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Condensing Rooftop Unit Installation and Best Practices Guide

MARCH 2021

Post Falls, ID

OVERVIEW

This guide outlines best practices for the proper installation of condensing rooftop units (C-RTUs). These recommendations are based on a comprehensive field study conducted during the 2018/2019 heating season, in combination with a literature review of state and national code requirements and manufacturer guidelines.

To learn more about the field study, visit **betterbricks.com/solutions/hvac/c-rtus.**

CONDENSATE MANAGEMENT

C-RTUs process furnace exhaust to capture the latent heat of combustion byproducts, thereby providing heat to the conditioned space. This process produces condensate that must be properly managed. This guide details code requirements, best practices, and cost information to provide clarity on C-RTU condensate management for utilities, installing contractors, architects and design engineers.

CONDENSATE CREATION AND PROPERTIES

In condensing heating appliances, the products of combustion include O_2, N_2, and H_2O (water vapor), as well as CO_2, CO, NO_X and trace amounts of sulfur compounds. As the water vapor condenses into a liquid, the other flue-gas components dissolve into it. When this happens, dissolved CO_2 and CO will form carbonic acid, NOx will form nitric acid and nitrates/nitrites, and sulfur compounds will form sulfuric acid and sulfates. The presence of nitric and sulfuric acids in the condensate can make it corrosive and therefore must be properly disposed of.

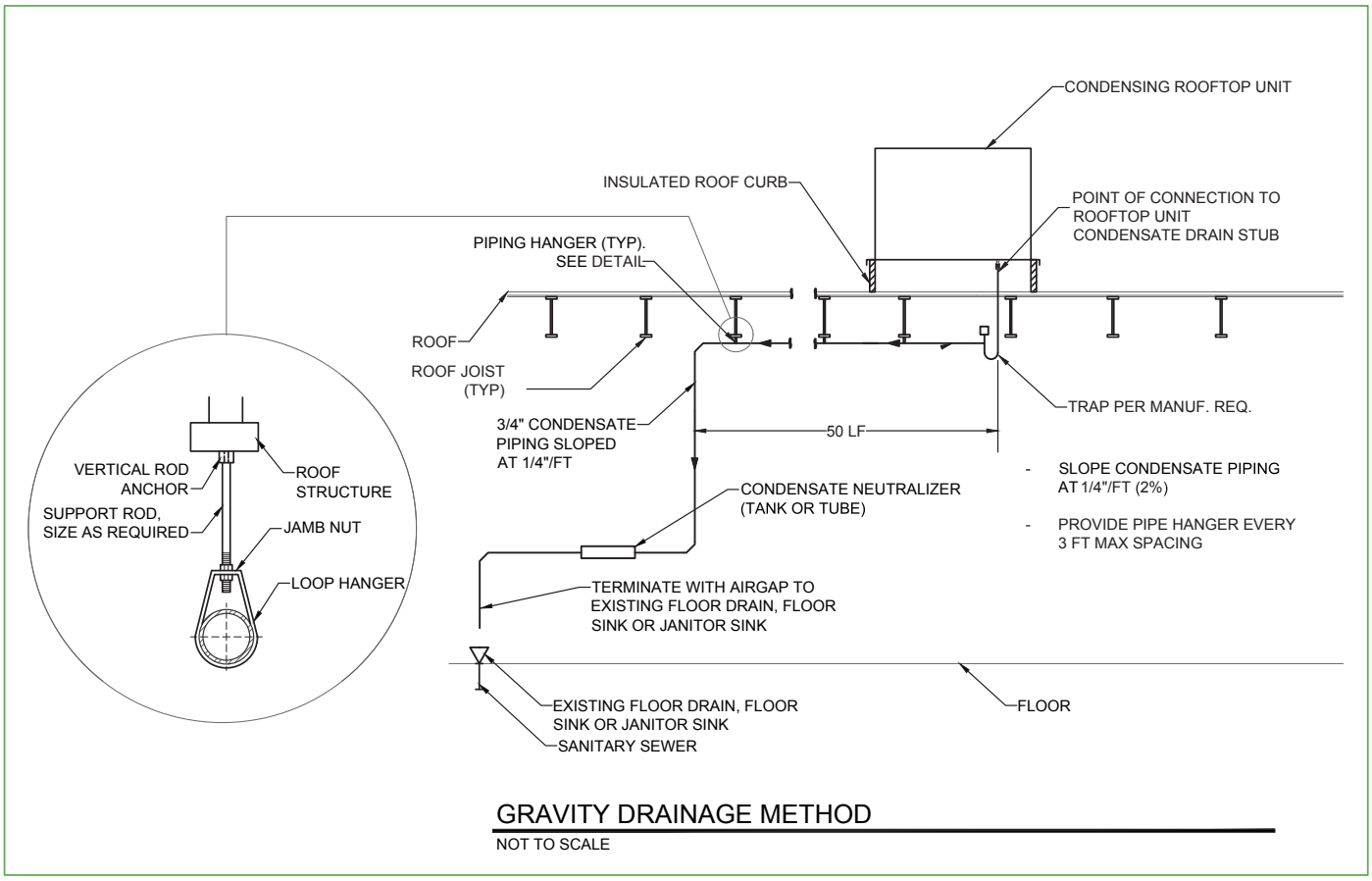
SYSTEM TYPES: GRAVITY DRAINAGE AND PUMPED DRAINAGE

