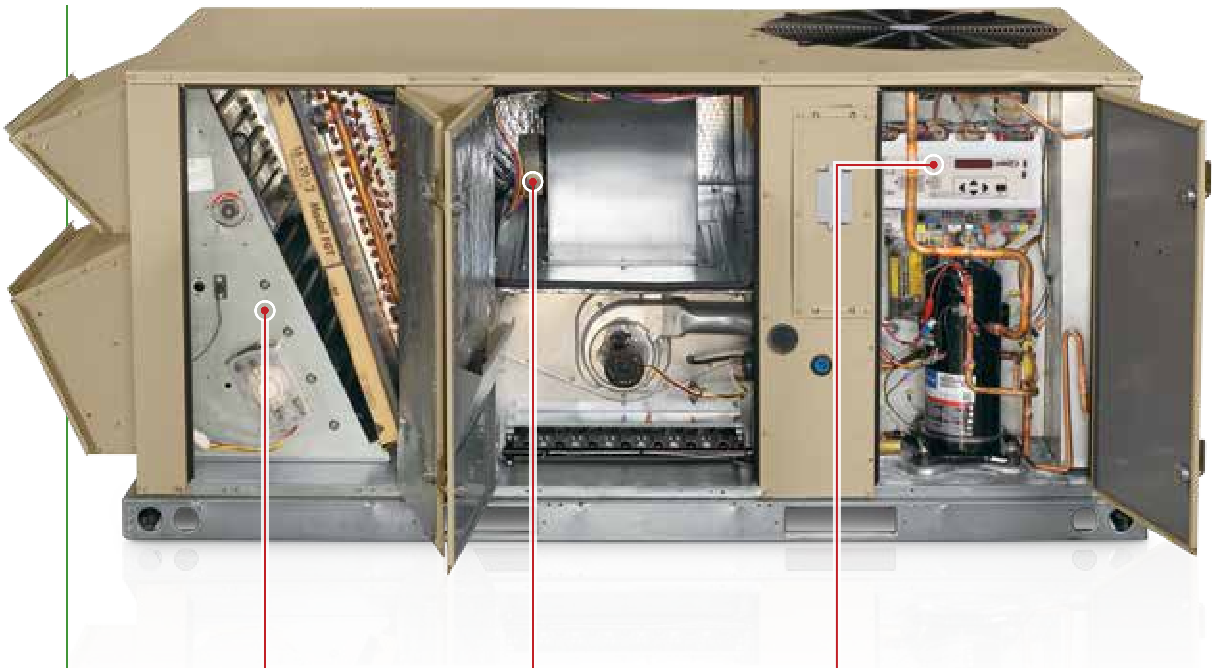


*SmartAirflow™ System*

WHITE PAPER

# SMARTAIRFLOW™ SUPPLY AND VENTILATION AIRFLOW MEASUREMENT

## CONTENTS



## SUMMARY

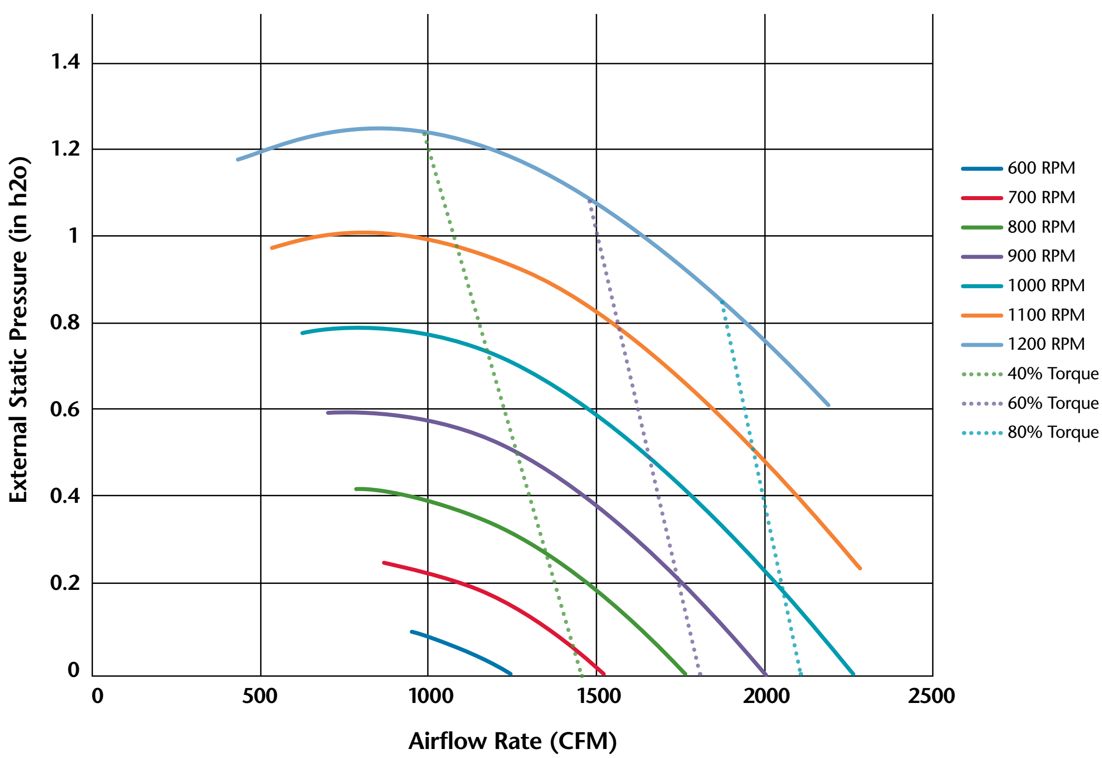
Lennox' SmartAirflow™ technology is a complete airflow management system that enhances the capabilities of the Energence® rooftop unit by providing proper airflow to the building. Proper airflow management is a critical function for the optimal performance of a rooftop unit; and the benefits of proper airflow management go beyond efficiency. In this white paper, Lennox will discuss the technology behind the SmartAirflow system, the current methods of commissioning and controlling airflow of rooftop units, and the benefits associated with the technology.

