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CASE STUDY FROM RECENT RESEARCH

# Advanced Drop-In Wall Furnaces

## OVERVIEW

- Field monitoring measured furnace operation, IAQ
- Laboratory testing measured performance, flue emissions
- Project also characterized costs, operability & reliability
- Eight existing standard wall furnaces in Los Angeles, Oakland & Sacramento homes
- Three advanced wall furnaces installed as retrofits:

**Williams AC2030TN single-sided**

**Williams AC3040TN double-sided**

**Williams TG2030TN single-sided & self-powered**

## RESULTS

- **Natural Gas Savings:** 67%
- **Utility Cost Savings:** 66%
- **Emissions Reductions:** 86% CO, 89% NOx, 92% THC
- **IAQ Effects:** Mixed
- **Payback:** 8+ years

*Figure 1: Williams Advanced Drop-In Wall Furnaces, AC2030TN Single-Sided & AC3040TN Double-Sided (L & R)*

Funded by the California Energy Commission and Southern California Gas, a team of researchers from GTI Energy and Frontier Energy recently evaluated advanced wall furnaces designed as easy drop-in replacements for existing inefficient wall furnaces.

Wall furnaces are small, natural gas-fueled furnaces, sized and shaped to fit into the wall cavity between studs on an interior wall. They can be single- or double-sided, to heat one or two rooms. Standard wall furnaces are simple devices with no frills, while advanced wall furnaces have features to improve heat delivery, energy efficiency, and emissions.

| Wall Furnace Features | STANDARD | ADVANCED |
|---|---|---|
| Heat Distribution: | Gravity | Fan-type |
| Burner Ignition: | Standing pilot | Intermittent pilot or Hot surface igniter |
| Emissions: | No controls | Low NOx controls |
| AC Power: | Self-powered | AC- or self-powered |
| Rated Thermal Efficiency (TE): | ANSI Z21.86-2016 70% minimum; as low as 50% on existing furnaces | ANSI Z21.86-2016 75% minimum; 85% non-condensing |

There are no emissions regulations that currently apply to wall furnaces, although central furnace NOx emissions are limited to 0.033 lbm/MMBtu (14 ng/J) by two California air quality management districts (SCAQMD Rule 1111 & SJVAPCD Rule 4905).

All existing wall furnaces were standard gravity wall furnaces with rated input of 25,603 and TE of 66%. Three types of drop-in units were installed in place of the standard furnaces, all from Williams Comfort Products:

**Four AC2030TN top vent, fan-type, single-sided, AC-powered wall furnaces in Los Angeles, rated at 30,000 Btu/hr, 85% TE**

**One AC3040TN top vent, fan-type, double-sided, AC powered wall furnace in Oakland, rated at 40,000 Btu/hr, 85% TE**

**Three TG2030TN top vent, fan-type, single-sided, self-powered wall furnaces in Sacramento, rated at 30,000 Btu/hr 82% TE**

## STATISTICAL AVERAGES from Furnaces at 8 Sites

**Furnace Age:**
Std Existing: 32 years
Avg Retrofit: new

**Tested Thermal Efficiency:**
Std Existing: 63%
Adv Retrofit: 80% +17%

**Tested Input Capacity:**
Std Existing: 32,420 Btu/hr
Adv Retrofit: 31,250 Btu/hr -4%

**Pilot or Power Use:**
Std Existing: 740 Btu/hr inactive
Adv Retrofit: 0-12.5 W active

**Tested Output Capacity:**
Std Existing: 20,240 Btu/hr
Adv Retrofit: 25,010 Btu/hr +24%

**Annual Operation:**
Std Existing: 182 hours
Adv Retrofit: 138 hours -37%

**Annual Furnace Cycles:**
Std Existing: 405
Adv Retrofit: 200 -50%

## CONTACT

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# Laboratory Testing & Field Monitoring Findings

Advanced drop-in wall furnaces were significantly more energy efficient than standard existing wall furnaces due to enhanced combustion controls and elimination of the standing pilot. Laboratory tests showed that advanced furnaces also had 24% higher output capacity than standard furnaces.

Field monitoring showed that wall furnaces tend to be turned on and off manually by occupants. Due to higher capacity and better distribution of heat, drop-in wall furnace annual hours of use were 37% lower and they cycled half as much as standard furnaces.

Overall, drop-in furnaces reduced natural gas use by 67%. All the drop-in furnaces eliminated standby pilot energy use. The AC-powered AC2030TN and AC3040TN furnaces drew 12.5 W while active, while the self-powered TG2030TN units used no electricity. Emissions of carbon monoxide, nitrogen oxides, and total hydrocarbons decreased by 86% or more compared to standard existing furnaces. All drop-in furnaces met the 0.033 lbm/MMBtu NOx limit for central furnaces.

Despite greatly reduced emissions, indoor air quality only improved slightly after drop-in wall furnaces were installed. Wall furnace operation – even just operation of a standing pilot – was found to draw enough air from the space to remove indoor pollutants produced by other sources.

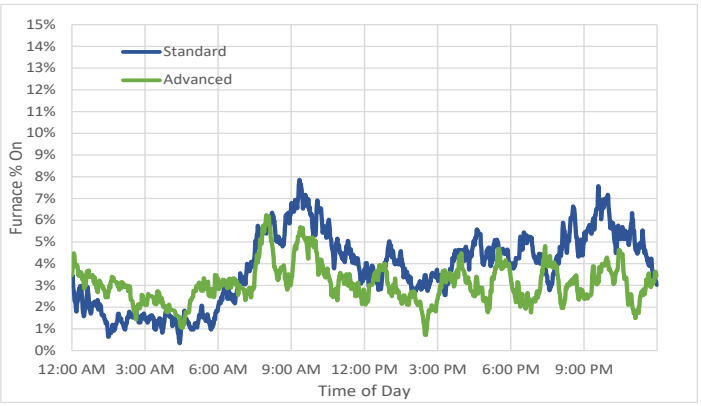


*Figure 2: Monitored Daily Drop-In Wall Furnace Operation*

# Challenges and Next Steps

To realize their potential, advanced drop-in furnaces could benefit from operational improvements. First, they should aim to adhere to ASHRAE 6.2 noise limits for intermittent indoor fans. Second, thermostatic controls can be improved to make them more responsive to occupants. Third, units powered by self-charging batteries need further testing to ensure their reliability.

Incremental costs for drop in wall furnaces are also currently quite high, with simple paybacks ranging from 8 to 26 years in this study. Based on energy savings alone, the extra expense of advanced wall furnaces is most cost effective in colder climates with higher heating needs. Utility incentives are recommended to encourage adoption until costs of advanced drop in wall furnaces can be reduced.

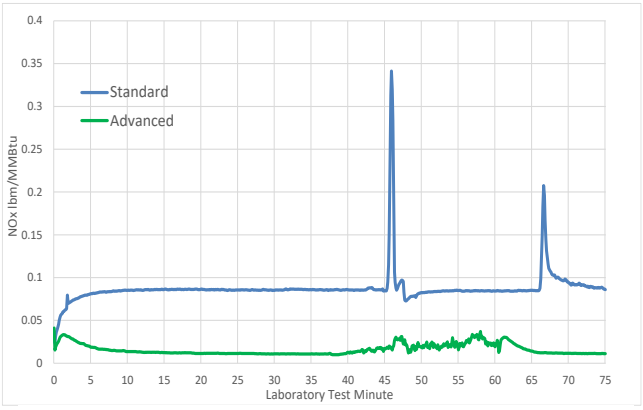


*Figure 3: Tested Drop-In Furnace NOx Emissions*