Green Building Practice Summary 3/10/2011

Sector: Residential

Category/Practice: IEQ / Safer Combustion Appliances: Existing Buildings

Proposed GB Practice

Description

All natural draft combustion appliances must pass the Building Performance Institute (BPI) combustion safety test, including carbon monoxide (CO) production and spillage, under "natural conditions."

Exception: Induced-draft furnaces

Combustion safety testing will be performed by certified contractors.

When appliances meet this requirement but fail a BPI "worst-case" depressurization test, the contractor must provide, and the building owner must sign, a City-provided disclosure form describing the risks.

Applicability

New Construction: Does not apply (see companion proposed amendment: "Safer Combustion Appliances: New Construction")

Existing Buildings/Additions: Applies (companion proposed amendment – "Safer Combustion Appliances: New Construction" – may also apply)

Existing Buildings/Alterations: Applies when combustion appliances (furnace, water heater, fireplace) are replaced

Intent

Reduce potential health and safety hazard of combustion products spilling into building.

Benefits and Costs

Triple Bottom Line Benefits

People: Health and safety for occupants.

Economic: No direct benefit. Improved health can potentially reduce health care costs.

Environment: None

Costs Passed to Owner

"Low" cost
Approximately $75 to $150 if only the combustion safety test is required. If an appliance fails the test, costs for mitigating the problem could range from "low" to "very high."

Implementation

Availability of Products and/or Services

A number of local HVAC and home performance contractors have recently received BPI Building Analyst certification through the City's Home Efficiency Program training.

Practicality

Conducting the combustion safety test is practical. The "natural conditions" qualifier for the test is intended to screen out the appliances most liable to cause health and safety hazards. If an appliance fails the test, mitigation may be easy and low cost in some cases, challenging and expensive in other scenarios.

Residents will face some risk when replacing their combustion appliances. They won't know until the initial work is completed whether or not their natural draft appliances will pass. If they don't, the resident could face significant expense to mitigate the problem. This risk must be weighed against the risk of significant health problems related to combustion appliance spillage and CO poisoning.

Certification Issues

BPI Building Analyst certification (or other credential approved by the Building Official) is required to conduct combustion safety testing. Testing may be performed by the same company performing the other retrofit work that triggers this proposed requirement; i.e. third-party testing is allowed but not required.

Enforcement Procedures

Permit application/plan review: Applicant provides information describing the combustion appliances that will remain in place after equipment replacement. Building Department will notify applicant which appliances must meet this requirement.

Field inspection: Applicant must turn in signed affidavit documenting compliance. The document will include the testing contractor's certification number and expiration date. If an appliance passes the natural conditions test but fails the worst-case depressurization test, applicant must also submit a copy of the disclosure form.

Support Materials Needs

- Compliance form
- Disclosure form

Training Needs – Industry

Additional training opportunities should be made available to those wishing to become certified.

Training Needs - Staff

Building Department enforcement staff should receive training to understand combustion safety testing and how to interpret results submitted by contractors.

Background

Current Practice

The majority of furnaces, water heaters and fireplaces in existing Fort Collins homes are natural draft natural gas appliances.

Combustion safety testing is not routinely conducted in the situations that would trigger this proposed requirement.

Context

Natural draft appliances draw indoor air for combustion; the buoyancy of hot combustion gases is intended to vent combustion products out of the building. This venting process relies on very small pressure differences to push the gases out the chimney. Existing vent conditions may lead to insufficient pressure difference due to poor design, degradation or "orphaning" of commonly vented appliances. Further, venting pressures are easily disrupted by many factors: "stack effect" air leakage, exhaust fans (kitchen and bath fans, clothes dryers, radon vent systems, whole-house fans), other chimneys, leakage in the return ductwork, unbalanced supply and return heating and cooling flows to different parts of the building, wind, varying outdoor temperatures – acting alone or in combination. When this happens, combustion products, including potentially harmful levels of carbon monoxide (CO), can spill into the living space. The potential for this problem increases as buildings are tightened; a tighter envelope more readily supports pressure imbalances than a leaky one.

CO poisoning, in relatively low concentration, can be fatal. Lower doses, over time, can cause chronic illnesses which mimic other conditions. Other combustion products include nitrogren oxides (a respiratory irritant) and water (which can lead to excess humidity, mold, building damage).

Even when combustion appliances have been safely operating in a building, many factors can tip the pressure balance to unsafe operation. Small problems with the combustion process can create high levels of CO in the flue gases. Changes to the building or the way it is operated can easily change the pressure balance enough to create venting problems. Examples include installation of new or larger exhaust fans, radon mitigation systems, additions, air sealing (intentionally or through other energy improvements such as blowing insulation into exterior walls), ductwork modifications.

