HT 8: IMPROVE AIR QUALITY DURING & AFTER CONSTRUCTION

New York City Building Code
Proposal developed by the Construction Practices Committee

Summary

Issue:
Construction activities can lead to the release of substances, such as volatile organic compounds (VOCs) and particulates, that have an adverse effect on the health of construction workers and occupants alike.

Recommendation:
Provide ventilation during construction, protect the HVAC system from contaminants and absorptive materials from moisture, and flush out bad air before occupancy.

Proposed Legislation, Rule or Study

Amendments to the New York City Building Code:

1. Amend Section 3302.1 to include the following defined terms:

   **APPROVED AIR FILTER.** An air cleaning device that achieves either a minimum efficiency reporting value of 8 as measured by ANSI/ASHRAE 52.2-2007 (Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size) or an average efficiency of 30% as measured by ANSI/ASHRAE 52.1-1992 (Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter).

   **DUST-PRODUCING CONSTRUCTION OPERATIONS.** Construction activities, including sweeping, sanding, grinding, cutting, and polishing, that result in the dispersal of particles into the air.

   **HEPA FILTER.** High efficiency particulate air filter capable of removing 99.97% of airborne particles that are at least 0.3 micrometers (µm) in diameter.

   **IMPERMEABLE SEPARATION.** A barrier, typically composed of plastic, sheetrock, or plywood, that prevents the transmission of dust and air from construction areas to occupied spaces.

2. Add a new Section 3303.15 as follows:

   **3303.15 Protecting indoor air quality.**

   **3303.15.1 Cleanliness of HVAC system.** Construction sites shall comply with the following:

   1) Supply and return ductwork delivered to and stored at sites shall be sealed on both ends with a dust barrier to prevent contamination. The ends of installed ductwork shall be sealed daily to prevent dust and debris from settling inside the ductwork.

   2) During dust-producing construction operations, HVAC system openings shall be protected from dust and contamination by either temporarily sealing such openings in the construction work areas or, if the system is in use, installing an approved air filter over each return opening. Prior to occupancy of any space, air filters in such space shall be replaced.

   **3303.15.2 Ventilation during construction operations.** In enclosed spaces without an outside air source, such as operable windows or an opening in the exterior wall, the HVAC system shall be run during construction activities if it is functional. If the HVAC system is not functional and there is no outside air source, then construction workers may open any operable windows for the purposes of temporary ventilation or thermal comfort. This permission may be suspended during precipitation or severe cold that could damage building materials or systems.

   **3303.15.3 Protecting occupied spaces.** At any time that construction work is in progress in an occupied building:
1. An impermeable separation shall be maintained between work areas and adjacent occupied spaces to reduce the flow of contaminants into the occupied space.

**Exception,** Elevators or elevator shafts.

**3303.15.2 Other air quality protection measures during construction.**

1) Absorbent materials including, but not limited to, insulation, sheetrock, carpet, ceiling tile, fabric, and fabric based materials shall be protected from moisture at all times prior to installation. During storage, such materials shall be within an enclosure, protected with a waterproof cover, and raised above the floor.

2) During sweeping, dust shall be suppressed with wetting agents or sweeping compounds. When using such agents and compounds, the work space shall be ventilated in accordance with manufacturer recommendations.

3) Any accumulated water on a floor surface shall be removed immediately.

4) Any vacuum used indoors prior to the issuance of a temporary certificate of occupancy for the work area shall be equipped with a HEPA filter.

**3303.15.3 Post-construction flush out.** After construction work is completed, sites with an indoor work area greater than 5,000 square feet shall comply with either Section 3303.15.2.1 or 3301.15.2.2.

**3303.15.3.1 Flush out option.** Flush the interior air through either of the following methods:

1) Prior to occupancy of a portion of a structure intended for any occupancy classification, deliver a total air volume of 14,000 cubic feet of outdoor air per gross square foot of indoor work area while maintaining an internal air temperature of at least 60 degrees Fahrenheit and a relative humidity no greater than 60%.

2) Prior to occupancy of a portion of a structure intended for any occupancy classification other than Institutional Groups I-1, I-2, I-3 and I-4 or Residential Groups R-1, R-2 and R-3 or that is to be occupied by persons more than 21 hours per day, deliver a total air volume of 3,500 cubic feet of outdoor air per gross square foot of work area while maintaining an internal air temperature of at least 60 degrees Fahrenheit and a relative humidity no greater than 60%. After occupancy, until a total of 14,000 cubic feet per square foot of outside air has been delivered to the indoor work area, ventilation of the indoor work area shall commence at least 3 hours prior to occupancy at a rate of 0.3 cubic feet per minute of outside air per square foot and continue throughout such occupancy.