## HOW DOES THE SMARTAIRFLOW™ SUPPLY AIRFLOW MEASUREMENT WORK?

Figure 1 is a plot of the performance of a 4-ton Energence® rooftop unit blower. The vertical axis represents the external static pressure applied to the unit, while the horizontal axis shows the supply airflow rate provided by the blower. Solid lines are constant speed lines, and dotted lines indicate constant torque. For every given supply airflow and static pressure combination, there is a unique fan speed and torque required. For example, at a supply airflow of 2,000 CFM and a static pressure of 0.5", the fan speed required is 1,100 rpm with a required torque of slightly more than 80%. If need be, these calculations can be reversed; if the motor torque and speed are known, the supply airflow rate and ESP can be determined using the table.

The high-efficiency fan motor used in the Energence 3- to 5-ton unit is capable of measuring the motor torque and the shaft speed. In units equipped with SmartAirflow™ technology, this data is communicated to the Prodigy® controller, which contains an embedded fan map for the unit. The control feeds the current torque and speed into the map, allowing the controller to calculate the current supply airflow.

*Figure 1: 4-Ton Energence® Blower Map*



## BENEFITS – COMMISSIONING, SUPPLY AIRFLOW

Supply airflow rate is set directly in the Prodigy® controller. On units with the SmartAirflow™ system, the technician may specify the airflow rate in CFM (cubic feet per minute) using the user interface or network interface, and airflow settings may be changed anytime. SmartAirflow uses a calibration table, unique for each application, to set the motor torque command based on the user-specified airflow rate. Data in the calibration table is collected using a calibration routine that operates the blower at different torque settings to determine the application's specific relationship between torque and airflow. Calibration can be initiated by the technician anytime. It will also occur automatically 24 hours after initial startup if not previously done. Calibration should be initiated with all ductwork in place and with clean filters. With SmartAirflow, getting the proper airflow simply requires entering the desired airflow rate into the controller.

## BENEFITS – ENERGY SAVINGS, SUPPLY FAN POWER

The SmartAirflow option enables the setting of five different supply fan speeds rather than two speeds on the standard unit. This saves energy by enabling the fan to run at a lower airflow rate when operating in ventilate (fan only) mode.

Figure 2 shows the fan performance data of a 5-ton Energence® rooftop unit running attached to a duct system that creates 1" external static pressure at 2,000 CFM.

*Figure 2*

| Mode | Airflow (CFM) | External Static (in h2o) | Fan Power (w) |
|---|---|---|---|
| Cooling High | 2,000 | 1.0 | 766 |
| Cooling Low | 1,335 | 0.44 | 242 |
| Ventilate | 943 | 0.25 | 99 |

There is a power savings of 143 watts when dropping the supply fan speed from 1,335 (cooling low) to 943 (new ventilate mode). The fan must be running when the zone is occupied, approximately 12 hours per day, 5 days per week for most commercial buildings. We will assume that during 50% of the occupied time, there is no need for heating or cooling; however, the supply fan needs to run continuously for ventilation purposes. During this ventilate mode, the supply fan can run at the lower ventilate speed for additional energy savings.

