILTERS					
89	Do air filters appear to need cleaning? How often are they cleaned or replaced? _____ _____ _____ *(* Have air filters cleaned and replaced.)*		x			
90	Are there any filters that contain aldehyde resins? (Obtain information from suppliers.) *(* Although filters containing aldehyde resins are not likely to cause an air quality problem, they should be replaced with filters that do not contain aldehyde resins if practical.)*		o			
	MIXING CHAMBER					
91	Is there indication that the air mixing dampers are not functioning properly? Outdoor Return Relief *(* Arrange to have the dampers serviced. Ensure that operations and maintenance staff are preventively maintaining them.)*		 x x x			
92	Do the walls and floor of the chamber appear to need cleaning? *(* Arrange for the cleaning of the mixing chamber. Ensure that this measure is part of the regular operations and maintenance schedule.)*		x			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

C	Inspection for potential problems within the building mechanical systems	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
93	Is the lighting in the chamber burned out? *(* Burned-out lighting in the mixing chamber indicates that the chamber may not have been inspected or cleaned for some time. Fix lighting.)*		o			
94 Z	Does airflow appear restricted at the outdoor air supply registers? *(* Have qualified personnel determine the cause of inadequate airflow. Probable causes are closed intake dampers or plugged filters.)*		x			
	COILS					
95 Z	Are there residues in the vicinity of the spray coil?		x			
	Is there foaming in the vicinity of the spray coil? *(* Have the residues and foaming removed or cleaned. Ensure that this measure is a part of the operations and preventive maintenance program.)*		x			
96	Are there water stains on the floor under pumps and evaporative coolers? *(* Have the water stains cleaned. Determine the source of the water and correct the problem.)*		x			
97	Is there a chemical water treatment program in place?					

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

C	Inspection for potential problems within the building mechanical systems	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
98	Do coils require cleaning? *(* Have the coils cleaned. Ensure that this measure is a part of the operations and preventive maintenance program.)*		x			
99	Have any coils been replaced or overhauled recently?					
100 Z	Is there stagnant water or are there water stains on the floor in the vicinity of coils? *(* Have the stagnant water or water stains removed. Determine the source of the water and correct the problem.)*		x			
101	Is there stagnant water or residue formation in condensate pans? *(* Have the condensate pans cleaned. Ensure that they are sloped correctly so that they drain properly.)*		x			
	CONTROLS					
102	Does the building lack a ventilation strategy? What is the ventilation schedule on weekdays? Weekends? _____ _____ _____ *(Ventilation strategies are used to conserve energy. Consider putting one in place.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

C	Inspection for potential problems within the building mechanical systems	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
103	Are there any signs that indicate controls are not functioning properly? If yes, what are they? _____ _____ _____ _____ _____ *(* Arrange for qualified personnel to service the control system.)*		x			
	LOCAL EXHAUST SYSTEMS					
104 Z	Are there indications that local exhaust systems are not operating continuously, or when they are supposed to? *(* Ensure that local exhaust systems are operating when they are supposed to. If they are not, install a means for automatically employing these systems when they are supposed to be used; or operate them continuously.)*		o			
105	Do occupants have control of the operation of local exhaust systems? *(* Ensure that occupants are utilizing local exhaust systems when they are supposed to. If they are not, install a means for automatically employing these systems when they are supposed to be used; or operate them continuously.)*		o			

DETAILED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (concluded)

C	Inspection for potential problems within the building mechanical systems	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
106	Do the main switches for the local exhaust systems need to be more visible or more easily identified? *(* If occupants have control over the use of local exhaust systems, the switches for them should be easily identified. Have the switches clearly labelled.)*		o			
107	Are they interlocked with the supply system or the equipment they serve?		o			
108	How high are exhaust stacks above the roof and what are their directions of discharge? _____ _____ _____ _____ _____					
109	Are there any exhaust outlets through exterior walls? If yes, specify directions that the walls face. _____ _____ _____ _____ _____ *(* Exhaust outlets through exterior walls are subject to a variation in wind pressure. When there is a strong wind blowing on a wall having an exhaust outlet, the amount of air exhausted can sometimes be severely reduced.)*		o			

ANNEX 7.3

7.3 Abbreviated Indoor Air Quality Inspection Protocol

This protocol is to be used for regular, follow-up preventive inspections and performance evaluations.