**3303.15.3.2 Testing option.** Demonstrate safe air quality through air quality testing that complies with Sections 3303.15.3.2.1 and 3303.15.3.2.2.

**3303.15.3.2.1 Maximum concentrations.** Prior to occupancy, demonstrate through air quality testing that no substance listed in Table 3303.15.3.2.1 is present in concentrations greater than that permissible in such table.

**Table 3303.15.3.2.1**

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Maximum Permissible Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>50 parts per billion</td>
</tr>
<tr>
<td>Particulates (PM10)</td>
<td>50 micrograms per cubic meter</td>
</tr>
<tr>
<td>Total Volatile Organic Compounds</td>
<td>500 micrograms per cubic meter</td>
</tr>
<tr>
<td>4-Phenylcyclohexene</td>
<td>6.5 micrograms per cubic meter</td>
</tr>
</tbody>
</table>
Carbon Monoxide | 9 parts per million and no greater than 2 parts per million above outdoor levels

3303.15.3.2.2 Air quality testing procedures. Air quality testing shall follow the following procedures:

1) Indoor air quality testing shall be conducted after construction ends and prior to occupancy using testing protocols in accordance with the United States Environmental Protection Agency Compendium of Methods for the Determination of Air Pollutants in Indoor Air.

2) All air samples shall be conducted during normal hours in which the work area is intended to be occupied, and with the building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.

3) All interior finishes shall be installed, including but not limited to millwork, doors, paint, carpet, and acoustic tiles. Non-fixed furnishings such as workstations and partitions are not required to be in place for the testing.

4) The number of sampling locations will vary depending on the size of the building and number of ventilation systems. For each portion of the work area served by a separate ventilation system, there shall be no less than one sampling point per 25,000 square feet, or for each contiguous floor area, whichever is smaller, and shall include areas with the least ventilation and greatest presumed source strength.

5) Air samples shall be collected between three feet and six feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

6) When retesting indoor work areas where one or more substance was present in concentrations greater than that permissible in Table 3303.15.3.2.1 in prior tests, samples shall be taken from the same locations as the first test.

Supporting Information

Issue - Expanded

Indoor air quality is important to everyone, since Americans spend about 90% of their time indoors. Both construction workers on the job site and building occupants face a range of health risks from indoor air quality.

On construction sites, tasks such as abrasive blasting, emptying bags of cement, cutting wood and masonry, painting, gluing, cleaning with solvents, welding, and using diesel-powered heavy equipment contribute to poor indoor air quality. Data from the National Center for Health Statistics indicate that construction workers face an increased risk of dying from lung cancer compared to the general population; for crane operators, the risk is 80% higher.

Workers are often discouraged from opening windows during construction activities, limiting access to a ready source of fresh outside air. If the option is available, workers should be able to open windows to increase ventilation levels or, if possible, permanent building ventilation systems should be run to increase the amount of fresh air delivered to the construction workers. This will contribute to a better working environment for the construction workers.

Ventilation systems, if unprotected, can become contaminated with dust, debris, and/or organic material that could support the growth of mold. Covering ductwork at the manufacturer’s facility and covering ductwork as it is installed will reduce contamination and provide the permanent building occupants with a cleaner air delivery system.

Buildings under construction can be open to the outdoors, permitting moisture infiltration and high humidity. Coupled with the right temperature range and a food source, this can create conditions that support mold growth. Absorptive materials should be protected from moisture by covering them and keeping them off the floor, and by delaying the loading of such materials as long as is reasonable practical.

New or fresh adhesives, paints, carpets, and sealants emit volatile organic compounds (VOCs) that can be irritating or even harmful to the respiratory system. Other Green the Codes proposals limit the amount of VOCs allowed in building products, but there will still be residual VOCs in building interiors upon completion of a project. Ultimately these VOC’s dissipate once the tenant occupies the space and operates the air systems or opens windows to circulate air. Prior to building occupancy, the level of VOCs in the air should be reduced to acceptable levels. This can be accomplished by flushing out air from the building for a defined duration, or as an alternative, sampling the air to demonstrate that the VOCs in the space are within acceptable levels.
Currently, the operation of permanent ventilation systems is at the discretion of the owner/builder. This proposed code amendment will avoid situations where the permanent ventilation system is turned off for cost or convenience, promoting better indoor air quality in buildings under construction by increasing the amount of fresh air delivered to workers.

**Environmental & Health Benefits**
This proposal will improve air quality on the job site and after construction work has occurred. As a result, it will improve the health of construction workers and building occupants.

This proposal was found to have no significant environmental impact.

This proposal was found to have a high positive health impact per building and to impact a large number of buildings. It was thus given a health score of 3.