Each C-RTU installation can present distinct challenges. The best installation path and strategy depends on a variety of factors including the location of the C-RTU, location of nearest acceptable disposal location, climate, building characteristics and local jurisdiction. In addition to meeting all national, state, and city mechanical and plumbing codes, each installation should follow C-RTU manufacturer's recommendations. If possible, it is preferable to install a gravity drainage system, which are simpler, less expensive, less prone to failure, and require less maintenance than a pumped drainage system. However, when the nearest appropriate drainage location is 50 feet or more from the location of the C-RTU, it may be necessary to use a pumped drainage strategy.

The following tables provide guidance for each system type. When the recommended best practices described below are not feasible for a given project, the alternate good practices can be followed to maintain efficacy.

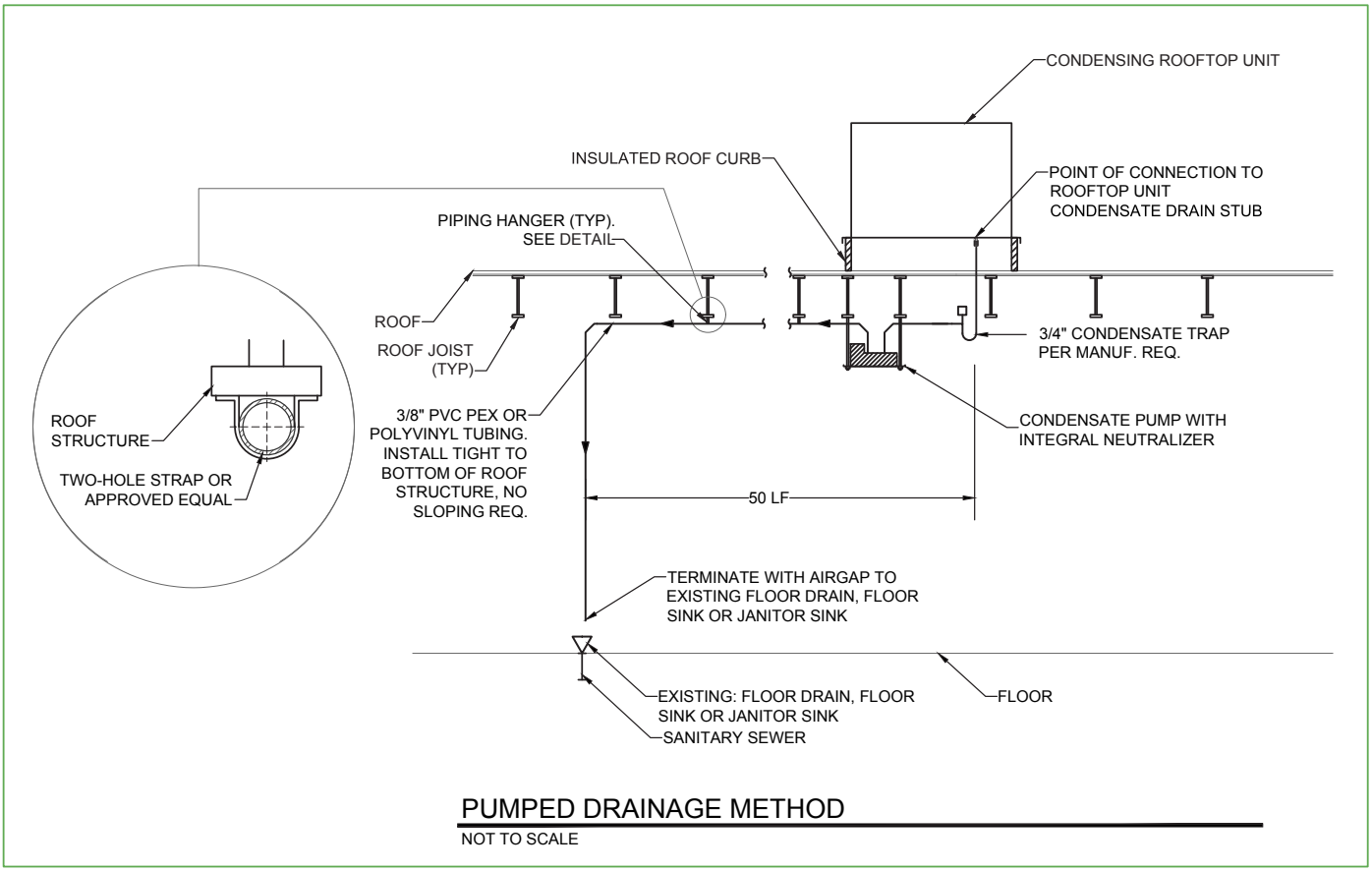
Renton, WA — PVC condensate line installation at a 2% (1/4-inch per foot) slope utilizing conventional hangars and unistrut supports.