**Vent Fan runtime = 50% x 12 hours/day x 5 days/week x 52 weeks/year = 1,560 hours/year**

**Energy savings = (242-99) watts x 1,560 hours/year = 223kwh**

**At $0.1/kwh = $22/year**

## PROPER SUPPLY AIRFLOW

Setting the correct supply airflow rate can have significant impact on the performance of the equipment.

Figure 3 is the EER of a 5-ton Energence® rooftop unit running at 95°F outdoor, 80°F indoor with 51% humidity attached to a duct system which would provide a static pressure of 1" at 2,000 CFM. From the table, one can see that the system EER decreases as the supply airflow is increased. A variation in the blower airflow from 2,000 to 2,200 CFM changes the EER from 11.86 to 11.43, a 3.6% efficiency decrease. The larger the blower airflow variation (higher than required), the bigger the efficiency losses.

*Figure 3*

| Net Capability | Supply Airflow | Torque | Blower Power | Total Power | EER |
|---|---|---|---|---|---|
| 60,955 | 2,200 | 91 | 969 | 5,335 | 11.43 |
| 60,956 | 2,100 | 84 | 860 | 5,221 | 11.64 |
| 60,723 | 2,000 | 77 | 763 | 5,120 | 11.86 |
| 60,381 | 1,900 | 70 | 677 | 5,026 | 12.01 |
| 59,960 | 1,800 | 64 | 599 | 4,940 | 12.14 |
| 59,383 | 1,700 | 59 | 529 | 4,858 | 12.23 |
| 58,633 | 1,600 | 53 | 465 | 4,780 | 12.27 |

By simplifying the airflow setup process. SmartAirflow™ can make it more likely to set the proper supply airflow.

## VENTILATION/IAQ BACKGROUND

Ventilation air is outdoor air brought into a building solely for the purpose of maintaining proper indoor air quality (IAQ) for building occupants. Ventilation air is required by building code regardless of the energy costs associated; when the building is unoccupied no ventilation is required.

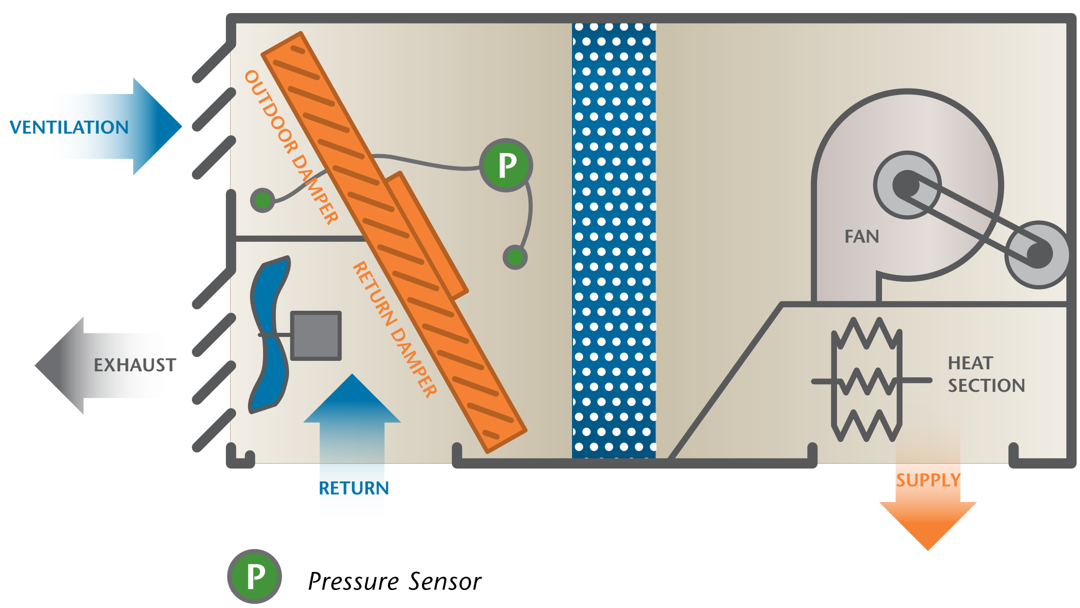
The required amount of ventilation air is set during the building design process by the HVAC engineer using indoor air quality standards such as ASHRAE 62.1. Per the standards, the amount of ventilation air is a function of the number of occupants, the usage type and the overall floor area. For typical applications, the ventilation airflow rate ranges between 10–30% of the total unit supply airflow rate.

Two types of ventilation are commonly used on rooftop units: fixed ventilation and demand control ventilation. With fixed ventilation, the HVAC system is required to provide a constant amount of ventilation air when the building is occupied. Occupancy is typically set based on a schedule. For example, a 5-ton unit may be required to provide 300 CFM of ventilation between 7:00 a.m. and 7:00 p.m. With demand control ventilation, the ventilation rate varies based on the occupancy of the zone. Occupancy is typically sensed using $CO_2$ sensors. The SmartAirflow™ system is compatible with both ventilation strategies.