A range of combustion appliances are found in the Fort Collins housing stock:

- Furnaces. The oldest units are low efficiency, natural draft furnaces with "draft hoods," vulnerable to spillage. These frequently share a common vent with atmospheric water heaters. For about the last two decades, higher federal efficiency requirements meant that the typical furnaces installed in new construction or as replacement units have been induced-draft designs (approximately 80 AFUE). Though still natural draft, these have no draft hood. A pressure sensor in the exhaust is designed to shut down the furnace when venting problems occur; compared with the draft hood units, a significantly higher pressure imbalance is necessary for induced-draft furnaces to spill combustion products. Sealed-combustion furnaces first became widely available about two decades ago. In these designs, combustion products are fully isolated from the living space and are pushed out of the building by a blower; they virtually eliminate the chance of combustion product spillage. Sealed combustion furnaces are now commonly installed in new construction and many have been installed as replacement units by

building owners as energy efficiency upgrades. They cannot be commonly vented with a water heater; a dedicated vent is required.

- Boilers. The situation is analogous to furnaces. (Boilers constitute a very small part of the Fort Collins market.)
- Water heaters. Typical practice in buildings of all vintages is the conventional storage water heater. These are natural draft with draft hoods, vulnerable to spillage with small pressure imbalances. These units frequently share a common vent with atmospheric furnaces. Only in very recent years have safer water heater designs – power-vented, direct-vent, sealed-combustion – begun to make significant inroads in new construction. In a 2007 new home survey in Fort Collins, about one-third of the sample had safer gas water heaters.
- Fireplaces. Older fireplaces are natural draft, including masonry and sheet metal designs, wood- or natural gas-fired. They are vulnerable to combustion product spillage. When burning, wood-fired fireplaces draw large amounts of air from the building and can create significant pressure imbalances that can cause water heaters or furnaces to spill. Most fireplaces installed in the last two decades have been direct-vent units that are fully sealed from the living space and virtually immune to spillage.

A common scenario is the "orphan" water heater. The starting point is a natural draft water heater commonly vented with a natural draft furnace. The furnace is replaced with a high-efficiency, sealed combustion unit, using a new, dedicated vent. The water continues to use the original vent, which was sized based on the size of the furnace and water heater together and is now much too large for the water heater alone. Because the relatively small heat output of the water heater doesn't heat the flue to the same temperature that it did when the furnace was commonly vented, this situation increases the likelihood of spillage and flue damage due to condensation of combustion products. To mitigate these problems, the existing flue should be "lined" with a smaller vent. This is done in some cases, not others; building code provides mixed guidance.

Building scientists have long recognized the potential for combustion safety problems with conventional appliances. They recommend performance testing rather than prescriptive approaches. In the last decade, the Building Performance Institute's combustion safety testing protocol has been increasingly referenced. This test evaluates pressure imbalances in the zones in which combustion appliances are located, draft in the vent, CO production and spillage of combustion products into the building. It defines testing under "natural" conditions (normal building operation) and "worst-case depressurization" conditions (building operated in a manner most likely to cause spillage problems).

The City has provided training and education to builders, trades and consumers, addressing combustion safety concerns, since the early 1990s.

When combustion appliances are replaced, the building code requires contractors to follow manufacturer instructions and that "all heating and cooling equipment be tested to ensure such equipment is operating within the manufacturer's recommended operating parameters and standards, including within such parameters and standards for sufficient combustion, according to the applicable protocols established by the building official and in accordance with the mechanical code adopted by the City." There are several other provisions in the code that rely on prescriptive approaches to aid combustion safety; none explicitly require testing to be performed to document that the equipment operates safely. The code also includes provisions addressing pressure imbalances caused by exhaust fans. These provisions have rarely been enforced in the past. There are no code provisions regarding combustion safety that are triggered by other

changes to the building. As noted in "Current Practice," combustion safety testing has not routinely been conducted.

The City's Home Efficiency Program (HEP) for existing homes includes a strong emphasis on combustion safety. All program audits, for homes with appliances that can potentially spill combustion products, include a BPI combustion safety test.

In the HEP, disclosure forms must be provided by the auditor or contractor, for the customer to sign, when an appliance fails the combustion safety test under either natural or worst-case conditions. The City provides a CO detector for homes without one.

Related Green Building Practices

Summarizing some of the information in "Context," above, there are four ways to approach combustion safety:

- Install safer combustion appliances. This gets at the root of the problem.
- Install vulnerable combustion appliances, following prescriptive instructions, and assume they will operate safely.
- Install combustion appliances, following prescriptive instructions, and test them to see if they produce low amounts of CO and safely vent all combustion products out of the building under a range of operating conditions.
- Install CO detectors.

Known Objections

- Higher costs for combustion appliance replacement due to testing costs
- Potential for higher costs to mitigate when appliances fail combustion safety tests
- This will pose a particular challenge for emergency replacements of furnaces and water heaters.
- May drive more equipment replacement work underground; i.e. non-licensed contractors installing equipment without a building permit
- There aren't many deaths from CO poisoning.
- CO detectors are an alternative, lower cost solution for combustion safety.