Outdoor Air Delivery Monitoring

1 point

Intent

Provide capacity for ventilation system monitoring to help sustain occupant comfort and well-being.

Requirements

Install permanent monitoring systems that provide feedback on ventilation system performance to ensure that ventilation systems maintain design minimum ventilation requirements. Configure all monitoring equipment to generate an alarm when the conditions vary by 10% or more from setpoint, via either a building automation system alarm to the building operator or via a visual or audible alert to the building occupants.

FOR MECHANICALLY VENTILATED SPACES

- ❑ Monitor carbon dioxide concentrations within all densely occupied spaces (those with a design occupant density greater than or equal to 25 people per 1000 sq.ft.). CO_2 monitoring locations shall be between 3 feet and 6 feet above the floor.
- ❑ For each mechanical ventilation system serving non-densely occupied spaces, provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor airflow rate with an accuracy of plus or minus 15% of the design minimum outdoor air rate, as defined by ASHRAE 62.1-2004.

FOR NATURALLY VENTILATED SPACES

Monitor CO_2 concentrations within all naturally ventilated spaces. CO_2 monitoring shall be located within the room between 3 feet and 6 feet above the floor. One CO_2 sensor may be used to represent multiple spaces if the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.

Potential Technologies & Strategies

Install carbon dioxide and airflow measurement equipment and feed the information to the HVAC system and/or Building Automation System (BAS) to trigger corrective action, if applicable. If such automatic controls are not feasible with the building systems, use the measurement equipment to trigger alarms that inform building operators or occupants of a possible deficiency in outdoor air delivery.

Summary of Referenced Standard

There is no standard referenced for this credit.

Approach and Implementation

Building HVAC systems are designed to flush out indoor airborne contaminants by exhausting old air and replacing it with fresh outdoor air. The rate of ventilation air exchange is generally determined in the design phase based on space density and type of occupancy. Many conventional ventilation systems do not directly measure the amount of outdoor air delivered. Implementation of the following strategies is recommended to achieve this credit.

Outdoor Air Flow Monitoring

Air flow monitoring of the outdoor air rate validates that the HVAC equipment is delivering the required ventilation rate. Air balance control methodologies, such as fan tracking and measuring building-pressurization based strategies, do not directly determine that appropriate ventilation air is being provided and do not satisfy the credit requirement. The ventilation rate can be measured at the outdoor air intake to an air distribution system using a variety of airflow devices including Pitot tubes, Venturi meters and rotating vane anemometers. Ventilation rate for a particular HVAC system can also be accurately determined from a mass balance calculation if both supply air flow and return air flow are directly measured with air flow monitoring devices. To satisfy the requirements of this credit, the measurement devices must detect when the system is 15% below the design minimum outdoor air rate. When the ventilation system fails to provide the required levels of fresh air, the monitoring system should be configured to deliver a visible or audible alert to the system operator. This alert will indicate to the system operator that operational adjustments may be necessary.

The minimum outdoor air rate may change based on the design and modes of the HVAC system. Constant volume systems, with steady-state design occupancy conditions usually have different outdoor air rates for weekdays and nighttime or off-peak conditions. In variable-air-volume (VAV) systems, the rate of outdoor air needs to stay above the design minimum even when the supply air flow is reduced due to reduced thermal load conditions.

CO_2 Monitoring

The effectiveness of the ventilation system to deliver the needed outdoor air can also be monitored using carbon dioxide (CO_2) monitors. In demand controlled ventilation (DCV) systems, where the outdoor air rate supplied to an area is based on readings taken by one or more CO_2 monitors located within the occupied spaces, the system-wide outdoor air rate will fluctuate. A DCV system, is a typical energy conservation strategy for large spaces with variable occupancy, such as a large lecture hall where the number of people and times of use varies significantly. In this type of operation, the monitoring system confirms that the space—the lecture hall—is receiving adequate outdoor air for the current occupancy, and that the central system adjusts the ventilation rate to match the changing requirement.

CO_2 sensors, when properly placed, are a practical means of confirming that a ventilation system is functioning properly. There are two typical system configurations that generally meet the requirements of this credit.

One approach utilizes CO_2 sensors that use measured concentration to provide an alert. An indoor concentration of 1000 ppm has commonly been used in the past as the setpoint for the alarm, but a higher alarm concentration may be appropriate when the design complies with Standard 62.1-2004, since the effective ventilation rate per person has been reduced significantly for some zones. ASHRAE 62.1-2004 Users Manual Appendix A provides a further discussion on CO_2 sensors including demand control ventilation.

CO_2 monitoring locations should be selected so that they provide representative readings of the CO_2 concentrations in occupied spaces. Providing multiple CO_2 monitoring stations throughout occupied spaces will provide better information and control than providing a single CO_2 monitor for the entire system. A single CO_2 monitor, typically installed in the return air duct, is less expensive and more straightforward to implement than proving multiple sensors, but may not yield information that identifies areas within the building that are under-ventilated.

CO_2 Monitoring in Densely Occupied Spaces

Within buildings that are mechanically ventilated, the CO_2 level within each densely occupied space needs to be monitored to satisfy the credit requirements. The density factor is 25 people per 1000 sq.ft. or 40 sq.ft. per person; for example, a 240 sq.ft. conference room planned for 6 or more people would need to be monitored. CO_2 monitors in densely occupied spaces should be mounted in the space within the vertical breathing zone—between 3 and 6 feet above the floor.

Ventilation Air Flow Monitoring in Non-Densely Occupied Spaces

For mechanically-ventilated spaces with occupant density less than 25 people per 1000 sq.ft., this LEED-NC credit requires that the outdoor ventilation rate be directly measured and compared against the minimum required ventilation rate. Typically this will be provided by air flow monitoring stations located in the outdoor air intakes of each central HVAC air distribution system. The direct outdoor airflow measurement device must be capable of measuring the outdoor airflow rate at all expected system operating conditions within an accuracy of plus or minus 15% of the design minimum outdoor air rate.

CO_2 Monitoring in Naturally Ventilated Spaces

For naturally ventilated buildings, monitoring CO_2 levels in the occupied space provides feedback to building occupants and operators, so that they can make operational adjustments, such as opening windows, if the space becomes under ventilated. The CO_2 monitors in naturally ventilated spaces should be mounted in the vertical breathing zone between 3 and 6 feet above the floor.

Operations & Maintenance

As part of the system commissioning, project teams should confirm that the outdoor air delivery monitoring system is calibrated, and that the appropriate setpoints and control sequences have been implemented. Provide the building owner, maintenance personnel and occupants with the information needed to understand, maintain and respond to the monitoring system. Maintenance personnel should make inspection of CO_2 monitors and airflow monitoring stations part of routine O&M and preventive maintenance activities. Sensors should be recalibrated based on the manufacturer's requirements. It is recommended to use CO_2 sensors that require recalibration no less than every 5 years. If a CO_2 monitor is allowed to fall out of calibration it may indicate that indoor CO_2 concentrations are lower or higher than they actually are, leading to under- or over-ventilation of the space.

A permanent ventilation monitoring system assists in detecting indoor air quality problems quickly so that corrective action can be taken. Under-ventilation of a space can lead to unsatisfactory indoor environmental conditions and occupant discomfort. Over-ventilation of a space may needlessly increase HVAC energy costs.

Building Type

Air flow and CO_2 monitoring systems can be applied to any building or HVAC system type—including both mechanically and naturally ventilated buildings. In addition to ventilation alarms, such monitors can provide building operators and automated control systems (i.e., demand control ventilation) with information that allows for operational adjustments, such as increasing or decreasing intake airflow rates.

For naturally ventilated buildings and spaces served by HVAC systems that do not allow for active control of ventilation rates, CO_2 monitors in the occupied spaces can provide building occupants and operators with useful information that allows for operational adjustments, such as opening windows or adjusting fixed ventilation rates, if the CO_2 monitors indicate that the space is under ventilated.

Calculations

There are no calculations required for this credit.

Exemplary Performance

This credit is not eligible for exemplary performance under the Innovation in Design section.

Submittal Documentation

This prerequisite is submitted as part of the **Design Submittal**.

The following project data and calculation information is required to document credit compliance using the v2.2 Submittal Templates:

- ❑ Confirmation of the type of ventilation system and installed controls.
- ❑ Design narrative describing the project's ventilation design and CO_2 monitoring system. Include specific information regarding location and quantity of installed monitors, operational parameters and setpoints.
- ❑ Provide copies of the applicable project drawings to document the location and type of installed sensors. Drawings should also show natural ventilation components (operable windows, air intakes, etc.) as applicable.

Considerations

Cost Issues

CO_2 and ventilation rate monitoring systems increase initial construction costs compared to ventilation systems without such monitoring capabilities. Capital costs and annual costs for air flow monitoring equipment maintenance and calibration procedures may be offset by reduced absenteeism, increased occupant productivity and/or reduced HVAC energy use.

Regional Issues

Ambient outdoor CO_2 concentrations may fluctuate somewhat based on local and regional factors, between approximately 300 and 500 ppm. The time-of-day fluctuations near major congested highways and annual fluctuations, if any, should also be considered. High ambient CO_2 concentrations are typically an indicator of combustion or other contaminant sources. Lower ventilation rates may yield a sense of stuffiness or general dissatisfaction with IAQ.

Resources

Please see the USGBC website at www.usgbc.org/resources for more specific resources on materials sources and other technical information.

Websites

ASHRAE 62.1-2004 Users Manual Appendix A

www.ashrae.org

Provides information on CO_2 sensors including demand control ventilation.

American Society of Heating, Refrigerating and Air-Conditioning Engineers

(ASHRAE)

www.ashrae.org

(404) 636-8400

Advances the science of heating, ventilation, air conditioning and refrigeration for the public's benefit through research, standards writing, continuing education and publications.

Building Air Quality: A Guide for Building Owners and Facility Managers

www.epa.gov/iaq/largebldgs/baqtoc.html

(800) 438-4318

An EPA publication on IAQ sources in buildings and methods to prevent and resolve IAQ problems.

Print Media

Air Handling Systems Design by Tseng-Yao Sun, McGraw Hill, 1992.

ASHRAE Standard 55-2004: Thermal Environmental Conditions for Human Occupancy, ASHRAE, 2004

ASHRAE Standard 62.1-2004: Ventilation for Acceptable Indoor Air Quality, ASHRAE, 2004

ASHRAE Standard 62.2-2004: Ventilation for Acceptable Indoor Air Quality in Low-Rise Residential Buildings, ASHRAE, 2004

ASTM D 6245-1998: Standard Guide for Using Indoor Carbon Dioxide Concentrations to Valuate Indoor Air Quality and Ventilation, ASTM, 1998

Efficient Building Design Series, Volume 2: Heating, Ventilating, and Air Conditioning by J. Trost and Frederick Trost, Prentice Hall, 1998.

Definitions

CO_2 is carbon dioxide.

Mechanical Ventilation is ventilation provided by mechanically powered equipment, such as motor-driven fans and blowers, but not by devices such as wind-driven turbine ventilators and mechanically operated windows. (ASHRAE 62.1-2004)

Natural Ventilation is ventilation provided by thermal, wind, or diffusion effects through doors, windows, or other intentional openings in the building. (ASHRAE 62.1-2004)

ppm stands for parts per million

Ventilation is the process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space. (ASHRAE 62.1-2004)