## VENTILATION/IAQ BACKGROUND *(continued)*

There are a number of ways to bring ventilation air into a building. For the purposes of this white paper, we are focusing on applications where an economizer is used for ventilation (as shown in Figure 4). In these applications, the supply fan is operated continuously during the occupied period and the economizer is opened slightly to provide the required amount of outdoor air. The position of the economizer when operating in this mode is commonly referred to as the minimum damper position.

*Figure 4*




During the commissioning process, the test and balance contractor measures the ventilation airflow rate and adjusts the minimum damper position of the economizer to match the airflow rate specified on the design drawings. Since the ventilation airflow rate is a nonlinear function of the supply airflow, a separate minimum damper position should be set for each supply airflow to ensure ventilation at each supply airflow setting. Ideally, a typical MSAV® (multi-stage air volume) system will operate at five different supply airflow rates, requiring five different minimum damper settings. Due to the complexity and time associated with calibrating all five settings, most MSAV units only have two damper settings: Min Low, which corresponds to the lowest supply airflow rate, and Min High, which corresponds to the highest supply airflow rate. When supply airflow rates fall between the min and max, the ventilation damper position is selected between Min Low and Min High depending on the supply airflow rates in relation to the min and max supply airflow settings.

## SMARTAIRFLOW™ SYSTEM: VENTILATION AIRFLOW CONTROL

The SmartAirflow™ system is a feature of the Prodigy® Control System, which enables the controller to directly measure the ventilation airflow rate. Measurement of the ventilation airflow rate is accomplished through the use of a calibrated economizer damper and an additional airside pressure sensor. The ventilation airflow measurement is then used as sensor input into a feedback controller, which automatically and continuously adjusts the damper position to achieve a user-defined ventilation airflow rate.

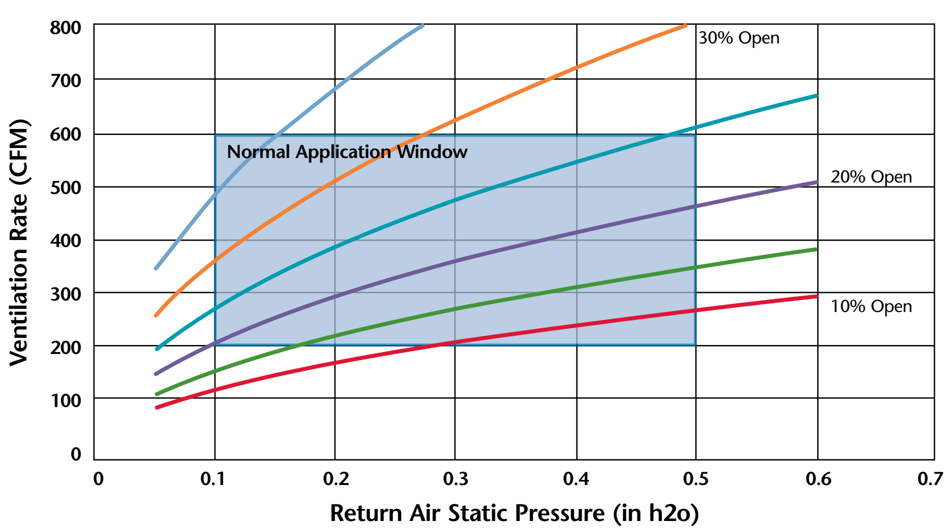
## HOW IS VENTILATION AIRFLOW MEASURED?

Ventilation airflow rate is calculated based on the damper position and the static pressure drop across the outdoor air blades. Figure 5 shows a plot of the typical ventilation flow rate through the economizer as a function of the static pressure difference across the economizer. Each line corresponds to a different economizer damper position.

The static pressure across the damper blade is primarily a function of the return duct pressure drop. Systems installed with restrictive return ducts will have a higher static pressure than those with larger, less restrictive ducts. In typical applications, the static pressure drop will be between 0.1" and 0.5" h2o.

In a typical application, the ventilation rate ranges from 10–30% of the design system airflow rate. The blue shaded box encompasses the normal application window. Most systems will operate inside this window during ventilation operation.

*Figure 5: Energence® 3- To 5-Ton Tall Ventilation Rate*




*For the purposes of experimentation, we measured the ventilation airflow through multiple samples of economizers installed in our Energence® rooftop units at a variety of damper positions and return duct pressure drops. Based on this data, we developed a numerical model of the damper which calculates the airflow through the outdoor damper as a function of damper position and pressure difference.*

## WHAT IS THE ACCURACY?

The accuracy of the ventilation measurement varies depending upon the operating conditions, the ventilation rate and the type of economizer installed. Across all conditions and systems, the average uncertainty is 15% of reading. This accuracy is consistent with the applied accuracy of typical test and balance instrumentation currently used today. See appendix A for a detailed accuracy analysis.

