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## DOE Study Confirms Space-heating Benefits

**W**arehouses, distribution centers, and other large, open facilities often pose unique design considerations for space heating.

For example, in thermal stratification, warm air naturally rises and can cause the ceiling air temperature to be 10°-20°F warmer than the thermostat set point. As a result of this temperature gradient, heating systems must run longer to meet the needs of the building's occupants near floor-level.

Loading dock door infiltration results when shipments and outgoing products are loaded and sent away in warehouses. Cold air enters the building and pushes/displaces warm air toward the ceiling and away from building occupants, increasing heating loads.

### Technology Background

To better understand the thermal performance and potential energy savings of new, direct-fired heating technology, the U.S. Department of Energy (DOE) recently conducted a field demonstration at a warehouse outside of St. Louis.

Generally, direct-fired heat-

ing products deliver warm air by combusting natural gas within the supply outdoor airstream at 90-plus percent thermal efficiency. To ensure safety and IAQ, all direct-fired heaters must comply with ANSI Z-83.4 "Non-recirculating Direct Gas-Fired Industrial Air Heaters" and related standards that limit the output of combustion byproducts to safe levels and specify natural gas-ignition, combustion-air, and flame-control measures to ensure safe operation. By bringing in outside air, direct-fired equipment does not increase the amount of air entering the building; rather, the airflow brought in by the direct-fired equipment creates a slight positive pressurization and offsets the infiltration that would normally enter through building seams. Through this method, the amount of air entering the building and the related infiltration heat load remains roughly the same.

Direct-fired natural gas heaters can supply ventilation and/or space heating airflow to maintain comfortable conditions for building occupants. By raising the supply air to a sufficiently high-temperature, direct-fired prod-

ucts can also satisfy conduction heating loads in the building.

### Demonstration

Headquartered in Bridgeton, Missouri, Langendorf Supply Co. has supplied HVAC contractors throughout the greater St. Louis area with equipment and materials since 1975. Langendorf's warehouse includes several aisles of shelving racks that extend to the approximately 24-foot-high ceilings as well as six loading docks across 42,000 square feet.

The company partnered with the nearby manufacturer Cambridge Engineering Inc. to upgrade the warehouse's space heating system before the 2013-2014 heating season. Cambridge proposed replacing the existing 80 percent thermal efficiency gas-fired heating system with 100 percent outside air, high-discharge-temperature heating and ventilation (HTHV) direct-fired natural gas heaters with 92 percent thermal efficiency.

The designation HTHV refers to the high discharge temperature of the product that minimizes the required outside airflow to satisfy conduction heating loads; the high velocity of the airflow

that generates vertical circulation throughout the building, which reduces stratification; and the fact that the technology provides space heating and ventilation air.

Langendorf and Cambridge Engineering collaborated with the DOE to study the project's energy savings and performance benefits. To understand site-specific attributes affecting energy consumption, the demonstration study evaluated the new and existing heating equipment during side-by-side operation of alternating months over the 2013-2014 heating season. Monitoring equipment collected data on equipment operating hours, temperatures throughout the building, loading dock openings, and other factors. Because the energy consumption of heating equipment depends on outdoor conditions, energy consumption was normalized over the monitoring period according to the number of heating degree days (HDD).

### Results

In a side-by-side comparison of alternating months over the 2013-2014 heating season, the new, HTHV direct-fired natural gas heaters demonstrated the fol-

lowing benefits:

• **Energy Savings (therms, kWh)** — The new natural gas heaters consumed 20 percent less natural gas than the existing heaters on a normalized basis over the monitoring period. Because the new natural gas heaters utilize a high-pressure blower to reduce stratification, increased fan electricity consumption offsets some of the thermal savings.

• **Utility Savings** — Over an average heating season for the host site in Bridgeton, Missouri, (3,705 average HDD of 60°F), the new natural gas heaters would save approximately 15 percent on space heating utility costs at average utility rates for the site of 80 cents per therm and 8 cents per kilowatt hour.

• **Performance** — As evidenced by the temperature readings near the floor and ceiling, the new natural gas heaters reduced temperature stratification and maintained more uniform and comfortable temperature distributions.

## Next Steps for Purchasers

Contractors serving building owners with high heating bills should consider HTHV direct-fired natural gas heaters for their customers' facilities. Nevertheless, the suitability and economics for the technology will vary from site to site due to climate zone, utility rates, temperature set points, installation cost, ceiling height, and other factors. Colder regions will have the highest cost savings potential and shortest payback periods due to the higher number of HDDs experienced each year.

Because high-velocity blowers distribute air over a larger area and distribute more heating energy toward the floor, contractors may be able to replace many pieces of heating equipment with a smaller number of HTHV natural gas heaters, further shortening the payback period. If contractors or building owners can identify the most active heaters, either by observation or a monitoring system, such as

an advanced thermostat, they can potentially achieve quicker paybacks by replacing heaters with the highest runtimes. Additionally, several natural gas utilities offer rebates and incentives to lower the incremental cost even further. **N**

For more information on this technology demonstration, please see the full DOE study, available on the DOE Better Buildings Alliance website (<http://bit.ly/HEGasHeaters>). The DOE's Better Buildings Alliance provides a number of resources, including a purchasing specification, payback calculator, demonstration report, case study, and other tools to help contractors, building owners, and purchasers identify and adopt high-efficiency natural gas heaters. Information courtesy of Jim Young, managing consultant in Navigant Consulting Inc.'s Energy Practice. Contact him at 312-583-3743 or at [jim.young@navigant.com](mailto:jim.young@navigant.com).

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