The abbreviated walk-through inspection should be conducted at least once a year and preferably more frequently. The checklist for this inspection presents situation questions. When answered, these provide indicators of operating conditions and performance. Each question is to be answered by a "tick" in the "Yes" or "No" columns. A "No" response would indicate no corrective action is required and a satisfactory situation exists, whereas a "Yes" response would indicate further attention is required and possibly a Level 1 investigation, using the detailed checklist.

Recommended remedial measures are the same as outlined on the detailed checklist.

ABBREVIATED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION

A	Performance evaluation focussed on prevention of problems outside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	FRESH AIR INLETS					
1	Are fresh air inlets exposed to air contaminant sources? *(e.g., building air exhaust outlets within 2 m of inlets, vehicle traffic, cooling towers, chimneys, industrial plants, roof or asphalt repairs, outside building painting, etc.)*					
2	Are there any signs of blockage of fresh air inlets? *(e.g., leaves, snow, vegetation, etc.)*					
	ENTRANCES — OCCUPANT					
3	Can inward airflow be sensed at these entrances?					
4	Are entrances exposed to air contaminant sources? *(e.g., major vehicle traffic routes or parking vehicle or other combustion engines running when being loaded or unloaded. etc.)*					
	ENTRANCE — FREIGHT & GARAGES					
5	Can inward airflow from the garage or the freight entrances to the building interior be sensed at doorways and elevators?					

ABBREVIATED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Performance evaluation focussed on prevention of problems inside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	MECHANICAL EQUIPMENT ROOMS					
6	Do floors and walls appear to need cleaning?					
7	Are there signs of accumulated moisture? *(e.g., stagnant water on floor, wet spots or mould on walls or floor, paint peeling, etc.)*					
8	Is the mechanical room used as a storage space?					
	OFFICE SPACE					
9	Are there indications of inadequate cleaning? *(e.g., floors and walls, window sills, drapes, bookshelves, around air diffusers and return grilles, etc.)*					
10	Are there signs of condensation on or around windows and moisture staining on walls?					
11	Are there any other stains or residues? *(e.g., under-diluted industrial cleansers or improper usage of cleaners, etc.)*					
12	Are there any noticeable odours, dryness, stuffiness or drafts?					

ABBREVIATED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Performance evaluation focussed on prevention of problems inside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	AIR CIRCULATION					
13	Is air motion non-existent at diffusers and grilles?					
14	Has effectiveness of registers and grilles been reduced by deliberate blockage, by items placed on top of grilles, or by furniture or other obstructions?					
15	Do any office partitions exceed 1.8 m in height or are any less than 15 cm above the floor?					
	OFFICE EQUIPMENT					
16	Does any equipment such as photo-copiers or other machines appear to be causing air contamination?					
	TEMPERATURE					
17	Does the office space seem to be too hot or too cold?					
18	Are thermostats exposed to draft, or sunlight or blocked by obstructions?					
19	Are occupants adjusting the temperature settings?					
20	Do drapes or blinds remain open when they should be closed and closed when they should be open?					

ABBREVIATED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (continued)

B	Performance evaluation focussed on prevention of problems inside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
	LIGHTING					
21	Do occupants complain of inadequate lighting or sunshine glare?					
	NOISE					
22	Does noise from the ventilation system or from occupant activities or occupant equipment appear to present problems?					
	OCCUPANT DENSITY					
23	Does occupant-to-space ratio appear to be below minimum standard?					
	SPECIAL PURPOSE SPACE (repeat 24 to 28 for each SP space)					
24	Indicate type and location of the Special Purpose Space _____ _____ _____ _____ _____					
25	Is there a need for a separate special ventilation system in this space?					
26	Are there noticeable odours, stuffiness or dryness?					
27	Do the lighting or noise levels appear to present problems?					