## WHAT ARE THE BENEFITS?

**For those using test and balance to set ventilation airflow rates, the benefit is reduced commissioning time.**

The SmartAirflow™ system will save significant test and balance time. Currently, test and balance contractors must guess an appropriate minimum damper position and measure the ventilation rate. The minimum damper position is then gradually adjusted until the measured ventilation rate matches the desired value. The savings are even more significant for MSAV® systems that use multiple different minimum damper position settings to optimize ventilation airflow for each supply airflow rate.

**For those who guess a minimum damper position, the benefits are accurate ventilation, compliance and energy savings.**

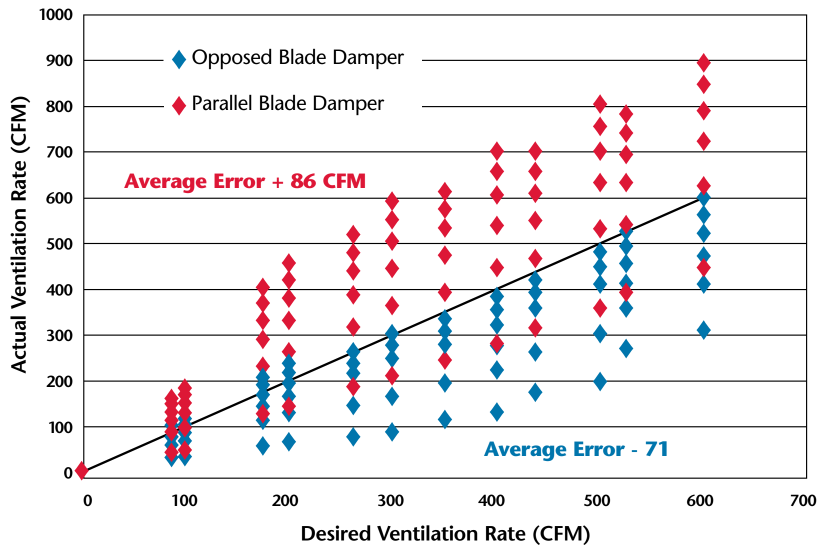
Many contractors set the minimum damper position by making the assumption that the percentage the damper is open corresponds to the percentage of outdoor air entering the system (i.e., 10% open = 10% outdoor air). This is far from accurate. In most cases this leads to overventilation, which wastes energy.

Since the measurement errors vary depending on the application and equipment setup, a Monte Carlo analysis was performed on a 5-ton rooftop unit to determine the distribution of errors for different ventilation calibration methods. ***Figure 6 shows this distribution.***

For cases where the outdoor air is assumed to be equal to the percentage open, overventilation is the most likely result. For a parallel blade damper, the average overventilation is 86 CFM. An opposed damper tends to underventilate an average of 71 CFM. Looking at the chart, there are cases when the unit could be over- or underventilating by 300 CFM.

It is important to note that underventilation is also a problem, because it fails to provide the building occupants with the necessary fresh air. Both the SmartAirflow system and best-in-class test and balance average at 0 CFM with a very tight distribution.

*Figure 6: Ventilation ERROR When Using Percent Open = Percent OD Air*




An annual energy simulation was performed to estimate the difference in energy cost between various ventilation operating cases. The simulation assumes a simple linear building load in which the heating or cooling load is a linear function of the difference between the indoor and outdoor temperature. The balance point, 45F, is the outdoor temperature at which there is no heating or cooling required. The building load is sized such that the unit runs at 90% cooling capacity on the hottest day of the year. TMY2 weather data for cities in each of the 7 ASHRAE climate zones was used. Unit performance is based on data in the Lennox Engineering handbook for a 4-ton Energence rooftop unit with gas heat. The electric cost $0.11 per kwh. Natural gas cost of $0.85 per therm. Zone temperature is 76F and zone relative humidity of 50.

Table 7 shows the results from the annual simulation. The first three columns list the cooling, heating, and total energy costs for a system which provides no ventilation. The remaining columns show the cooling, heating, and total energy costs of a system providing 240 CFM (15% of supply) of ventilation airflow 12hrs/ day 5 days a week. The last column is the difference in the total cost between no ventilation and 15% ventilation, which is the net cost of providing 15% ventilation. The cost of ventilation averages $235 across all climate zones.

