Indoor Air Quality

Commissioning For Good Indoor Air Quality in New and Renovated Office Space

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Abstract

Specific building commissioning and project management practices which are implemented before, during, and after building renovations can contribute substantially towards ensuring good indoor air quality. This paper presents a template to assist the project manager in carrying out renovations to an office building with occupants. It was initially published in the proceedings from the Healthy Buildings conference in Finland in year 2000.

Introduction

Many organizations in Canada, both government and private sector, have been downsizing for the last ten years. As a result, there are fewer employees and more consolidation of office space. It has now become common practice to renovate office space with sitting tenants. Moving tenants into swing space during construction is being resisted because of its disruption to the occupant's business. It is now common to renovate commercial space without entirely evacuating the people by the process of:

- increasing population density, squeezing more people into less space,
- renovating the newly vacant area,
- moving everyone into the newly renovated space,
- then renovating the rest of the floor,
- and finally replacing the occupants in their finished workstations.

This has risks to the indoor air quality of the office workers who are crowded into the smaller space because this building occupancy condition may exceed the building's heating, ventilation, and air conditioning (HVAC) design capacity in that space. The situation is exacerbated by dusts and odors from the renovation processes, including increased indoor

sources of airborne particulate matter, and of volatile emissions from new materials. In addition, pre-existing sites of indoor microbials may be disturbed by the demolition.

Template - Design Phase

At the Design Phase, choose construction products and materials with the least emissions. Examine the manufacturer's literature and the Material Safety Data Sheets (MSDS) issued by the manufacturers.

It is important for designers to recognize that many new materials give off a complex mixture of chemicals (i.e. plastics, fabrics, carpets, adhesives). Few building materials have been adequately aired prior to shipping, so they can be expected to off-gas after installation, and to be sources of indoor air contaminants. These contaminants may combine in unexpected ways. They may also be adsorbed by other building materials. This adsorption process may reduce the environmental effects, or alternatively, may extend the duration of off-gassing.

Designers should be instructed to compare materials and select those with the least emissions. Adhesives must be given special consideration. Work and material processes must also be considered. For example, pre-fabricated pieces delivered to site typically cause less dust and disturbance than millwork on site. Be aware too that "No VOC products" do not actually mean that, but are below a certain emission level.

During the Design Phase, it is also essential to plan ventilation modifications to the demolition and construction areas to ensure air is exhausted directly outdoors rather than recirculating construction dusts and fumes into the building return air.

- One technique involves the use of enclosures and plastic sheeting to isolate the work area.
- Another involves the use of portable, local exhaust fans to create negative pressure in the work area relative to occupied parts of the building. Windows may be removed and replaced with plywood with a fan mounted in the plywood to draw odors and dusts outside.
- The return air part of the HVAC system serving each construction area must be turned off or sealed off, to avoid mixing construction fumes and dust with non-construction parts of the floor or the building.

It is also recommended that other factors which affect building air quality be checked and deficiencies corrected. Such factors include locations of air intakes (i.e. those placed over or near loading docks, garbage compactors, and exhaust vents). Consider methods to reduce sun loading on the south and west sides of the building (northern hemisphere). Replace undersized and lined ductwork, outdated controls and diffusers. Assess any potential for carbon monoxide accumulation from underground parking or traffic to enter occupied space. Ensure that food

and cafeteria odors and cigarette smoke are not drawn into office space. Take advantage of the building renovations to consider upgrading telecommunications wiring.

One valuable tool which is frequently overlooked is communication. Occupants should be told that a decision was made to keep them together and in the same area during this renovation, rather than moving them elsewhere during the work. This knowledge commonly ensures greater patience from workers during the inconveniences of construction that are bound to ensue. Providing work schedules and project deadlines lets workers know the anticipated dates of changes. Issuing regular information bulletins keeps them informed and lets them know if the work is on schedule, or if other situations are arising. Showing design layouts, fabric and material samples is also a good practice, to encourage occupants visualizing the renovated space they will occupy after the work is completed.

Part of communication is an effective complaint process, so that problems can be investigated and corrected. Ensure that complaints are answered and actions are taken. Assign responsibility for signing off on these actions. Keep a log of complaints, with a resolution column. Make this log part of the weekly construction meetings.

Template - Construction Phase

As soon as occupants have been moved into the space they will occupy during the demolition and first construction phase, verify the indoor air quality in that space. Check thermal comfort, temperature and relative humidity. These should be within the ASHRAE 55-1992 guidelines [1]. (Temperature between 20 and 23 degrees C in winter, between 23 and 26 degrees C in summer. During spring and fall in North America, when many HVAC systems are unable to adjust to heating one day and cooling the next, the full range of 20 to 26 degrees C is acceptable. Relative humidity should be kept below 60% in summer, and raised above 25% in winter. In Canada, we accept 20% RH for the coldest days of winter). If these conditions cannot be achieved, the HVAC system should be adjusted to ensure the best performance possible. System balancing may be required.