ABBREVIATED INDOOR AIR QUALITY CHECKLIST FOR WALK-THROUGH INSPECTION (concluded)

B	Performance evaluation focussed on prevention of problems inside the building	No	* Yes	Action Taken	Action Still Req'd	Specific location where action is still required
28	Are chemicals or solvents being handled or stored in this space? If yes, what are they? _____ _____ _____ _____					
	INDOOR PARKING GARAGE (If applicable complete 29 to 33.)					
29	Does air appear to flow inward rather than outward in entrance vestibules, stairs and elevators?					
30	Can airflow from the garage to the building be sensed at doorway or elevators?					
31	Are there any odours entering the building from the garage?					
32	Does the garage cleaning need to be improved?					
33	Is the garage missing carbon monoxide sensors?					
	LOCAL EXHAUST SYSTEMS					
34	Are local exhaust systems operating continuously?					
35	Are the intake grilles, outlet grilles and duct-work obstructed and do they show signs of dust and grease build-up?					

A "yes" answer will require follow-up action. Refer to the Indoor Air Quality Manual, Annex 7.2 for further investigative measures and for suggested corrective actions.

ANNEX 7.4

Information Form — Occupant Environment Complaint Register

Building Name: _____

Date/Time Notified: _____

Name of Occupant: _____ Position: _____

Location in the Building Where Occupant Spends the Most Time:

_____

_____

Nature of Complaint (Symptoms): _____

_____

_____

Time When Symptoms were First Experienced: _____

_____

_____

Frequency of Symptoms: _____

_____

_____

Specific Times or Circumstances that May Be Causing Symptoms: _____

_____

_____

When Symptoms Go Away: _____

_____

ANNEX 7.5

Information Form — Summary of Occupant Environment Complaints

Building Name: _____

For the Period (Specify Dates) _____ to _____

Number of Occupants in Building: _____

Number of Complaints: _____

Nature of Complaints (Symptoms): _____

_____

_____

Locations where Complaints Occur: _____

_____

_____

When Complaints Started: _____

_____

Frequency of Complaints: _____

_____

Specific Times or Circumstances that May Be Causing the Symptoms: _____

_____

_____

_____

When Symptoms go Away: _____

ANNEX 7.6

Information Form — Inventory of Chemicals Used in Cleaning, Maintenance, Operations and Pest Control

Building Name: _____

Chemical (include brand name)	Use	Frequency of Use	Location Where Chemical is Stored

ANNEX 7.7

Information Form — Building Characteristics

Building Name: _____

GENERAL INFORMATION

Age of Building: _____

Basic Construction: _____

Number of Floors: _____

Area per Floor: _____

Note: General information about the building may already be recorded in a building performance review report. If available, it may be useful to attach a copy of it to this form.

BUILDING SYSTEMS

Type of Heating System: _____

Type of Cooling System: _____

Type of Humidification System: _____

Ventilation System:

Central ☐ Compartmental ☐ (check one)

Constant Flow ☐ Variable Air Volume ☐ (check one)

Number of Systems: ☐

Floors and Rooms Served by Each System:

_____

_____

Can outdoor air supply be modulated? _____

Amount of Fresh Air Introduced into the Ventilation System:

Design: _____

Measured (if possible): _____ Date: _____

Filtration System:

Type Used: _____

Frequency of Scheduled Maintenance: _____

RENOVATIONS OR OPERATING CHANGES

List any major renovations or operating changes that have been made in the last year. Items in this category include changes in office layout (e.g., relocation and/or addition of partitions and screens); repairs and decorative renovations, such as new furniture; carpeting and paint.

Descriptions of Changes in Office Layout	Date

Note: Where new partitions have been added, indicate whether or not the supply air has been readjusted.

Description of Major Repairs	Date

Description of Decorative Renovations	Date

ANNEX 7.8

7.8 Description of Air Contaminant Sources

The principal sources of indoor air contaminants are building materials and furnishings, building air-handling equipment, tenant equipment, building and tenant operations, the people themselves and, in some cases, the outdoor air. Some indoor contaminants may be concentrated in localized areas and may warrant installation of special local ventilation systems. Other contaminants may be distributed throughout the occupied space. Dilution and removal of these contaminants relies on the general ventilation system in the building.

Outdoor Air Quality

On most building sites, the quality of the outdoor air entering the building is good enough to provide for effective building ventilation. Most outdoor contaminants are generated by automobiles and factories with combustion or chemical processes. If the outdoor air is contaminated beyond acceptable levels, some means of contaminant removal may be required before the outdoor air is admitted into the building through the general ventilation system.

Combustion and Other Processes

Furnaces and other combustion equipment are potential sources of air contaminants when they are not properly vented. Contaminants, such as carbon monoxide and nitrous oxides, are always present, of course, in indoor garages and may also be found in special purpose buildings.