*Table 7: Annual Energy Costs of Operating a 4-ton Energence Unit*

| | | No Ventilation Airflow | | | 240 VFM Ventilation (15% of supply) | | | Difference |
|---|---|---|---|---|---|---|---|---|
| | | Electric | Natural Gas | | Electric | Natural Gas | | |
| City | Zone | Cooling & Fans | Heating | Total | Cooling & Fans | Heating | Total | Total |
| Miami, FL | 1 | $1,029 | $0 | $1,030 | $1,164 | $3 | $1,167 | $137 |
| Houston, TX | 2 | $683 | $27 | $710 | $842 | $67 | $909 | $199 |
| Atlanta, GA | 3 | $464 | $72 | $537 | $539 | $189 | $728 | $192 |
| Ft. Worth, TX | 3 | $622 | $40 | $662 | $749 | $102 | $851 | $189 |
| Seattle, WA | 4 | $126 | $79 | $205 | $162 | $229 | $391 | $186 |
| St. Louis, MO | 4 | $359 | $161 | $521 | $449 | $336 | $785 | $264 |
| Phoenix, AZ | 4 | $495 | $8 | $503 | $656 | $32 | $688 | $185 |
| Columbus, OH | 5 | $312 | $216 | $528 | $375 | $405 | $780 | $252 |
| Minneapolis, MN | 6 | $250 | $414 | $664 | $315 | $690 | $1,005 | $341 |
| Rochester, NY | 6 | $327 | $353 | $680 | $386 | $587 | $973 | $293 |
| Fairbanks, AK | 7 | $175 | $1,494 | $1,669 | $238 | $1,980 | $2,218 | $549 |

Table 8 displays only the ventilation costs from the simulation. The Total Cost column is the net ventilation cost (same as the last column on table 7). The Ventilation Error columns show the additional cost of excess ventilation due to various commissioning errors or faults. The column showing the cost of 86 CFM excess ventilation averages to be 35% of the baseline ventilation cost. Recall that 86 CFM is the average ventilation error when assuming % open = % outdoor air.

*Table 8: Annual Cost of Providing CFM*

| City | Zone | Baseline Ventilation Cost | Additional Cost at Various Rates of Excess Ventilation | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 50 cfm | 86 cfm | 100 cfm | 150 cfm | 200 cfm | 250 cfm |
| Miami, FL | 1 | $137 | $29 | **$49** | $58 | $88 | $120 | $150 |
| Houston, TX | 2 | $199 | $41 | **$72** | $84 | $128 | $173 | $216 |
| Los Angeles, CA | 3 | $31 | $6 | **$10** | $11 | $16 | $21 | $26 |
| Atlanta, GA | 3 | $192 | $40 | **$68** | $79 | $119 | $159 | $199 |
| Ft. Worth, TX | 3 | $189 | $39 | **$68** | $79 | $120 | $162 | $202 |
| Seattle, WA | 4 | $186 | $39 | **$66** | $77 | $117 | $157 | $196 |
| St. Louis, MO | 4 | $264 | $55 | **$94** | $109 | $163 | $218 | $273 |
| Phoenix, AZ | 4 | $185 | $36 | **$61** | $70 | $103 | $134 | $168 |
| Columbus, OH | 5 | $252 | $52 | **$89** | $103 | $154 | $205 | $256 |
| Minneapolis, MN | 6 | $341 | $70 | **$120** | $140 | $209 | $278 | $348 |
| Rochester, NY | 6 | $293 | $61 | **$104** | $121 | $181 | $241 | $301 |
| Fairbanks, AK | 7 | $549 | $114 | **$195** | $226 | $339 | $451 | $564 |
| **Average** | | **$235** | **$48** | **$83** | **$96** | **$145** | **$193** | **$242** |
| Percent of baseline | | | 21% | **35%** | 41% | 62% | 82% | 103% |

*The annual cost of providing 250 CFM of ventilation ranges from $31 to $549 per year for the given cities. For those with parallel blade dampers that assume 15% open equals 15% outdoor air, the average over-ventilation is 86 CFM, leading to an annual added cost ranging from $10 to $195 per year. In some cases, the ventilation error could be as much as 250 CFM, causing an added cost of $26 to $564 per year.*

## ONGOING BENEFITS

**With test and balance, setting the minimum damper position is a one-time event.**

Over the life of the equipment, supply airflow and duct system pressure drops change. These changes will cause the ventilation airflow to differ from the original calibrated value. The SmartAirflow™ system continuously adjusts the damper position to deliver the correct amount of ventilation air. It can compensate for changes in supply airflow rate due to filter loading and airflow setting changes, and it will also compensate for changes in the duct system due to building reconfiguration.

This active control of ventilation airflow rate enables other control strategies that dynamically adjust the supply airflow based on conditions.