GRAVITY DRAINAGE SYSTEM



	Best Practice	*Good Practice*
Piping material	Use PVC piping sloped at 2% (1/4-inch per foot).	Use PVC or PEX piping with support sloped at 1% (1/8-inch per foot).
Piping support	Use commercial-grade piping hangers such as clevis or swivel loop hangers.	Use perforated metal strap hangers.
Neutralization	Provide neutralization of condensate prior to disposal into approved drain.	Neutralization is recommended.
Overflow/bypass	Provide a bypass of the neutralizer in case of overflow.	Bypass is recommended.
Discharge	Terminate piping into approved sewage floor drain with air gap.	

PUMPED DRAINAGE SYSTEM



PUMPED DRAINAGE METHOD

NOT TO SCALE

	Best Practice	*Good Practice*
Pump location	Locate condensate pump directly below the C-RTU equipment.	Locate pump as close to the C-RTU equipment as possible.
Piping	All piping between C-RTU and pump must slope downward (use rigid copper or PVC to avoid high spots with commercial grade pipe hangers).	Use sloped PVC or supported PEX piping from the C-RTU equipment to the inlet of the condensate pump.
Neutralization	Either 1) use combination pump/neutralizer, 2) neutralize before the pump inlet, or 3) ensure pump is rated for acidic condensate liquid.	
Overflow alarm	If the pump is located below the C-RTU equipment, provide a drain pan and overflow alarm.	
Piping material	Use PEX or polyvinyl tubing from the pump discharge to an approved disposal location. (Note: To avoid corrosion, plastic fittings are preferred over brass).	
Piping support	Support flexible piping with commercial quality supports such as Unistrut and pipe clamps.	Support flexible piping with pipe clamps attached to the structure or strap hangers.

PIPING MATERIAL, COMPONENTS AND ROUTING

Condensate byproducts can be corrosive to some materials including carbon steel pipes, brass drain grilles, reinforced concrete, and some plastics. For this reason, PVC, CPVC or PEX used for condensate drain piping must meet the appropriate ASTM/CSA specifications.

Best practices for condensate drain installation include:

- Prepositioning the flexible condensate line up through the roof deck or duct passage opening inside the roof curb, so it can connect to the C-RTU drain port.
- Setting the C-RTU on the roof curb for completion of the condensate line connection in the RTU.
- Bringing the drain line directly into a conditioned space below the RTU, if possible. This will avoid the need for any heat tape and insulation on the drain line for freeze protection.
- Installing the drain trap in a serviceable area in the conditioned space below the RTU to avoid freezing conditions.
- Ensuring that all drain piping connections downstream of the C-RTU are permanent until accessible areas within the building interior are reached.
- When installing multiple C-RTUs on a building, the separate drain lines can be connected into a common drain line, but only downstream of the individual RTU drain traps.
- Where gravity is driving the flow of condensate through the pipe, a slope of 1%, or 1/8-inch per foot, is required by code (a 2% slope, or 1/4-inch per foot, is preferable, if space allows). In addition, it is recommended to provide supports or hangers for the piping at maximum 3-foot intervals for pipe stability.