Building Materials and Furnishings

Building materials and furnishings that are composed of pressed wood products, such as plywood panelling, particle board and fibre board, off-gas small amounts of formaldehyde during the first year or two. Other office furnishings, such as carpets, drapes and upholsteries, fabricated or installed with the use of formaldehyde glues, contribute to the level of formaldehyde, as do wet process photocopiers. The rate of off-gassing is highest when these materials are new, as indicated by the typical graph below. Research is being conducted to determine the exact shape of the off-gassing decay curve.

Human Activity

Human respiration and perspiration also generate air contaminants. Smoking, where still permitted, contributes significantly to indoor air contamination.

Components of HVAC Systems

Some components of HVAC systems such as humidifiers and cooling coil pans contain open water or have wet surfaces. If untreated, the stagnant water can contribute to the growth of biological contaminants. However, chemical treatment in such components may also be a source of air contaminants, so careful management of the related preventive maintenance routine is required.

Commercial Products

Chemicals used in cleaning, maintenance, operation and pest control can be sources of air contaminants if they are not utilized or stored properly.

ANNEX 7.9

7.9 Basic Concept of Operation of Air Quality Control Systems

In all buildings, there is an exchange of air between the indoors and outdoors. This is required for ventilation. For indoor air quality to be properly controlled by ventilation, several criteria must be met. There must be sufficient good quality outdoor air; air intakes and air-handling units must be well designed and properly installed and operated; and finally, the air distribution and circulation system must be arranged to suit the office layout and adjusted to achieve an effective circulation of air. Most air quality problems can be corrected by making some adjustments to the ventilation system.

Outdoor Air Intakes

The location of outdoor air intakes has a lot to do with the quality of outdoor air that is drawn into the building. Intakes should be located upstream of external contaminant sources, such as major vehicle traffic routes, parked delivery vehicles, cooling towers, exhaust outlets, chimneys and vents from nearby buildings, and away from vegetation that is a source of pollens and spores. When possible they should be located high up on the building so that the cleanest possible outdoor air is obtained. Air intakes should be kept clear of leaves, snow, paper and other materials.

Air Flow Dampers and Fans

General ventilation systems usually consist of supply and return air fans. The flow of outdoor air is, in most cases, controlled by three sets of interconnected dampers: the outdoor air damper, the relief damper and the return air damper. In some buildings, the outdoor air flow is fixed and cannot be modulated. Air handling systems in these buildings are also equipped with outdoor air dampers. These dampers are fully open when the air handling systems are on and fully closed when the systems are off.

Air Filters

Filtration of building air is normally achieved using a pre-filter section equipped with flat filters and a main filter section with bag-type filters. In older buildings, the efficiency of air filters may not meet the current specification. Additional filtering capability may be installed, provided that there is enough room in the air filter section.

