CAPTIVEAIRE
COMMERCIAL KITCHEN VENTILATION

TECHNICAL BULLETIN

Fundamental Weaknesses of Rooftop Packaged Units for Commercial HVAC TB18-1010

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Application Background:

Rooftop Packaged Units (RTU) are the most commonly specified HVAC unit type for light commercial, single story buildings in the United States [1]. The relative ease of installation, reduction in requirements for field work, and low cost all favor their use.

Unfortunately, the status quo offering from major HVAC vendors all inherently have numerous weaknesses in design and application, which results in unfavorable outcomes for end-users with regards to Indoor Air Quality (IAQ), namely the ability to consistently provide a comfortable space which is free from contaminants.

This bulletin serves to outline those fundamental weaknesses, as well as identify how CaptiveAire's Paragon HVAC approach can resolve these issues for the commercial marketplace.

Comparison Chart of Typical RTU vs. CaptiveAire Paragon HVAC Unit

Symptom	Traditional Roof Top Unit	CaptiveAire's Paragon HVAC Unit
Discharge temperature fluctuation due to fixed stage heating and cooling.	Heating and cooling are limited to stages which result in major swings in discharge temperature as each stage kicks on/off to meet the demands of the space.	Fully modulating heating and cooling through the use of an inverter duty compressor and modulating gas valves results in highly accurate and consistent temperature delivery. This avoids major drafts and fluctuations, ensuring user comfort.
Excessive humidity in the space.	Humidity can only be removed from the airstream when the cooling system is active; however, with fixed speed compressors and limited controls, traditional rooftop equipment cycles often. When cycling, moisture is not removed from the airstream.	Due to the inclusion of a fully modulating, inverter duty compressor, as well as an optional reheat system, the Paragon approach maintains consistent and accurate space humidity without cycling the cooling system. Highly accurate, user set controls monitor and maintain a target humidity or dew point setting.
Excessive utility costs.	Units are frequently oversized, expected to handle more outdoor air than they are capable of and often designed only to meet minimum code efficiency requirements. Due to fixed speed designs, units are most efficient only at peak load, which is less than 1% of the year [2].	A fully modulating design approach allows for the unit to be engineered for peak efficiency at 75% of maximum load, resulting in higher efficiency for users throughout the year. Units exceed all current and known future energy efficiency requirements by a large margin. Lack of unit cycling saves on inrush current demand-based utility expenses as well as the heating and cooling performance losses due to cycling; approximately 15% for typical equipment.
Inconsistent air balance resulting in drafty buildings, dust and dirt, and excessive humidity.	Standard designs rely upon outdoor air for ventilation from each unit; therefore, multiple points of entry and tuning are required. Units have inaccurate outdoor air dampers (economizers) which are nearly impossible to set accurately during test and balance, with up to +/-20% common [3]. Technicians in the field frequently bypass damper mechanisms in an attempt to resolve.	Using a single, highly accurate, AMCA Class 1A low leakage damper, along with precise and measured controls for adjustment (down to 1%), all outdoor air is delivered from a single source to maintain a positive building balance. A positive building balance is a simple one step process per unit. Due to the use of a direct drive plenum blower, balance is maintained indefinitely (no belt wear resulting in change over time).
Insufficient capacity; unit unable to keep up with heating or cooling needs due to outdoor air requirements of ASHRAE 62.1.	As part of the requirements for RTU efficiency testing, the units are engineered for 100% recirculating air [2]. As such, the evaporator coils and heaters cannot handle large quantities of outdoor air, shifting the unit away from its design point. The result is higher utility expenses.	Paragon is designed for up to 100% outdoor air, utilizing both highly efficient multi-row evaporator coils as well as advanced controls. Paragon maintains a consistent delivery temperature and humidity throughout the operating range of the equipment.
Units frequently out of service due to failed belts. Unit noise due to belt squealing.	With the exception of smaller RTUs, manufacturers do not offer a direct drive solution. Users are left with costly bi-annual belt maintenance and the risk of belt failure looming at all times. Unit air delivery is constantly changing as belts wear and slip. Units frequently squeal at startup and whenever blowers cycle.	Paragon units are exclusively available with direct drive, plenum blower supply fans, for high efficiency and accurate air delivery for the life of the unit. Belt maintenance, failure, and variation is eliminated.
Units cycling frequently resulting in shorter component life and excessive wear.	Due to the aforementioned capacity and humidity issues, designs are often engineered with excess capacity margins to cover for unknowns. Unfortunately, this results in excessive cycling and may actually result in higher humidity in the space as the units cool less often. Additionally, this results in poor unit efficiency and extra initial costs for owners.	By designing for the exact capacity needs of the space, and due to the ability of the units to fully modulate, engineers no longer need to oversize and maintain excessive margins. The Paragon approach results in a unit which cycles infrequently, avoiding excessive wear of the components, noise, and costly utility expenses from the inefficiencies of cycling.