**Cost & Savings**
As described in the Executive Summary, Bovis Lend Lease prepared cost estimates for each Task Force proposal in the context of well-defined construction projects in specific buildings. Where possible, members of the Technical Committees prepared savings estimates for some of these projects and buildings. These cost and savings estimates are presented in the February 1st draft version of Appendix A. The innate uncertainty in how construction and operation will vary from one building to another, the complexity of the Task Force proposals, and the wide range of applications in which the proposals may be realized mean these figures are truly estimates.

This proposal was estimated to increase first capital costs by 0.02% to 0.09%, depending on building type. It was thus categorized as incurring a low to medium capital cost increment.

**Precedents**
New York City already has laws in place requiring all new school construction to align with the New York City Green Schools Guide, which includes two Indoor Air Quality measures. These measures, based on similar credits in the LEED rating system, are Q2.1R: Construction IAQ Management Plan, During Construction and Q2.2R: Construction IAQ Management Plan, Before Occupancy. Measure Q2.1R requires the management plan to meet the IAQ Guidelines for Occupied Buildings of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and use filters with a Minimum Efficiency Reporting Value (MERV) of 8. Measure Q2.2R requires a full flush-out be done prior to occupancy.2

California requires rooms where activities produce hazardous fumes or chemicals to exhaust the fumes and isolate them from adjacent spaces. Filters that provide a MERV of 13 are also required in occupied areas of mechanically ventilated buildings.3

**LEED**
This proposal will facilitate achievement of the following credits: LEED NC-EQ cr. 3.1 & 3.2 Construction IAQ Management Plan; LEED CI-EQ cr. 3.1 & 3.2 Construction IAQ Management Plan; LEED EB-EQ cr. 3 Construction IAQ Management Plan; LEED for Schools EQ cr. 3.1 & 3.2 Construction IAQ Management Plan; and LEED for Homes EQ cr. 8 Contaminant Control.

To earn credits under the LEED 2009 rating systems, during construction projects must meet or exceed the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines For Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3). Since the measures outlined in this proposal do not make reference to these standards, project teams must research to verify LEED compliance for individual projects.

Air filtration devices are required by LEED to achieve a minimum efficiency reporting value of 8 as measured by ANSI/ASHRAE 52.2-2007. Therefore, this proposal has a direct relationship with LEED for filtering media standards.

LEED for Homes does not follow these criteria, and has its own established guidelines. Some aspects of this proposal will be applicable.

**Implementation & Market Availability**
This proposal is similar to credits outlined in current LEED rating systems, which many projects throughout the country have used as guidelines for implementing similar measures. Most of the largest construction companies, including those with active projects in New York City, have already successfully implemented similar measures on completed projects. Items such as filters and components to construct impermeable barriers are readily available in the marketplace.
Concerning method 1 of 3303.15.3.1, a 14,000 cf/s flushout in a regular commercial building typically translates to 10-12 days of continuous flushout. High rise residential buildings relying on operable windows as their primary ventilation methods typically lack sufficient mechanical ventilation capacity to meet the intent of a flush out.

Notes

1) The committee broadly supported the proposition that green building standards should address indoor air quality during construction, not just during occupancy. The committee also noted that worker health and safety is regulated by OSHA, although the construction industry, particularly smaller-scale projects, does not always comply with these standards. Thus, there is a need to balance the reality of construction practice with the fact that air quality would be adequate on all sites if there were full compliance with OSHA. The committee considered a range of requirements to ventilate spaces during construction, including requiring fans to bring fresh air directly from the outside. Ultimately, the committee settled on a requirement that HVAC systems (if working) be activated during construction and that workers have the option of opening windows when the HVAC system is not operational. Doing so is standard practice in well-managed construction projects and will improve air quality in a reasonable and cost-effective manner.

2) Requiring that ductwork be delivered to the site sealed at both ends results in a substantial increase in transportation impacts since it prevents the ductwork from being “nested” one inside the other. According to several local sheet metal (ductwork) fabricators, an inability to deliver ductwork nested can increase the number of truck trips by as much as 30%. The committee decided to proceed with the requirement of sealing supply and return ductwork because it offers a direct benefit to the building occupant and there may be alternative means of nesting ductwork or reducing travel trips that could still protect ductwork from contamination during delivery. Exhaust ductwork, on the other hand, should not be sealed to keep the number of truck trips as low as possible. The proposal expressly limits the requirement that ductwork be delivered covered to supply and return ducts, and does not extend the requirement to exhaust ducts (which has no impact on indoor air quality).

3) Sealing the ends of lined ductwork could capture moisture inside the duct that could condense and sustain mold growth. To avoid this build up, sheet metal fabricators should make a minor perforation in the seal to allow moisture to escape.

ENDNOTES:

