Green Building Practice Summary 12/13/2010

Sector: Residential

Category/Practice: IEQ / Whole-building Ventilation

Proposed GB practice

Description

A whole-building, controlled, mechanical ventilation system, designed to meet ASHRAE Standard 62.2 requirements, must be provided. Key design parameters must be documented. The installed system must be commissioned.

Air handlers used to move ventilation air must be equipped with efficient blower motors. Exception: Motors rated at one-quarter horsepower or below.

Applicability

New Construction: Applies

Existing Buildings/Additions: Does not apply (address with education)

Existing Buildings/Alterations: Does not apply (address with education)

Intent

Improve indoor air quality

Benefits and Costs

Triple Bottom Line Benefits

People: Improved health due to better indoor air quality.

Economic: Potential for indirect benefits due to improved health. As noted under "Costs Passed to Owner," below, controlled ventilation represents an energy cost rather than a benefit.

Environment: N/A

Costs Passed to Owner

There are several types of ventilation systems that can satisfy this proposed requirement. Each has first costs associated with design and installation, plus operating costs.

The least expensive system to install uses an exhaust-only approach based on an upgraded bath fan engineered to operate quietly and continuously. The incremental first cost of a system like this, with no other changes, is estimated at "low" to "medium" ($150-400).

For the prototype house, the operational cost of an exhaust-only system like this, running continuously, year-round, in a gas-heated house, is approximately $120 per year, due to increased fan electricity use (~10%) and energy for heating and cooling the make-up air (~90%). The cost will go down proportionately if the owner chooses not to operate the system year-round.

Other system types – exhaust-only based on fans with more sophisticated controls, exhaust-only using a remote fan with more pickup points, supply-only, balanced with heat recovery – will all have a higher first cost, ranging from "Medium" to "Very high" cost. Operating costs may be higher or lower than the simple exhaust-only system, depending upon the fan(s) and whether or not the system includes heat recovery.

Lost Opportunity

It is less expensive to install a whole-building ventilation system at time of construction than to retrofit it later.

Implementation

Availability of Products and/or Services

Though whole-building ventilation has not been extensively used in the Fort Collins market, equipment is available. Increased market penetration is anticipated to improve the local product supply infrastructure. Relatively few local HVAC contractors have much experience installing whole-building ventilation systems.

Practicality

No obstacles have been identified.

Certification Issues

Contractor certification requirements must be established; i.e. who will be allowed to perform or oversee the testing and sign off on the commissioning form (the ventilation system commissioning is a subset of the proposed "HVAC Commissioning" amendment).

Enforcement Procedures

Permit application/plan review: Applicant submits a whole-building ventilation system design as part of permit application.

Field inspection: Building inspectors visually verify presence of system components.

Certificate of Occupancy: Applicant will submit completed, signed commissioning form documenting compliance with requirements. The document will include the testing contractor's certification number and expiration date. (The ventilation system commissioning is a subset of the proposed "HVAC Commissioning" amendment)

Support Materials Needs

- Template for the ventilation system design submittal
- Commissioning form (the ventilation system commissioning is a subset of the proposed "HVAC Commissioning" amendment)

Training Needs – Industry

Training regarding design, installation and testing of whole-building ventilation systems will be needed for builders and HVAC contractors. This can be offered as a subset of comprehensive training on HVAC system design, installation and commissioning.

Training Needs - Staff
Enforcement staff will need at least introductory training about whole-building ventilation systems, with an emphasis on inspection requirements.

Background

Current Practice
A very small proportion of Fort Collins buildings, including new buildings, are equipped with whole-building ventilation systems.

Context - Ventilation
Building scientists have long advocated a systems approach to healthy indoor air, of which controlled, whole-building ventilation is one component. The City has sponsored builder training supporting this approach since the early 1990s. The availability of high-quality, quiet, low-power ventilation fans and innovative controls has increased over that period.

A fact sheet addressing a systems approach to healthy indoor air, including whole-building ventilation, developed by Fort Collins Utilities and E-Star Colorado, has been widely distributed since 2005.

Controlled ventilation in most Fort Collins buildings is provided by windows operated by occupants (less so than in the past with increasing use of air conditioning and increased security concerns), bath fans and, in a minority of buildings, vented kitchen range hoods (bath fans and kitchen hoods have been used for intermittent, user-controlled, spot ventilation). These are augmented by uncontrolled air leakage through holes and cracks in the building envelope, which is highly variable with weather conditions and building operation. Very few whole-building ventilation systems have been installed.

A national standard, *Ventilation and Acceptable Indoor Quality in Low-Rise Residential Buildings*, ASHRAE 62.2, published in 2003, addresses both whole-building and local exhaust ventilation. It specifies required ventilation rates (which are quite low), controls, maximum sound ratings for fans and related “building-as-a-system” practices.

The ASHRAE ventilation standard allows a number of whole-building ventilation strategies, including low-cost approaches such as using bath fans, double-duty, for spot and whole-building ventilation. It recognizes the importance of duct sizing and system testing to ensure that the system is meeting design specifications.

National voluntary energy efficiency and green building rating systems are increasingly referencing this standard: it is a mandatory element of both LEED/Homes and ENERGY STAR New Homes, Version 3 (to be fully effective in January 2012). It has not yet been referenced in the national model codes.

The *HVAC Quality Installation Specification*, ANSI/ACCA 5 QI-2007, developed by the Consortium for Energy Efficiency and Air Conditioning Contractors of America (a national trade association of HVAC contractors) supports a systems approach, from design through installation, performance testing, documentation and owner education. The 2007 edition of this standard did not address ventilation systems; updates currently underway may extend the standard to ventilation.

Context – Efficient Air Handler Blower Motors

Conventional, permanent-split-capacitor (PSC) air handler unit (AHU) motors represent one of the largest end uses of electricity in homes with forced-air heating/cooling. Few people are aware of this "invisible" load, which is estimated by the Appliance Standards Awareness Project to average 1100 kWh per year, on the order of 10% to 15% of total electricity use in a gas-heated home. At current FC Utilities rates, this costs about $80/yr. The energy use in a given home depends on the motor size, the resistance to air flow presented by the ductwork and how the AHU is controlled.

Average energy use of these motors has markedly increased in recent decades, with:

- Larger homes with larger heating and cooling loads and, therefore, larger AHU blower motors
- Rapidly increasing market penetration of central air conditioning; AC systems require higher air flow rates than heating systems and operate during the summer.
- Increase in number of owners who operate AHU fans continuously, for a variety of reasons: air filtration, humidification, attempts to mix the air and equalize temperatures in different parts of the building.

AHU blowers are sometimes also used to move air for whole-building ventilation. In this scenario, the AHU is liable to operate considerably more hours than when only used to meet heating and cooling needs.

For systems operated many hours, the electrical bill impact is much higher than the average noted above. For example, a ¾ HP PSC AHU motor operating 24/7 throughout the year will use about 6,000 kWh per year of electrical energy, costing the homeowner about $450 per year at current electric rates.

Because these motors are part of the heating and cooling systems, they virtually always operate during the electric utility's peak system electrical demand both winter and summer, increasing the cost of electricity for all residents.

Most AHUs incorporate conventional PSC motors. These have a relatively high power draw and, when operating many hours, use a substantial amount of electricity. In a sample of new Fort Collins homes surveyed in 2007, all AHUs used PSC motors with power draws ranging from 400 to 1000 Watts.

Motor sizes observed in the new home survey:

- 27%: 1/3 HP (typical with 3-ton AC system)
- 40%: ½ HP (typical with 3.5- to 4-ton AC system)
- 27%: ¾ HP (typical with 4- to 5-ton AC system)
- 7%: 1 HP (occasional with 4-ton and 5-ton AC systems)

Efficient AHU motors – powered by direct current (DC) rather than alternating current – have been available for at least two decades. The best known is the "Electrically Commutated Motor" (ECM) from General Electric. In addition to lower power draw and energy use, ECMs offer other advantages such as variable speed control and the ability to move more air through restrictive duct systems. To date, HVAC manufacturers have offered the DC motors primarily in higher-end, variable-speed, high-efficiency (AFUE 94+) furnaces. The incremental cost for such furnaces is approximately $1000 to $1300 compared with a basic, sealed-combustion, 90 AFUE furnace, or $2000 to $2300 compared with a code-minimum, induced-draft, 80 AFUE unit.

Efficient DC motors have recently become available as drop-in replacements for blower motors in existing AHUs. They are currently available from two manufacturers in a limited range of sizes. Though these can be retrofit into new AHUs with PSC motors, this voids the AHU manufacturer's equipment warranty, so few owners or contractors choose this option.

Depending on motor size and the way in which the heating/cooling/ventilation system is controlled, annual savings by using the more efficient motor may range from:
- Low-end: Approximately $30 (1/3 HP motor operating an average 25% of the time)
- High-end: Approximately $300 (1 HP motor continuously operated year-round)

The City offers incentives for efficient AHU blower motors in existing homes, through the CheckMe! and Home Efficiency Programs. CheckMe! provides a rebate for retrofit of PSC motor to DC motor in an existing AHU. The Home Efficiency Program also provides rebates for installation of a new AHU with DC motor and retrofit of PSC motor to DC motor in an existing AHU.

Federal tax incentives are available for very high efficiency replacement furnaces in existing homes; the 95 AFUE criteria can only be met by variable capacity units.

To date, AHU blower motor efficiency has not been addressed by federal standards or the model energy code. However, U.S. Department of Energy rulemaking on AHU motors must be completed by the end of 2013.

ENERGY STAR New Homes Version 3 guidelines, which will be fully effective in January 2012, require an efficient DC motor if the whole-building ventilation system uses the AHU blower.

The proposed exemption encourages right-sizing of equipment (which is usually smaller than when sized using rules-of-thumb). Entry level buildings tend to be smaller, with smaller loads and smaller heating/cooling equipment.

Related Green Building Practices
Whole-building ventilation is just one part of a systems approach to healthy indoor air. Other, closely related practices include:
- Pollutant source control, including safer combustion appliances that can't spill combustion products into the living space, attached garage isolation from the living space and radon-resistant construction.
- Tight construction
- Spot ventilation
- Efficient motors for blowers used in the whole-building ventilation system
- Proper duct design and installation
- HVAC system commissioning ("V" is for ventilation)
- Buyer education about the ventilation system and how the items they bring into their living spaces affects indoor air quality

Known objections

- Higher first cost
- Higher operating cost
- Occupants open windows when they need more fresh air