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Efficient Gas Rooftop Units for Commercial Buildings

System Requirements and Compliant Equipment

Introduction

Throughout the United States, rooftop units (RTUs) supply heating and/or cooling to meet the thermal comfort requirements of commercial buildings. In the Northwest states of Idaho, Montana, Oregon and Washington more than 400,000 RTUs exist, and more than half include a standard gas furnace module with 80% thermal efficiency. The Northwest Energy Efficiency Alliance's (NEEA) research indicates higher performance RTUs exist that utilize condensing heat exchangers, heat or energy recovery ventilators, or improved cabinet design.

Thermal efficiencies greater than 90% are possible by using secondary heat exchangers that capture a greater percent of the combustion energy. The flue gas temperatures of these systems are low enough to result in condensation of the water vapor in the combustion exhaust gases which delivers more heat to the supply air stream for a given amount of fuel combustion, boosting overall efficiency.

Additionally, other energy-saving measures can be incorporated into RTU design that can achieve comparable results without the need for a condensing system. NEEA's research indicates insulation and higher performance dampers save considerable energy at small incremental costs. Heat and energy recovery equipment can also be installed on RTUs that introduce outside air and provide up to 40% total HVAC savings.

The highest-performing RTUs incorporate a combination of energy-saving features, including condensing heat exchangers, high insulation values, low-leakage dampers, and heat or energy recovery.

For additional information and resources, visit: betterbricks.com/solutions/hvac.

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Purpose and Scope

This specification provides guidance to manufacturers and market actors for developing and delivering efficient gas RTUs that reliably deliver heating energy savings in Northern climates and are easy to install as a direct replacement for existing RTUs. The end goal of this effort aims to make efficient RTUs common practice for all commercial replacement and new construction RTUs.

Equipment Types

This specification covers commercial packaged RTU with gas-fired furnaces that may or may not also provide ventilation air and/or cooling, in addition to space heating.

Also covered by this specification are specialized RTUs with the primary function of providing outside air to a building that are capable of heating and other air treatment of the outside air. Such systems include dedicated outdoor air systems (DOAS) which provide 100% outdoor air for building ventilation to maintain indoor air quality and make-up air units (MAU) which provide 100% outdoor air to offset exhausted or exfiltrated air to prevent negative pressure within a building.

Applications

Heating capacity and percent of outside air processed through the RTU are the primary application differences to support the heating and indoor air quality needs of commercial buildings. Outside ventilation air can vary from 0-100%. The RTUs with larger outside air percentages (>60%) include DOAS and MAUs.1 However, the majority of RTUs supply around 30% outside air or less for ventilation. The capacity of these units varies widely, but in the Northwest 80% of installed units have a capacity of 10 tons or less.[2]

Climate

This specification intends to ensure high performance in heating dominant climates,[3] or locations in North America within the International Energy Conservation Code climate zones 4 or higher,[4] herein referred to as "Northern climates."

Valuing Efficiency in RTUs (CSA P.8 Standard)

The most common efficiency metric used for commercial furnaces in the United States, thermal efficiency, focuses on the burner efficiency and therefore does not account for a variety of efficiency opportunities in RTUs. CSA Group, an international standards organization, is developing a new metric to better value efficiency in RTUs. This new metric serves as a valuable tool for NEEA and other efficiency entities to set meaningful performance targets for programs and guidelines.

CSA P.8 is a standard for thermal efficiencies of industrial and commercial gas-fired packaged furnaces published by the CSA Group. The CSA P.8 standard (Edition 3.0) is undergoing revisions which will include both a test procedure and a calculation method to calculate a new efficiency metric, the Total Heating Season

[1] Past NEEA research indicates DOAS and MAUs make up 6% of the installed RTUs and 12% of the installed RTU capacity in the Northwest.

[2] Northwest Energy Efficiency Alliance's 2014 Commercial Building Stock Assessment

[3] NEEA defines heating dominant climates as with 4,000 heating degree days or higher and average ambient winter temperatures below 60 degrees Fahrenheit; however this is not a program requirement.

[4] https://basc.pnnl.gov/images/iecc-climate-zone-map

Coefficient of Performance ($TCOP_{HS}$). $TCOP_{HS}$ includes factors that influence total equipment efficiency and energy consumption to better represent the energy an RTU will actually consume during the heating season.

These factors include burner efficiency, total enclosure heat losses, fan energy consumption, and heat gains from heat recovery. The new $TCOP_{HS}$ metric establishes a realistic, consistent point of comparison that includes all of the most important elements of RTU design that affect energy consumption. The performance path of this specification includes $TCOP_{HS}$ targets to allow for more flexible options in meeting each tier. While the CSA P.8 standard is not final at the time of this document, NEEA includes this performance path option to encourage manufacturers to adopt the $TCOP_{HS}$ metric early.

System Requirements

The following system requirements include two Efficient RTU Tiers. Additionally, each Tier can be met through one of two paths:

1. **A prescriptive path** defining specific RTU characteristic requirements.
2. **A performance path** using the CSA P.8 efficiency metric, $TCOP_{HS}$, to allow a manufacturer to meet efficiency requirements in the method best suited to their product line. While the CSA P.8 standard is not final at the time of this document, the calculation method is available for manufacturers to start using.