**Increased accuracy due to gear backlash compensation.**

Economizers are driven by gears that have small gaps between the gear teeth. When the economizer actuator switches from opening to closing, part of the closing movement of the actuator is used to shift the gear clearance from one side of the tooth to the other. This leads to a difference in the relationship between the damper position and damper blade angle when opening and closing. The SmartAirflow system has a proprietary (patent-pending) method of compensating for this error.

**Compensation for wind.**

Wind blowing across the roof can have a significant impact on the amount of ventilation air. We performed a series of tests using our wind machine to simulate wind on a rooftop. Based on lab data, on a 5-ton rooftop unit, a

wind speed of 15 MPH blowing directly into the economizer inlet causes 65 CFM of over-ventilation. The SmartAirflow system partially compensates for the wind, leaving only 33 CFM of overventilation, reducing ventilation error by just under 50%.

## APPENDIX A: ACCURACY OF VENTILATION RATE MEASUREMENT

### Energence® 3- to 4-Ton Standard Economizer

| Measurement Uncertainty (CFM) | | Outdoor damper pressure difference (in h2o) | | | | |
|---|---|---|---|---|---|---|
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 80 | 19 | 16 | 19 | 22 | 18 |
| | 160 | 20 | 26 | 31 | 36 | 25 |
| | 240 | 26 | 22 | 23 | 36 | 40 |
| | 320 | 35 | 22 | 22 | 27 | 29 |
| | 400 | 45 | 29 | 23 | 24 | 26 |
| | 480 | 52 | 32 | 30 | 25 | 27 |
| Uncertainty (% of reading) | | Outdoor damper pressure difference (in h2o) | | | | |
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 80 | 24% | 20% | 24% | 28% | 23% |
| | 160 | 13% | 16% | 19% | 22% | 15% |
| | 240 | 11% | 9% | 10% | 15% | 17% |
| | 320 | 11% | 7% | 7% | 8% | 9% |
| | 400 | 11% | 7% | 6% | 6% | 7% |
| | 480 | 11% | 7% | 6% | 5% | 6% |
| Average | | 13% | | | | |

### Energence 5- to 6-Ton Standard Economizer

| Measurement Uncertainty (CFM) | | Outdoor damper pressure difference (in h2o) | | | | |
|---|---|---|---|---|---|---|
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 100 | 16 | 34 | 42 | 48 | 53 |
| | 200 | 22 | 27 | 18 | 26 | 29 |
| | 300 | 42 | 28 | 19 | 37 | 41 |
| | 400 | 49 | 31 | 32 | 21 | 22 |
| | 500 | 73 | 48 | 34 | 36 | 39 |
| | 600 | 81 | 82 | 54 | 59 | 40 |
| Uncertainty (% of reading) | | Outdoor damper pressure difference (in h2o) | | | | |
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 100 | 16% | 34% | 42% | 48% | 53% |
| | 200 | 11% | 14% | 9% | 13% | 14% |
| | 300 | 14% | 9% | 6% | 12% | 14% |
| | 400 | 12% | 8% | 8% | 5% | 5% |
| | 500 | 15% | 10% | 7% | 7% | 8% |
| | 600 | 13% | 14% | 9% | 10% | 7% |
| Average | | 15% | | | | |

## Energence® 3- to 4-Ton Low-Leak Economizer

| Measurement Uncertainty (CFM) | | Outdoor damper pressure difference (in h2o) | | | | |
|---|---|---|---|---|---|---|
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 120 | 21 | 34 | 27 | 31 | 35 |
| | 160 | 28 | 26 | 41 | 47 | 53 |
| | 240 | 51 | 34 | 32 | 36 | 40 |
| | 320 | 56 | 65 | 41 | 46 | 51 |
| | 400 | 63 | 68 | 79 | 90 | 100 |
| | 480 | 80 | 69 | 81 | 92 | 102 |
| Uncertainty (% of reading) | | Outdoor damper pressure difference (in h2o) | | | | |
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 120 | 18% | 28% | 23% | 26% | 29% |
| | 160 | 17% | 16% | 26% | 30% | 33% |
| | 240 | 21% | 14% | 13% | 15% | 17% |
| | 320 | 17% | 20% | 13% | 14% | 16% |
| | 400 | 16% | 17% | 20% | 23% | 25% |
| | 480 | 17% | 14% | 17% | 19% | 21% |
| Average | | 19% | | | | |

