



COLD CLIMATE HOUSING RESEARCH CENTER

CCHRC

Best Practices for Bath Fans

Bathrooms tend to produce high levels of moisture as well as odors that are unwelcome in the rest of the home. The best way to lower humidity and contain those odors is to install a dedicated exhaust fan in the bathroom to vent air directly outside.

Bathroom ventilation can take several different forms:

The simplest is a bath fan that never turns off. While this is great for moving air, it is not the best for energy efficiency. A continuous bath fan costs electricity to run and exhausts precious conditioned air. In some homes continuous bath fans are integral to the whole house ventilation system (check local codes and specific house controls).

Another option is to have a manual switch controlled fan that can be turned on when you walk into the bathroom and turned off when you leave. The drawback is that the fan may not have completed its business when you leave the bathroom. Setting a timer to let the fan run 5 to 10 minutes after you leave helps the fan perform its job.

The fan could also be set up to run automatically when the humidity in the bathroom reaches a certain point and continue until it drops to an acceptable level (known as a humidistat control). The only shortcoming is that the sensor only detects humidity and has no way to sense odor.

Ideally, you'll want a fan that does all of the above: a motion sensor that turns on when you walk in, a humidistat that turns on when humidity is high, and a manual control (in case someone's science experiment goes wrong and you need to evacuate all the bad air in the house, fast). All of these options can be expensive, so it's best to evaluate your house habits and choose the best controls that work for you.

The exhaust hood should be cleared of frost and debris to keep the ventilation system running smoothly.



CCHRC ran a bath fan study to look at best practices for installers. Temp and humidity sensors were placed in the fan box, duct, room, and outside to compare the different configurations.

Installation best practices

So we know bath fans are important and everyone needs one, but how should they be installed? In addition to following the manufacturer's recommendations, here are a few tips that can help improve fan operations.

Make sure the duct is insulated when it goes through an unheated space, like your attic.

Make sure your outside hood is clean and free of debris. It should have a gravity damper that only opens when the fan is on. It is helpful if the fan also has a damper at the duct connection.

Install the duct with a minimum 1/4" per foot pitch to the outside so any condensation inside the duct does not run back into the fan. Make sure the duct sections are connected so that joints are in the direction that is conducive to air flow and condensation drainage.

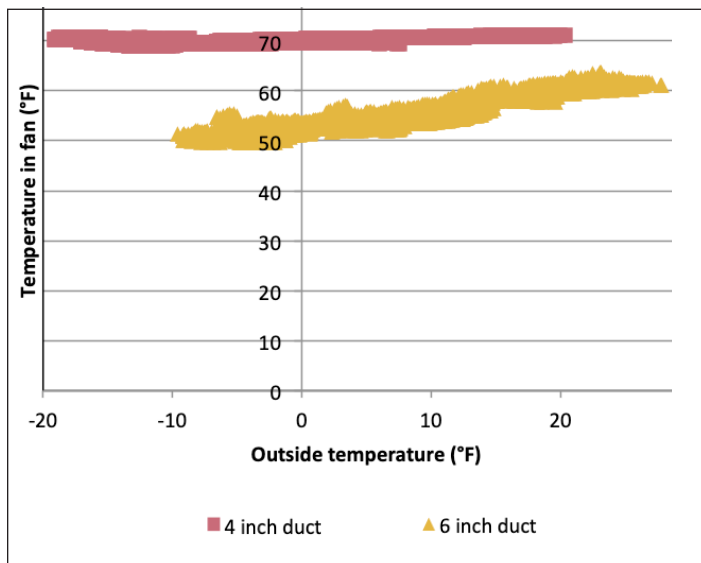
Exhaust should be terminated at the exterior wall away from attic venting (gable or soffit) to prevent moist air being pulled into the attic. This will prevent accumulation of hoarfrost and icicles at the vent too. The exhaust should also be 3 ft from any opening into the house.

If cold air leakage is a problem, for example, on the first floor of a two-story house, you can add a gasketed backdraft damper.