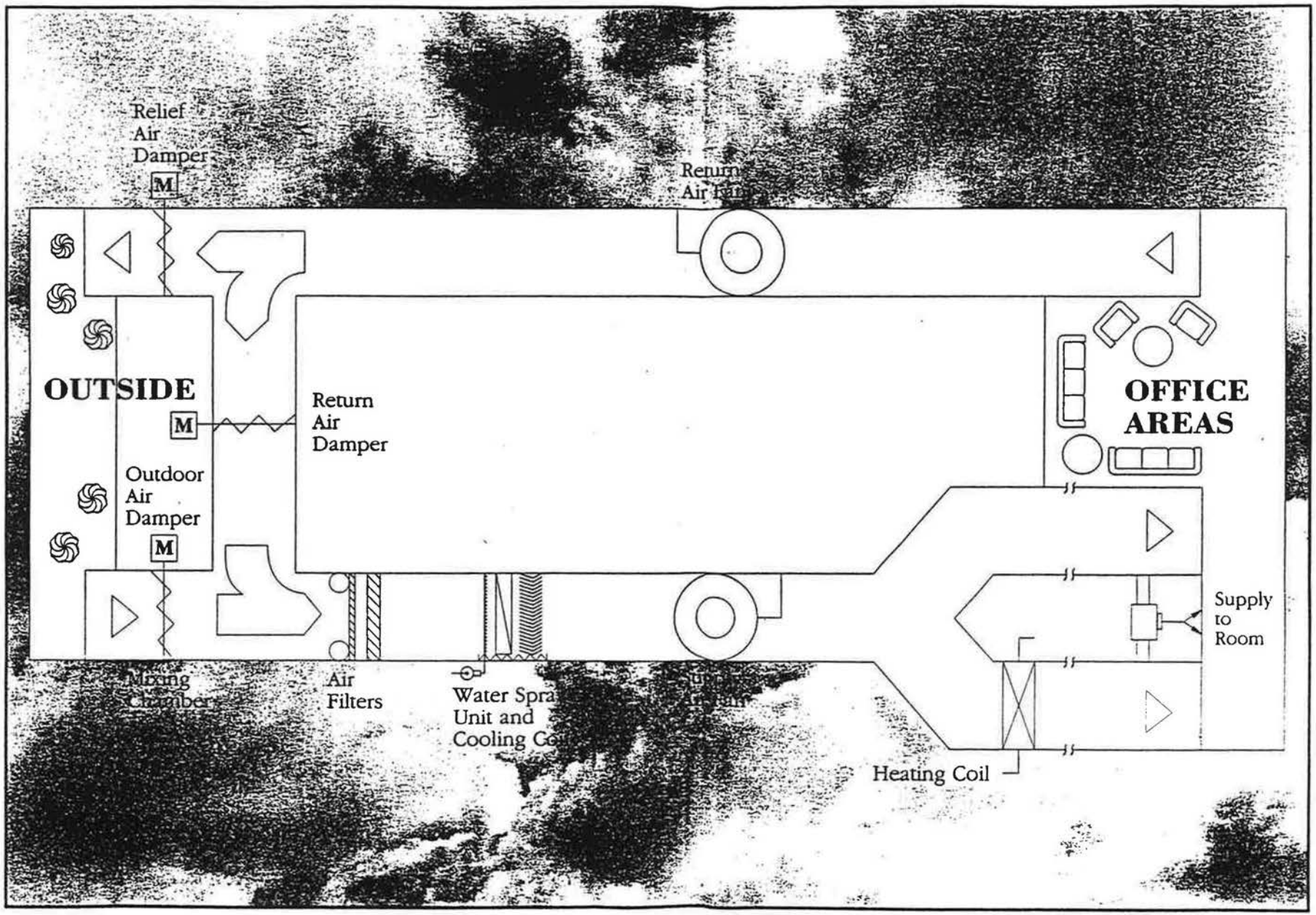
Humidity Control Devices

Where humidification is provided by steam, the chemical treatment of steam (where applicable) should be examined for toxicity. Where spray-type humidifiers are used, they must be cleaned regularly. Where atomizing humidifiers are used, special care must be taken to avoid the formation of white dust from minerals contained in the supply water. When cooling coils are used for humidity control, drip pans below them must be properly drained or spontaneous bacteria growth may occur in them.

Air Distribution

In office buildings there are generally one of two types of air handling system — central or compartmental. One of the most important indoor air quality-related features usually incorporated in a central system is free cooling. This allows up to a 100% supply of outdoor air at certain times of the year. In addition to the main building supply and return air-handling system, the compartmental system has a second stage of air-handling equipment located in mechanical rooms on various floors.

TYPICAL HVAC SYSTEM



In either type of air-handling system, the air distribution on each floor is often divided into two zones, the perimeter zone and the interior zone, with the boundary between the two located about five meters inside the perimeter wall area distribution. The air supplied to the perimeter areas is relatively much higher to compensate for additional solar gain through exterior windows and walls.

Air distribution is generally controlled by the temperature in the occupied areas. In constant volume designs, the temperature of the supply air is varied with the volume remaining constant. In variable air volume designs, the volume of supply air is varied with the temperature remaining constant.

Air Circulation

The air circulation pattern in the occupied space is governed by the location of air diffusers, the angle of the air diffuser vanes and the location of the air return slots. The layout of office partitions and acoustical screens, as well as the screen height and clearance above the floor, influence the effective circulation of the air in the work space.

It is relatively difficult to achieve and maintain optimum air circulation patterns with variable air volume systems due to the fluctuating air volume and corresponding air flow velocity.

A schematic drawing of a typical heating, ventilation and air conditioning system in shown in Figure 4.