## Energence 5- to 6-Ton Low-Leak Economizer

| Measurement Uncertainty (CFM) | | Outdoor damper pressure difference (in h2o) | | | | |
|---|---|---|---|---|---|---|
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 100 | 13 | 13 | 16 | 18 | 20 |
| | 200 | 27 | 19 | 20 | 23 | 25 |
| | 300 | 47 | 37 | 33 | 38 | 42 |
| | 400 | 61 | 55 | 44 | 49 | 54 |
| | 500 | 92 | 57 | 64 | 73 | 81 |
| | 600 | 98 | 72 | 83 | 94 | 104 |
| Uncertainty (% of reading) | | Outdoor damper pressure difference (in h2o) | | | | |
| | | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Ventilation airflow rate (CFM) | 100 | 13% | 13% | 16% | 18% | 20% |
| | 200 | 14% | 9% | 10% | 11% | 13% |
| | 300 | 16% | 12% | 11% | 13% | 14% |
| | 400 | 15% | 14% | 11% | 12% | 14% |
| | 500 | 18% | 11% | 13% | 15% | 16% |
| | 600 | 16% | 12% | 14% | 16% | 17% |
| Average | | 13% | | | | |

## APPENDIX A: ACCURACY OF VENTILATION RATE MEASUREMENT

The accuracy of ventilation measurement varies depending upon the operating condition and the type of economizer installed. The following tables show this measurement uncertainty, expressed in CFM or percent of reading as a function of ventilation rate and pressure difference. Based on statistical tolerance analysis, there is a 90% confidence that 95% of the data will have an error equal to or less than the uncertainty values listed in the tables. On average, across all conditions and all economizers, the average uncertainty is 15% of reading. This accuracy is consistent with the applied accuracy of typical test and balance instrumentation currently used today.

## APPENDIX B: ACCURACY OF FIELD VENTILATION RATE MEASUREMENTS METHODS

There is a variety of methods for measuring the ventilation airflow rate of a rooftop system running in the field. Below are a few of the methods used, along with their relative uncertainty.

### Test and Balance Flow Hood

One of the standard tools of the test and balance trade is a flow hood. Flow hoods are commonly used to measure the airflow rate at each register in the duct system. They can also be used to measure the outdoor airflow entering an economizer. This can be accomplished by covering the economizer air inlet such that the opening is consistent with the flow hood opening. Flow hood manufacturers specify an accuracy ranging from 3–5% of reading. However, studies indicate that when applied to measuring register airflow in a residential setting, the accuracy is typically 20–30% of reading (Wray et al LBNL-49697).

**http://epb.lbl.gov/publications/pdf/lbnl 49697.pdf**

### Velocity Traverse

There are several instruments that measure air velocity at a given point. Total airflow is calculated by performing a velocity traverse and multiplying by the duct area. Getting an accurate measurement requires collecting velocity measurements at precise grid locations distributed across the duct. Most references require 20 or more points to achieve good accuracy. On the short A-box the fresh air inlets are 2.33 $ft^2$. At an average ventilation rate of 300 CFM, the average inlet velocity is 128 FPM (feet per minute). Many of the velocity sensors currently used require at least 50 FPM to make a measurement. It is likely that some points in the velocity grid with be at or below 50 FPM, causing error in the total airflow measurement.

### Velocity Averaging Grid

A velocity averaging grid is one tool for performing a velocity traverse. The velocity grid uses differential pressure to measure velocity; this measurement is highly sensitive to wind and dependent upon the number of points collected.

### Vane Anemometers

A vane anemometer is another tool for performing a velocity traverse. This tool is mainly used for low-airflow applications.

## CONCLUSION

Lennox performed extensive testing to develop the SmartAirflow™ technology. Hundreds of hours of testing were conducted to accurately model the operation of the Energence® unit's supply and ventilation airflow modes for different operating conditions. This testing provides Lennox a unique insight into the operation of a rooftop unit's airflow system, giving Lennox the ability to develop a technology that accurately and effectively manages this critical function.

SmartAirflow is a technology that not only helps ensure the Energence rooftop unit is commissioned and set up as per design specifications, but it also protects the rooftop unit and the building against operating conditions that may cause the unit to drift away from initial setup. As the only factory-configured option for light commercial applications in the industry that can prevent overventilation, SmartAirflow saves up to 35% of ventilation energy savings by ensuring proper ventilation is performed, every time. This technology provides facilities managers or monitoring services additional insight into the management of the building's airflow conditions. Finally, with SmartAirflow, the building owner can ensure the occupants have a healthy and comfortable work environment by providing adequate ventilation and indoor air quality.

## ABOUT LENNOX COMMERCIAL

Lennox Commercial is a leading provider of high-efficiency packaged rooftop units, split systems, HVAC controls, furnaces and indoor air quality products for the light commercial industry. Committed to helping our customers through advanced products and unsurpassed customer service, Lennox Commercial delivers effective HVAC solutions that improve comfort and protect profits.

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