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COMMISSIONING BUILDINGS TO AVOID INDOOR AIR QUALITY PROBLEMS

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The risk of Indoor Air Quality (IAQ) problems appearing in new and reconditioned buildings is a problem of significant proportions. In North America, research has identified the source of IAQ problems to be malfunctioning, poorly maintained or inadequately designed HVAC systems in more than 50% of investigated buildings. Many problems could have been avoided by proper commissioning of the buildings prior to occupancy.

In 1989, the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) published the first formal guideline for commissioning of HVAC systems. To a great extent, the document was intended as a means of avoiding IAQ problems in newly constructed buildings. However, no specific instructions were provided. The guideline is now being revised and will incorporate a section devoted to avoiding IAQ problems in new and reconditioned buildings.

INTRODUCTION

Indoor air quality (IAQ) has become a pervasive problem plaguing the building industry worldwide. Poor IAQ in commercial and office buildings is primarily related to new building technology, new materials and equipment and energy management operating systems. Occupants of buildings with air quality problems suffer from a common series of symptoms. Those symptoms include eye, nose and throat irritation, dry skin, and mucous membranes, fatigue, headache, wheezing, nausea, and dizziness.(1) Although these symptoms are of significant concern and may in a limited number of cases lead to building related illnesses, by far the biggest problem facing the engineering community is discomfort of building occupants. Discomfort of building occupants leads to increased absenteeism, reduced performance and productivity and often is the reason why tenants chose to relocate.(2,3) Discomfort can also result in significant lawsuits.(4) In other words, the cost of poor IAQ may be very expensive and far outweigh savings due to reduced energy consumption.

As early as 1982 the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), an International organization of professionals representing the mechanical engineering industry, realizing the significance of the problem, produced a position statement that identified the problem and set in motion a strategy for its solution.(5,6) Much of that strategy has now been implemented, including Standard 62-1989 "Ventilation for Acceptable Air Quality",(7); Standard 90.1 "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings",(8); the 100 series of energy standards and Guideline 1 "Guideline for Commissioning of HVAC Systems".(9)

- Identify major outdoor sources of pollutants in vicinity of building site such as exhaust systems, cooling towers of neighboring buildings, and existing or proposed parking garages. Prevailing winds should also be taken into account. This may also include an assessment of soil and ground-water which will interact with the building structure.

- Identify need for supplemental exhaust from known indoor air pollution sources, possibly using transfer air.

Design Phase

- Examine manufacturers safety information for products specified in contract documents that may be suspected contributors to indoor pollutants, including carpets, flooring, linen, adhesives, wall coverings, partitions, and ceilings; insulating and fire-proofing materials; sealants on windows, walls and floors; use of preservatives, paints, varnishes, etc.

- Request manufacturers to provide information on curing, drying and airing procedures for their products to minimize subsequent emission rates. Manufacturers can be asked the following questions:

  * What information does the supplier have about emissions of volatile organic compounds after manufacture from their product? What chemical content labeling is included with the product?

  * What steps, both in manufacture and post construction treatment, does the manufacturer take to reduce emissions from their product before the product is installed in the building?

  * Is it possible for the manufacturer to air out the product before installation? If so, for how long and under what conditions?

- Review installation instructions for proposed adhesive materials used for installing sealing compounds, wall and carpet adhesives, paints, varnishes, etc., ensuring minimum use consistent with proper application.

- Review design documentation for compliance with applicable quality and thermal comfort codes.

- Review design documentation for specification of temporary ventilation and filtration practices during construction and initial occupancy.

- Review design intent under all projected modes of operation and anticipated outdoor conditions, such as minimum and maximum outdoor temperatures, and extreme outdoor conditions. Specific attention should be given to ventilation rates, and temperature and humidity control during all projected operation modes.

- Review orientation of air intakes and exhausts with respect to short-circuiting and local pollution sources such as garages, loading docks, and cooling towers.

- Assess configuration of office partitions with respect to ventilation effectiveness of HVAC design.

- Review provisions of supplemental exhaust from known indoor pollution sources.

- Review choice of filtration type and design, materials, and location within the ventilation system. This should incorporate placement of air filtration systems based on outdoor air conditions and desired indoor contaminant concentrations.

- Review specification of HVAC materials according to susceptibility to wind erosion, corrosion and microbial contamination.

- Review design of internal air supply system components such as condensate trays, water baffles, mist eliminators and cooling towers to control the presence of free water and minimize microbial contamination.

- Ensure availability of access doors and/or inspection ports to all chambers and components of air handling systems plenums. Ensure access doors on air handling units are adequate to allow proper cleaning of condensate pans and/or humidifier reservoirs.

- Review specification and placement of HVAC insulation materials with respect to potential microbial contamination.

Construction Phase

- Review installation of systems components, such as condensate pans and humidity control equipment to control free water within the air handling system.

- Ensure access to all critical components of the air supply systems that will require future cleaning and servicing.

- Ensure proper and careful installation of all HVAC insulation materials.

- Ensure implementation of temporary ventilation and filtration practices during periods of construction such as interior finishing. This may require increased ventilation rates and schedules and the use of items such as temporary operation pre-filters, unitary conditioning/filtering units, and removable windows.

- When the building is partially occupied during construction, the HVAC system should be operated to isolate occupied areas of the building from areas where construction is occurring. For example, this could be achieved by maintaining a relative positive pressure in occupied zones and diverting return air from the construction zones directly outdoors.

Acceptance Phase

- Examine all HVAC internals and filters for cleanliness and readiness for operation.
- Test and verify effective operation of those components of the air handling systems using free water, including humidification control equipment. Proper drainage of water around the building especially in the vicinity of all outside air intakes should be verified.
- Verify that installed materials and equipment are as specified and that appropriate information has been submitted for all substitutes.
- Examine all insulating materials for integrity and proper installation.
- Review test and balance reports and compare to design intent. A spot check of ventilation rates, and temperature and humidity control is recommended.
- Conduct air quality testing as specified by applicable codes and standards.
- Verify that all system operations and maintenance manuals are available.

Post Acceptance Phase

- Ensure adoption of temporary ventilation schedules and rates during and immediately after the acceptance phase.
- Review plans for post-commissioning indoor air quality testing compared to applicable standards and codes.
- Undertake an ongoing IAQ audit process periodically. The audit should include information on building occupancy and use changes.

DISCUSSION

The process of building commissioning if followed carefully throughout all phases of building design, construction and operation will help avoid IAQ problems. Based on conservative estimates, the process of commissioning could eliminate half of all IAQ complaints. In addition, ongoing performance auditing of the building after occupancy could virtually eliminate IAQ complaints in new and renovated buildings to which the commissioning process has been applied.

Building tenants are clearly sensitive to IAQ and comfort considerations when leasing space in new commercial buildings. Fully leased buildings with satisfied tenants will more than pay for the commissioning process. Owners should consider commissioning an indispensable budget item when costing new projects. To recover these costs, marketing agents should include information about commissioning for comfort as part of the leasing promotion package.

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TABLE ONE

INVESTIGATIONS OF PROBLEM BUILDINGS BY NORTH AMERICAN GOVERNMENT AGENCIES

	NIOSH (484 Buildings) Crandell, 1987		HWC (1362 Buildings) Kirkbride, 1990	
Problem Type	Number	Percent	Number	Percent
Inadequate Ventilation	252	52	710	52
Indoor Contaminants	77	16	165	12
Outdoor Contaminants	48	10	125	9
Building Fabric	20	4	27	2
Biological Contaminantion	26	5	6	0.4
No Problem Found	61	12	329	24