	Tier 1	Tier 2
Prescriptive Path	All Tier 1 efficient RTU requirements	Tier 1 efficient RTU requirements plus condensing furnace or heat/energy recovery
Performance Path (Draft)	$TCOP_{HS}$ > 0.70	$TCOP_{HS}$ > 0.80

Tier 1 Requirements

Tier 1: Prescriptive Path Requirements	
Thermal Efficiency	>=80% Thermal Efficiency[5]
Insulation	Cabinet shall be thermally insulated: • All panels (Door liners, top panels, divider panels, and mullions) adjacent to conditioned air, including the base, shall be fully insulated with a minimum of R-12 • Insulation exposed to supply air must either be cleanable foil-faced with sealed edges or be sealed within double-wall cabinet to ensure no insulation fibers enter the airstream

[5] Per DOE 10 CFR 431.76 for systems with a capacity (maximum rated input) of ≥225 kBtu/hr or ANSI Z21.47 for systems under 225 kBtu/hr.

Outdoor and Return-Air Mixing Dampers	Damper leakage rate shall be no greater than the rate described in ASHRAE/IESNA 90.1-2019 Table 6.4.3.4.3
Tier 1: Performance Path Requirements	
$TCOP_{HS}$ (Draft)	>0.70, as measured by CSA P.8 – Edition 3.0

Tier 2 Requirements

The Tier 2 prescriptive path shall be met by meeting all of the Tier 1 requirements and having one of the following addition efficiency options:

1. A heat or energy recovery ventilator, or
2. A condensing heat exchanger

Tier 2: Prescriptive Path Requirements (in addition to Tier 1 Requirements)	
Condensing Furnace Requirements	
Thermal Efficiency	>=90% Thermal Efficiency[6] (condensing heat exchanger)
Heat or Energy Recovery Requirements	
Heat or Energy Recovery	The unit must be equipped with a heat or energy ventilator that that allows for energy recovery (sensible or total) between the exhaust and ventilation air steams
Tier 2: Performance Path Requirements	
$TCOP_{HS}$ *(Draft)*	>0.80, as measured by CSA P.8 – Edition 3.0

Other Requirements

- General
  - Unit shall meet Federal minimum standards and any other applicable local energy codes and standards.
  - Unit shall comply with all UL, NFPA, and local safety code requirements.

- Indoor Air Quality
  - Unit shall be equipped with a filter that has a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 as follows:
    - 2-inch Minimum MERV 7, Factory-Installed for use during construction
    - 2-inch pleated Replacement Set: Minimum MERV 8

[6] Per DOE 10 CFR 431.76 above 225 kBtu/hr or ANSI Z21.47 for systems under 225 kBtu/hr.

- Filter compartment shall have a hinged, gasketed, access panel on one side of cabinet to allow for easy filter removal.

Design and Installation Guidelines

The following guidelines are not mandatory requirements to meet this specification but offer best practices for sizing and installation of RTUs.

- Sizing
  - The unit load and sizing should be calculated in accordance with the section "Load and Energy Calculations" from the most recent version of the ASHRAE Fundamentals Handbook.[7]
  - Unit should include roof curb or curb adapter appropriate for installation.

- Installation
  - For Condensing RTUs Only: Condensate Management
  - RTUs installed with a condensing heat exchanger should follow condensate management best practices specific to the application and location, identified in the report, "Condensing Gas Rooftop Unit Installation Tips and Best Practices," available at https://betterbricks.com/resources/condensing-gas-rooftop-unit-c-rtu-installation-tips-and-best-practices.

[7] In the 2017 ASHRAE Fundamentals Handbook, "Load and Energy Calculations" is chapters 14 through 19.

Compliant Equipment

The following currently available Efficient Gas RTU equipment meets the minimum equipment performance requirements based on the Prescriptive Path tables above:

Manufacturer	Product Line / Model #	Customization Required
Tier 1		
Aaon	RQ	
Aaon	RN	
Aaon	RZ / RZ-A	With optional low leakage damper included
Daikin Applied	Rebel Applied / DPSA	
Daikin Applied	Rebel (16-28 tons cooling capacity sized units) / DPS	With optional low leakage dampers included
Greenheck	RVE (DOAS)	
Modine	Atherion (DOAS) / B/C/D	
Tempeff	RG (DOAS)	
Tier 2: Heat Recovery		
Aaon	RQ	With optional ERV included
Aaon	RN	With optional ERV included
Aaon	RZ / A	With optional low leakage dampers and ERV included
Daikin Applied	Rebel Applied / DPSA	With optional ERV included
Daikin Applied	Rebel (16-28 tons cooling capacity sized units) / DPS	With optional low leakage dampers and ERV included
Greenheck	RVE (DOAS) / RVE	ERV is standard a component
Tempeff	RG (DOAS)	ERV is standard a component
Tier 2: Condensing		
Modine	Atherion (DOAS) / B/C/D	With optional ERV or condensing furnace included