Bend, OR — Condensing RTU with evaporative air conditioning feedwater piping visible. Because of the high efficiency of this unit, moisture in the flue gases is condensed and this condensate needs to be managed and disposed of appropriately.

PUMPS

For most installations where the C-RTU is installed on a roof curb, gravity will ensure the proper drainage of condensate away from the C-RTU. In situations where the unit is installed at or below ground level, or where a 1% slope (1/8-inch per foot) of the piping cannot be held for its entire run, the addition of a condensate pump is necessary.

The pump must be sized to handle the volume of condensate produced by the unit. Manufacturers typically provide charts or guidance on the amount of condensate that is produced in one hour. In colder climates, it's common to install a pump 2–3 times larger to avoid 100% runtimes.

It's important to note that if the pump is positioned before the neutralizer, the pump must be rated to handle acidic condensate. Some manufacturers offer pumps with built-in neutralizers. Pumps located after the neutralizer may be subject to the buildup of calcium deposits, which can limit the life of the pump. Because of this, it is recommended to inspect and clean the pump during routine maintenance visits. Additionally, the pump should be wired to the controls of the C-RTU to prevent it from running in the event of a pump failure.

NEUTRALIZERS

Neutralizers are a mature technology developed alongside the widespread introduction of condensing boilers. They are often available as an option from the C-RTU manufacturer, or available as an aftermarket component from suppliers.

Neutralizers usually consist of a PVC pipe or tank that is filled with a neutralizing medium. They are installed in line with the condensate piping before the point of disposal. Neutralizers are sized for gas-fired appliances ranging from 220,000–2,000,000 Btu per hour, or 220-2,000 MBH, corresponding to peak condensate production of 0.73-6.67 gallons per hour (GPH). While calcium carbonate is commonly used, magnesium hydroxide is beginning to enter the market as a high-performance alternative. The neutralizing medium is consumed as it reduces the acidity of the condensate; therefore, it must be replenished. The neutralizer usually has union fittings on either side that allow a service technician to remove the neutralizer and unscrew the cap at either end to add calcium carbonate.