CCHRC Bath Fan Study

CCHRC tested a number of bathroom fan installations to see how the fan performance was affected by different duct configurations; for example, a 4-inch diameter duct, a 6-inch diameter duct, and different lengths of ducting (pictured at right). The study showed that the wider 6-inch ducts made the inside of the fan colder when the fan was off than narrower 4-inch ducts, assuming the same length of duct, because more cold air leaked into the wider ducts from outside. It should also be noted that the fan in this experiment had an exaggerated stack effect because it was on the first floor of a multi-story building, which created more air leakage.

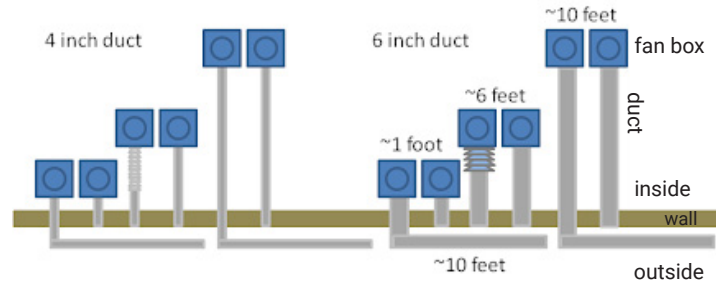
The main finding was that temperatures inside the fan box with 6-inch ducts fluctuated based on outdoor temperatures, as shown below, while the 4-inch ducts remained stable. While fans with 4-inch ducts were able to maintain fan temperatures of 65-70°F, whether it was 20°F or -20°F outside, the 6-inch duct was unable to maintain this temperature. When the outside temperature dropped to -10°F, the inside of the fan box dipped to 50°F.



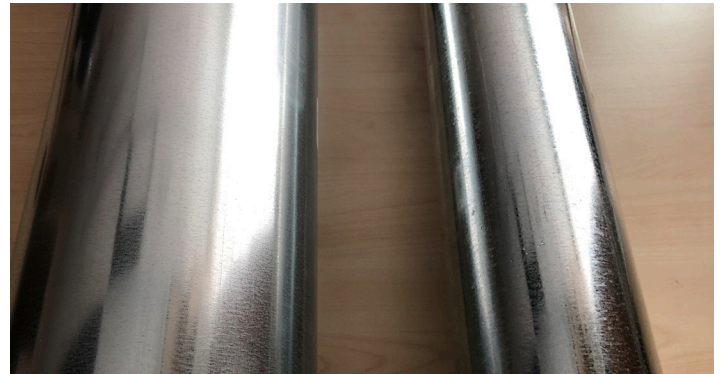
This pattern persisted over the course of the study—the colder it got outside, the colder the temperature in the fan with 6-inch duct. It didn't matter what type of ducting was used—including rigid duct or flex duct, insulated or uninsulated.

Relative Humidity

The fact that wider ducts make the fan box colder has greater implications than simply the heat that is lost through the ducts—it also impacts relative



The experiment included fans connected to various lengths and diameters of ducts to see what the optimal duct configuration was.



Four-inch ducts, pictured right, allowed less cold air to leak into the fan box than 6-inch ducts on the left.

humidity. Some fans have sensors in the fan box that automatically turn on the fan when the relative humidity exceeds a certain value. Because colder air can hold less moisture than warmer air, a colder temperature inside the fan box will mean a higher relative humidity. If the fan itself is colder than the surrounding room, it may sense greater relative humidity than there actually is in the rest of the room simply because cold air is leaking in through the ducting. That may cause the fan to turn itself on even when the relative humidity in the room is not high enough, which is a waste of energy.

In summary, our bath fan study confirmed that bigger ducts leak more cold air into the fan than smaller ducts. In colder climates, it is recommended to use 4-inch ducts to limit cold air leakage. When 6-inch ducting is needed because of complexity of the installation, adding a gasketed backdraft damper will reduce air leakage.

Funding from Panasonic Eco Solutions.

Fan was Panasonic bathroom fan, model FV-0511VKS2, with an internal humidistat controller. Exhaust hood where the duct exited the outside wall was either a gravity damper or a Panasonic "EZ Soffit Vent."