Building America Case Study

# Combustion Safety Simplified Test Protocol

Chicago, Illinois, and Minneapolis, Minnesota

## PROJECT INFORMATION

**Project Name:** Combustion Safety Simplified Test Protocol

**Location:** Chicago, IL, and Minneapolis, MN

**Partners:** Partnership for Advanced Residential Retrofit and Northern*STAR*

**Building Component:** Natural gas water heaters or furnaces in high-performance houses

**Application:** New and/or retrofit; single- and/or multifamily

**Year Tested:** 2015

**Applicable Climate Zones:** All

## PERFORMANCE DATA

The STP, a new combustion safety test, reduces false positives and eliminates the cost of replacing atmospheric appliances in some cases.

Estimated cost savings: $500–$3,000

Combustion safety testing is an important step in the process of upgrading homes for energy efficiency. Field practitioners use several approaches based on published standards. Researchers have indicated that test procedures in use are complicated to implement in the field and provide too many false positives—i.e., too many failures that do not relate to long-term problems in the home. Field failures often mean that the house will not be upgraded until after remediation—or not at all if the program does not include remediation of safety issues.

Two U.S. Department of Energy Building America teams—Partnership for Advanced Residential Retrofit and Northern*STAR* Building America Partnership—have developed a simplified test procedure (STP) to address this situation. The test is easier to implement than current tests and should produce fewer false positives. Together, the teams (1) surveyed state weatherization agencies with the assistance of the National Association for State Community Services Programs, (2) evaluated the STP compared to traditional worst-case options in the field, and (3) collected detailed field-monitoring data from 11 houses to correlate failures of the combustion safety test with persistent flue gas spillage events.

The STP provides a fixed position for interior doors; that position depends only on the presence of return ducts and a fixed set of exhaust fan settings. Failure criteria are established based on continued flue gas spillage beyond a 2- or 5-minute time horizon (depending on carbon monoxide levels in the flue), whether the duct starts out warm or cold, and whether the appliance is a furnace or water heater.

Many state weatherization agencies do not track combustion safety failures. However, available data suggest that (1) few failures are triggered by any cause other than dryer exhaust or leaky ductwork, and (2) only a very small number of homes are subject to the failures.

Based on the field evaluation, the STP identifies problem houses as effectively as the worst-case procedures in use. The project field data indicate that none of the houses with a code-compliant vent system showed a significant tendency

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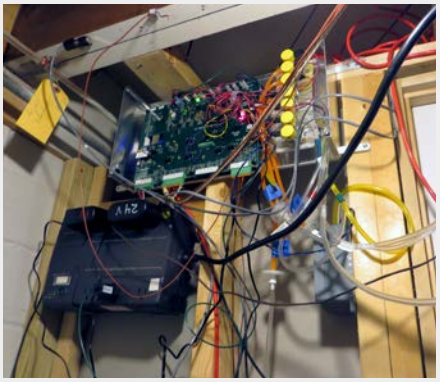
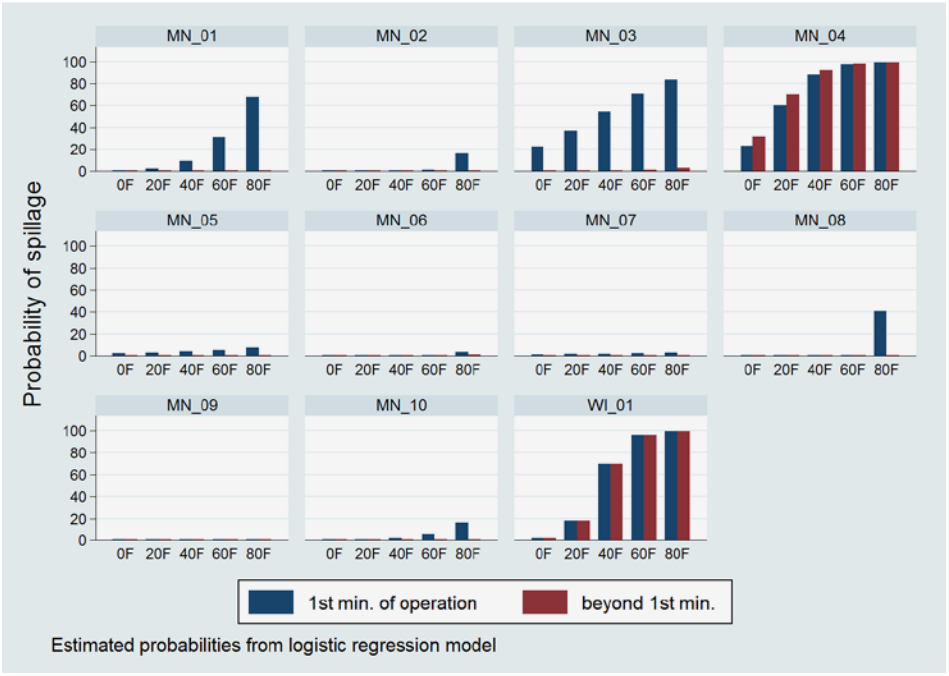
Instrumented water heater at a field-test site



Field data collection hardware

toward prolonged spillage in normal operation. This indication suggests that even the STP may overpredict hazards. These results are based on survey data from 17 states and 11 houses in Minnesota and Wisconsin, where the teams collected field-monitoring data for 7 months. The teams propose future work to confirm the results, including testing more sites during a full year.




Probability of flue gas spillage for the 11 test sites. Sites MN-04 and WI-01 had improperly vented water heaters.

## Lessons Learned

- Based on the limited number of sites tested, the STP predicts combustion safety failures as accurately as the worst-case test procedures and requires less testing time.
- Houses with code-compliant venting systems have a low likelihood of excessive spillage—even when they fail a simplified combustion safety test. Venting inspection is critical to accurately evaluate combustion safety, and it should be the first step.
- The number of combustion safety failures is small according to data collected from state weatherization teams.
- As expected, spillage correlates with exhaust fan operation and with higher outdoor temperatures.

## Looking Ahead

Many of the recommendations in the simplified test procedure were included in the BPI-1200-2015 standard, which was published in the spring of 2015.

For more information see the Building America report *Combustion Safety Simplified Test Protocol Field Study* at *buildingamerica.gov*.

Photo credits: Dave Bohac, Minnesota Center for Energy and Environment (MN CEE), Alex Haynor, MN CEE, and Dan Cautley, Seventhwave



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