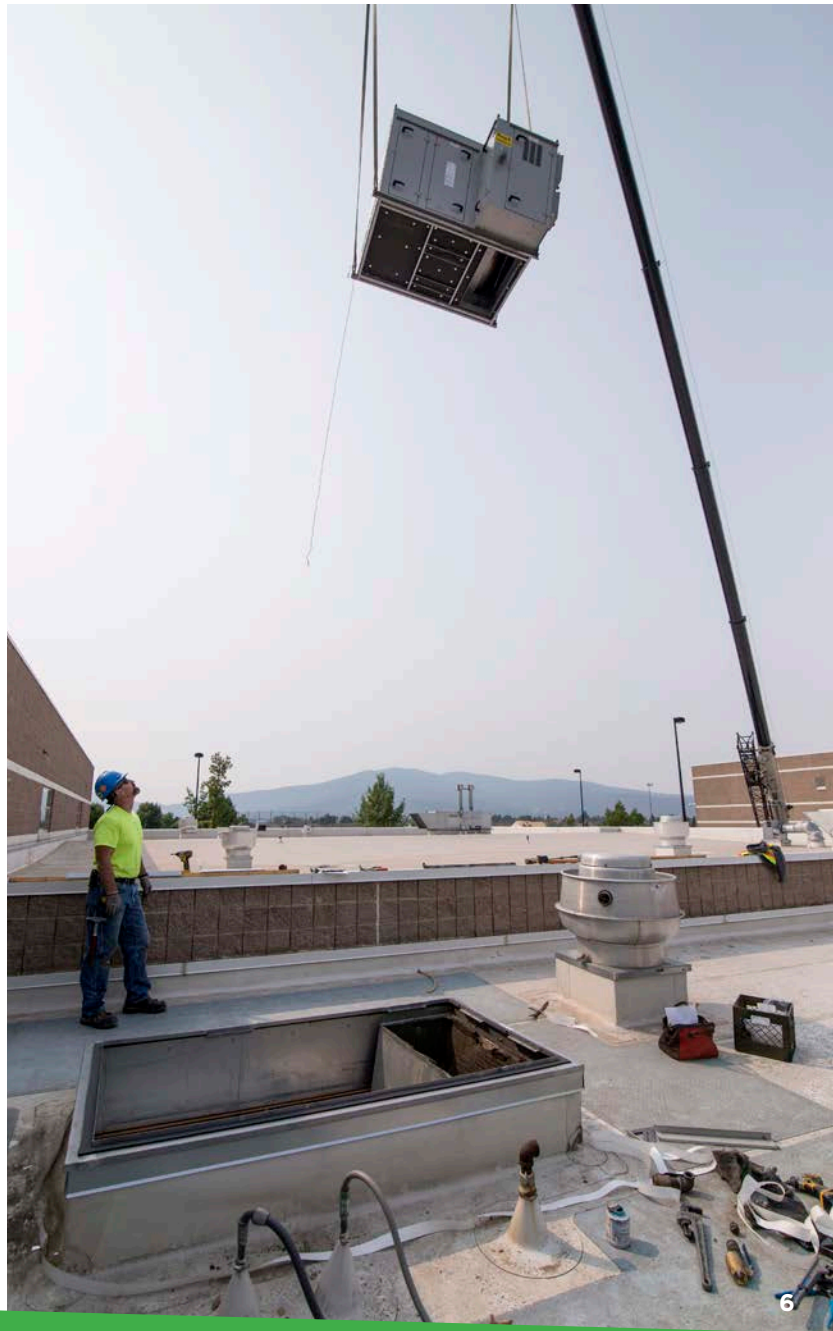
The neutralizer is sized for the condensate load, with an industry guideline of 1/3 gallon of condensate produced each hour for every 100,000 Btu per hour of input capacity. Therefore, the range in condensate production for C-RTUs at 50–800 MBH is approximately .17 to 2.67 GPH. If operated for 12 hours, the total volume of condensate produced would range from 2–32 gallons per day (GPD). The equivalent full-load hour (EFLH) of the annual firing capacity will establish the total gallons of condensate for the year. However, this will vary somewhat with condensing efficiency level, which is also affected by ambient temperature conditions—especially when processing 100% outside air with RTUs. Therefore, it is important to make sure the neutralizer is adequately sized to move the volume of condensate produced.

Neutralizers generally range in uninstalled cost from $50–$250 for 2,000 gallons (100,000 Btu/hr. input firing for 2,000 EFLHs) to 40,000 gallons (400,000 Btu/hr. input firing for 10,000 EFLHs) of condensate neutralization capacity, respectively.

FREEZE PROTECTION

In colder climates, winter temperatures can freeze condensate when piping is routed outside of the building. To avoid frozen condensate, it is advisable to route the drain line inside the building. Note that most manufacturer installation guides advise against routing the drain line to the roof. Where it is not possible to run the line inside the building, make sure the condensate is not allowed to collect in the pipe anywhere along its routing. Otherwise, freezing may occur before the condensate reaches its drain. Additionally, installers should use frost-free traps and heat trace along the pipe.

Post Falls, ID — Condensing RTU installed reusing the curb of the replaced unit.



LABOR AND EQUIPMENT COSTS

With proper experience and implementation of best practices, costs for properly disposing of condensate can be expected to fall into a range of $500 to $2,500 per installation. First-time installations may see a slightly higher cost due to a lack of direct installation experience, particularly when it comes to condensate management.

ONGOING MAINTENANCE

In general, C-RTUs follow the same maintenance practices and schedule as any other RTU.

It is recommended (and, in some cities and states, required) that a neutralizer is installed to treat condensate. The neutralizer media should be replaced on an annual basis to ensure adequate neutralization of the acidic condensate. The drain line should also be periodically checked for blockages to ensure condensate does not back up to the C-RTU. It is important to configure condensate drain lines with a clean-out to permit the clearing of blockages and other maintenance without requiring the drain line to be cut.

To mitigate overall risk, property managers or installation contractors should consider contracting an annual maintenance agreement after the installation of a C-RTU. When installing, ensure the neutralizer and pump are accessible for this recurring maintenance to take place.