It is recommended that the amount of vacuuming and cleaning in the occupied areas adjacent to construction be increased during this phase. Otherwise, occupants are apt to become dissatisfied if the premises are allowed to become dustier and dirty.

It is also recommended that airborne microbial levels be checked, to ensure that the renovation project has not disturbed unknown sites of microbial amplification. These checks are relatively simple and inexpensive, especially compared to the costs of problems of microbial dissemination. If airborne microbials are found to be unusual, then the source(s) must be found and corrected.

The occupied part of the floor should be tested for airborne mould, and a trained professional

should visit the mechanical room to look for standing water, leaks, stains, torn insulation, and any other microbial amplification sites. It is useful if a mechanical engineer can accompany this visit to visually inspect the condition and functioning of HVAC components, including the cleanliness of HVAC components.

The ventilation rates in the occupied areas should be checked by measuring carbon dioxide concentrations in the densest occupied areas. Carbon dioxide is commonly used to measure fresh air supply - levels should peak below 850 parts per million (ppm), and drop to below 400 ppm at night. If these values are exceeded, more ventilation is required, or some people will have to be relocated. Use these measurements to demonstrate the adequacy of the fresh air supply during the construction project. [2].

Thermal comfort may have to be sacrificed to ensure sufficient ventilation. Outside air at warmer or cooler temperatures than desired may be brought into the building in quantities sufficient to ventilate well, thereby raising or lowering the temperature by a degree or two. Control of relative humidity may be lost for short periods. If so, inform the occupants of the problem, of what is being done to improve the situation, and the anticipated duration. Temporary measures such as personal fans and portable heaters are not recommended, but may be necessary to provide adequate personal comfort.

Periodically during the demolition and construction, airborne dust levels should be checked in the occupied areas. This ensures that dusts from the construction site are not migrating. Outdoor readings should be taken at the same time, so that comparisons can be made. High levels of airborne particulates sometimes occur outdoors, and may have more effect indoors than the construction processes. It may also be advisable to change HVAC filters more frequently than normal during the construction process, or upon completion.

In all cases, it is recommended to share information with occupants.

Template - Post Construction and Pre-Occupancy

Arrange to sample airborne total volatile organic compound levels (TVOC's) after new carpet or vinyl flooring has been laid, when new furniture is in place, and if there is complaint of odours from the occupied space. PWGSC has found 1 mg/m3 of total volatile organic compounds to be a useful guideline. [3] [4] [5] We have found it unproductive to identify each individual VOC in this instance because the source is known (fit-up activities and emissions from new materials). If total volatile organic concentrations are found to be above the guideline in the occupied areas, exhaust air from the construction site will need to be increased, and leaks from the work area into the office area need to be located and sealed.

When the fit-up of the new space is completed, and before the occupants move in, check the airborne particulate levels in the new space, the TVOC levels, and formaldehyde. [6]

Formaldehyde is a suspected carcinogen released from many adhesives and laminated products. Recently renovated buildings are inevitably found to have elevated formaldehyde levels, often above the comfort level of 0.1 ppm, [3] and sometimes above the Health Canada threshold level of 0.3 ppm.[3] If particulates, TVOC's, or formaldehyde levels are elevated, delay the move, increase the air exchanges, run the HVAC system longer, repeat cleaning (for airborne particulate), and monitor again.

Template - Post Occupancy

Once everyone has been moved into the new space, wait a week for people to get back into routine. Then measure thermal comfort parameters and the ventilation rate (carbon dioxide concentrations in the occupied areas).

During the second phase of construction, the new space which is now occupied will need to be monitored periodically for airborne dust levels, TVOC's and formaldehyde to check for migration from the construction area, when complaints or construction activities warrant it.

When at last the project is completed, and occupants have moved for the last time, the HVAC system needs to be balanced for the current layout of people and equipment. Indoor air quality monitoring at this time should include the full range of parameters: temperature, relative humidity, ventilation, airborne particulates, and if off-gassing odors are still noticeable, TVOC and formaldehyde.

Some clients find it useful to post the IAQ reports on their intranet for their employees, others distribute paper copies through the health and safety committee.

Conclusion

This combined effort of the building owner, building operators, designers, contractors and sub-contractors, suppliers, and indoor air quality professionals, should result in healthy, comfortable, renovated office space that looks new. It is a win - win situation for all.

The trick to a successful renovation project in an occupied building is to do the following things:

- Choose low emitting materials and processes to the extent possible.
- Keep construction dusts and fumes away from the occupied spaces.
- Exhaust pollutants directly from the construction areas rather than recirculating air into occupied spaces.
- Verify pollutant levels within the occupied space when there are complaints.
- Communicate with occupants frequently, including acting upon their complaints.
- Upon completion of the work, commission the new space. Balance the HVAC system so

that it delivers air to match the new layout rather than the previous one. Verify that levels of dust and emissions are appropriate for occupancy.
- Continue flushing until odors abate.

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