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On Exhaust Air Heat Recovery

Additional submitted attachment is included below.

The Greenheck Group

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September 5, 2017

Mr. Mark Alatorre, PE
Building Standards Development
California Energy Commission
1516 Ninth Street, MS37
Sacramento, CA 95814

RE: Docket Number 2017-BSTD-01; Exhaust Air Heat Recovery (TN#-219857)

These comments are submitted by the Greenheck Group in response to the Exhaust Air Heat Recovery workshop presentation (TN#219857) from June 23rd, 2017 by Ken Takhashi.

Exhaust Air Heat Recovery Comments

As a manufacturer of exhaust air energy recovery preconditioners and dedicated outdoor air systems Greenheck has over 20 years of experience applying exhaust air energy recovery in commercial HVAC systems. We appreciate that California is taking its first steps towards codifying exhaust air energy recovery requirements where the economics indicate favorable payback for building owners and operators.

There are a vast number of ways to implement exhaust air energy recovery technology into HVAC system designs. Examples include installing energy recovery devices directly in primary air handling equipment, using separate preconditioners to feed air handling equipment, or supplying ventilation air directly to the space through dedicated outdoor air equipment. All of these variations incorporate control strategies and features that maximize recovered energy, optimize fan energy consumption, and affect economizer performance in different ways. Significant analysis is needed to truly evaluate the cost-benefit of exhaust air energy recovery and development of prescriptive requirements for energy conservation codes. Based on the limited analyses available and given that the proposed requirements align closely with ASHRAE 90.1, we recommend CEC adopt the ASHRAE 90.1 2016 as it relates to exhaust air energy recovery.

With regard to the analyses that were performed relating to exhaust air energy recovery, we have the following feedback that may help clarify why the current ASHRAE 90.1 requirements will be beneficial to California:

- The current Title 24 analyses focused on a Small Office, Medium Office and Medium Office-Lab. Offices generally don't have the high ventilation requirements that benefit from exhaust air energy recovery. Per the ASHRAE 90.1-2013 User's Manual, schools, hospitals and labs have relatively high ventilation requirements and are better suited for analyzing the applicability of exhaust air energy recovery. As such, 90.1 exhaust air

energy recover prescriptive requirements provide a stronger basis for codification given that they were developed based on high ventilation rate buildings.

- It is unclear from the presentation if separate analyses were performed for the two tables of ventilation system operating hours (i.e. less than 8,000 hr/yr, and greater than or equal to 8,000 hr/yr.). The proposal for fewer ventilation hours lines up well with ASHRAE 90.1, however the proposal for greater ventilation hours appears to contradict the apparent trends in ASHRAE 90.1-2016. These trends suggest that colder climate zones in California, specifically climate zone 16, will likely benefit more from exhaust-air-energy recovery when the ventilation operating hours are increased.
- Using the ASHRAE 90.1 fan system pressure credit factors for predicting pressure drop of exhaust air energy recovery devices may not reflect reality. The equation drives the correct behavior in that it allows more fan power to be consumed for devices that recover more energy. In this regard, the pressure credit equation allows larger air pressure drops for devices like energy recovery wheels with high total effectiveness values than it does for run-around-loops with moderate sensible effectiveness values. However, the relationship between enthalpy recovery ratio and pressure drop of individual components has the opposite trend. For example, to get higher recovery ratio values, heat exchangers need to be applied at lower velocities (i.e. be slightly oversized) and typically require less pressure drop.
- The enthalpy recovery ratio requirement works well in climates with dry summer conditions. In cases where the indoor and outdoor design humidity levels are identical the enthalpy recovery ratio and sensible recovery ratio will be the same. When the indoor design humidity is above the outdoor design humidity, sensible only recovery devices will inherently have a higher enthalpy recovery ratio and will provide greater energy savings during the cooling season. For this reason the Title 24 requirement doesn't necessarily need to deviate from ASHRAE 90.1 with a sensible only energy recovery requirement.
- Determining the fan power adjustments in economizer mode is difficult to predict, especially considering the numerous configurations and control strategies available. There are many configurations of HVAC systems that can reduce fan power in economizer mode, but they are configuration dependent. Some examples include:
 1. Air handlers that are fed ventilation air by separate exhaust air energy recovery preconditioners or dedicated outdoor air equipment which can be turned off and bypassed in air-side economizing modes.
 2. Larger air-handling equipment where bypass dampers and/or outdoor air intake configurations can reduce the air pressure drop in the outdoor air and exhaust air sections of the equipment.

Commenter Credentials:

Mike Wolf has over 31 years of experience with the Greenheck Group, a leading manufacturer of HVAC equipment. Mike has held positions in engineering, sales, marketing, software development and general management. As such, Mike has a solid foundation for understanding the impact regulations can have on a business and a market. Mike is active in the development of test standards and codes with industry trade associations including ASHRAE, AMCA, AHRI, UL, NFPA, ICC and others. Mike participated on the U.S. Department of Energy's Working Group responsible for developing recommendations on Commercial and Industrial Fan Energy Regulation. Mike is also a member of the U.S. Department of Energy's Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC).

Eric Erdman has over 11 years of experience designing and testing Makeup Air, Exhaust Air Energy Recovery and Dedicated Outdoor Air System equipment. Eric is an active member of the AHRI Energy Recovery committee and the ASHRAE and AHRI Mechanical Dehumidification committees.

The Greenheck Group is comprised of a number of brands including Greenheck, Unison Comfort Technologies, Innovent, Valent, Precision Coils, Accurex, and Airolite. Headquartered in Schofield, WI, Greenheck has offices and manufacturing facilities in California, Wisconsin, Kentucky, Tennessee, North Carolina, Mexico, and India. In the coming year we will be expanding our manufacturing footprint to include Oklahoma. Greenheck employs nearly 4,000 people worldwide, including over 3,500 in the United States. With over 70 years of family ownership, Greenheck is a worldwide leader in the manufacture of air-movement, conditioning and control equipment, systems and services. Greenheck's extensive product offering includes commercial fans and industrial blowers, laboratory exhaust systems, dedicated outdoor air systems, energy recovery ventilators, air handling equipment, make-up air equipment and kitchen ventilation systems. Related products include air-control dampers, fire and smoke control dampers, heating and cooling coils as well as architectural and mechanical louvers. Greenheck equipment is used in all types of commercial, institutional, and industrial buildings and applications ranging from comfort ventilation to industrial processes.

Industry Associations

Greenheck engineers are actively involved with many government and industry organizations working to establish performance standards and application guidance related to HVAC systems and products. Examples include:

- United States Department of Energy (DOE)
- International Standards Organization (ISO)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
- Air Movement & Control Association (AMCA)
- Air-Conditioning, Heating, & Refrigeration Institute (AHRI)
- International Code Council (ICC)
- California Energy Commission (CEC)

Greenheck's involvement with the aforementioned groups is largely focused on development of standards, regulations and programs that result in energy efficient HVAC systems as well as

practical selection and application of energy efficient products manufactured for these systems. Greenheck is continuously working with these organizations and other industry members to provide constructive, consistent and substantial insight regarding industry standards and regulations.

In closing, Greenheck very much supports efforts to reduce energy consumption through practical and timely initiatives. This includes coordination and harmonization between appliance standards, energy codes and related compliance requirements.

Respectfully Submitted,

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