CODE COMPLIANCE PRACTICES

National, state, and city mechanical and plumbing codes often refer to manufacturer's installation instructions to specify installation requirements. Common code requirements include:

MATERIAL

Piping shall be of approved corrosion-resistant material. The International Fuel Gas Code® (IFGC) and the City of Seattle list the acceptable materials for components of the condensate disposal system as: cast iron, galvanized steel, copper, cross-linked polyethylene, ABS, CPVC, PVC, or polypropylene pipe or tubing.

SLOPE

Consistent across all codes is the requirement that piping must maintain a minimum 1% slope (1/8-inch per foot), with several manufacturers specifying a minimum slope of 2% (1/4-inch per foot).

DRAIN PANS

IFGC and the City of Seattle require a drain pan for a Category IV condensing appliance where overflow may cause damage. There is an exception for appliances with an automatic shut-off in the case of a drain blockage.

CONDENSATE TREATMENT

The international plumbing code specifies that acidic, corrosive liquids should not be discharged into the plumbing system without being thoroughly diluted, neutralized or treated by passing through an approved dilution or neutralizing device. However, there is no indication that the condensate from gas-fired C-RTUs falls into this category. Regardless, the city IFGCs of Seattle and Portland specifically call for the neutralization of acidic condensate.

Post Falls, ID — Condensate neutralizer and overflow by-pass located just before a kitchen floor drain. Note the union fitting installed for easy servicing and replacement of neutralizer media.

Post Falls, ID — On-site planning ensures proper placement of condensate line.

MANUFACTURER INSTALLATION DOCUMENTATION SUMMARY

DRAIN AND PIPE LOCATION/MATERIAL

Schedule-40 material must conform to ASTM D1785 or CSA B137.3 (the materials standards for PVC pressurized piping in the U.S. and Canada, respectively) while pipe fittings must conform to ASTM 2855 or CSA B137.6. In Canada, all materials must also conform to ULC S636.

Several installation guides note that pipe runs should have a minimum of 2% (1/4-inch per foot) slope in order to avoid vapor lock and trapping of condensate, and it is recommended that support hangers should be spaced every three feet along the run of a suspended pipe.

Some manufacturers specify that the drainpipe should be run through a curb and include a freeze-resistant trap with the unit. Multiple manufacturer guides warn against draining condensate on the roof. One manufacturer specified that the drain trap height must be at least 6 inches to account for the negative pressure in the unit at the drain outlet. This ensures that air is not drawn into the system from the drain line.

NEUTRALIZATION

Condensate pH ranges from 3–6 according to various installation manuals. Manuals generally do not specify whether a neutralizer is required or recommended, instead referring the reader to local code for guidance. When installed, the size of the neutralizer should vary with the condensate flow rate. This flow rate can be estimated from the heating capacity of the unit using charts available in manufacturer installation manuals.

PUMPS

Where sloped drain lines and gravity are not an option to provide condensate drainage, a pump is required. Failure to drain condensate results in poor combustion and rapid failure of the heat exchanger. Where condensate pumps are necessary, a high-level switch should be installed to disable heating should the pump fail.

WARRANTY

In most manufacturer warranty statements, it is noted that failure to follow installation specifications will void the warranty. As it pertains to condensate management, it is only stated that the installer must confirm that 100% of the condensate is draining from the unit and is not draining directly to the roof. Traps, neutralizers, and pipe-run slopes are consistently shown in diagrams and components of the drainage assembly, while bypass piping is usually specified as an optional component.

DEFINITION OF TERMS AND ABBREVIATIONS

ABS	Acrylonitrile butadiene styrene, a polymer pipe material.
ASTM	American Society of Testing and Materials
BTU	British thermal unit
CPVC	Chlorinated polyvinyl chloride, a pipe material that is more flexible and temperature-resistant than standard polyvinyl chloride pipe
C-RTU	Condensing rooftop unit
CSA	Trademark of CSA Group. The CSA mark indicates that a product has been tested against and has met the requirements for safety, performance and/or energy efficiency for the U.S. and/or Canada
IAMPO	International Association of Plumbing and Mechanical Officials
IFGC	International Fuel Gas Code
NEEA	Northwest Energy Efficiency Alliance
PVC	Polyvinyl chloride, a rigid, resin pipe material
RTU	Packaged heating and cooling units located outdoors

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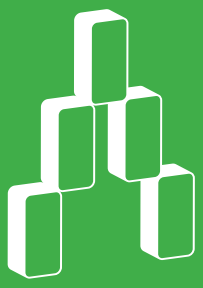

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