Comparison Chart of Typical RTU vs. CaptiveAire Paragon HVAC Unit (Continued)

Symptom	Traditional Roof Top Unit	CaptiveAire's Paragon HVAC Unit
Unit difficult to maintain for the life of the building; performance is inconsistent.	Due to poor quality components and a reactive maintenance approach, traditional equipment quickly wears and loses the original design capacity. Additionally, parts are often designed for obsolescence and manufacturers do not support the product for extended periods of time. Third party HVAC technicians are forced to modify or retrofit units to extend useful life. A useful life of 10 to 15 years is considered 'the norm' with high maintenance costs over that time frame [4].	Units are continuously monitored via the cloud on CaptiveAire's CASLink remote monitoring system for performance verification. If a failure or fault is identified, remote changes can be made via CASLink controls, or a local factory trained service technician is available for dispatch and immediate resolution. Maintenance costs are therefore reduced and unit life expectancy is 20+ years when serviced on a proper maintenance program. All components of the system are designed for extended life.
Inadequate air filtration.	Units typically have just 1" of outdoor air filtration, and an additional 1" of indoor air filtration. Units are limited on addition of higher quality filtration due to internal and external static pressure limitations of the belt-driven blower.	Paragon units have up to 6" of outdoor air and up to 4" of indoor air filtration. Robust direct drive plenum blowers easily handle higher static pressure requirements of high quality filters, ranging from MERV 8 to HEPA, without impacting the ability to deliver proper airflow to the space.

Application and Installation Requirements for a Proper Outcome:

Load Calculations:
For any design, whether the status quo RTU or a Paragon HVAC approach, an accurate initial load calculation is critical for proper system design.

Air Distribution:
For any design, whether the status quo RTU or a Paragon HVAC approach, air distribution is critical. Paragon delivers high quality, consistent air, but the delivery of this air must be fully engineered and well considered for a proper outcome.

System Design Verification (SDV); CaptiveAire Test and Balance:
All units must be verified as correctly installed, airflow must be measured, and the units must be remotely monitored via the cloud for a proper long term outcome. All Paragon HVAC units include an exclusive cellular connection for data transmission and remote monitoring; an industry leading solution for ensuring the proper outcome for your or your customer's building. In addition, all Paragon units receive a SDV inspection by factory trained CASService technicians following installation.

Proper Thermostat/Sensor Locations:
Unit performance is highly dependent upon both temperature and humidity sensor inputs. A poorly placed sensor can result in inaccurate data collection and significant indoor air quality repercussions for users. Fortunately, due to remote monitoring, the Paragon HVAC approach quickly identifies common issues such as poorly placed sensors and problems are rapidly resolved. Traditional equipment contains no feedback mechanism to address and identify these frequent issues.

After Install Tuning:
Based on the data collected by our CASLink remote monitoring system, it is clear that all sites, no matter how accurate the install, are in desperate need of fine tuning to achieve the best long term outcome. There are simply too many unknowns and dynamic factors specific to each jobsite for an engineer to properly account for everything during the design process. Fortunately, the Paragon unit is remotely adjustable to achieve this last (and continuous) level of tuning, resulting in an improved outcome for the end user.

For more information about Indoor Air Quality and CaptiveAire's Paragon HVAC unit, please visit:
www.CaptiveAire.com/Paragon

Sources
[1] "*Energy Savings Potential and RD&D Opportunities for Commercial Building HVAC Systems*." U.S Department of Energy, 12/2017

[2] "*ANSI/AHRI Standard 340/360-2007*." Air-Conditioning, Heating and Refrigeration Institute, 10/27/2011

[3] "*Measuring Rates of Outdoor Airflow into HVAC Systems*." Indoor Environment Department, Lawrence Berkeley National Laboratory. LBNL-51583, 2002

[4] "*Equipment Life and Maintenance Cost Survey*." (RP-186), Mustafa T. Akalin, ASHRAE Journal, Vol. 20, 11/12/1978