Let's Concentrate on Condensate

by Kenny Hart

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With warm weather just around the corner, thermostats soon will be switched from heat to cool. Those of us who inspect and repair HVAC systems for a living know that with the start of the AC season, the phone will begin to ring with cries from hysterical customers frantic about water dripping from their ceilings and water-soaked floors. Condensate may be behind their falling plaster and drenched carpets due to improper collection and control of this cooling-mode byproduct.

As air passes through the cooling coil of an air conditioner or heat pump, its temperature is lowered below the saturation point. While simultaneously hugging the fins of the coil and moving downward, moisture sucked from the air begins filling a collector positioned under the coil, which manufacturers call the primary condensate drain pan or just the condensate pan. As the pan fills, it must continually drain to prevent it from overflowing and causing damage to the equipment and to the surroundings. The pan also must drain quickly and completely to prevent it from becoming an unhealthy pool of contaminants. Failure to do so can lead to personal and real property damage and even to life-threatening illnesses.

Photo: Cased coils or coil boxes are often attached to furnaces. Photo from Carrier Literature

Blow-through and draw-through systems

The evaporators of air conditioners and the indoor coils of heat pumps, both used for cooling in summer, are installed so that a blower either pushes or pulls air over their cooling surfaces. When air is pushed across, putting the coil under positive pressure, it is considered a blow-through or positive pressure system. When air is pulled across the coil, it is a draw-through or negative pressure system. The majority of air handlers used with heat pumps or with modern AC cooling-only systems are draw-through systems. Blow-through systems are common when cooling coils are attached to a gas or oil furnace, as most furnace makers call for cooling coils to be placed downstream of the heat exchanger.

There are a few exceptions regarding cooling coil placement in the air stream generated by a furnace blower, but unless the furnace is listed and labeled safe to be downstream of a cooling coil, passing cooled air over the heat exchanger will result in extensive corrosion of the furnace, premature failure of the heat exchanger and moisture damage to the surroundings.

Home inspectors need to pay close attention to the cooling coil location when inspecting new furnace-based heating and cooling systems. If the system has yet to be operated in the cooling mode, there will be little evidence of a problem, and the client will be at the mercy of the inspector's experience and training. On the other hand, if the system has been operated in the cooling mode, in some cases even only for a few months, usually the evidence is glaring. The condensation process can age a furnace dramatically.

Condensate pans

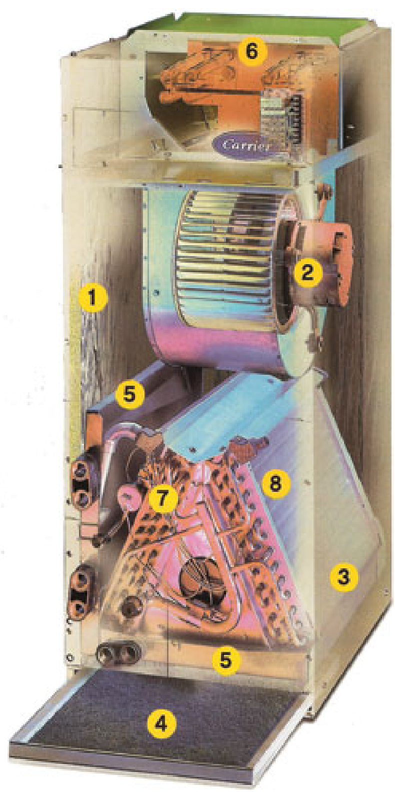
Cooling coils come in a variety of shapes and sizes. Slant coils, N-coils, horizontal slab coils and the popular A-coil style all are used in residential applications. Attached to the bottom end of these coils or placed under them is a gutter-like device or shallow pan that collects the condensate produced during cooling. They are used in both vertical and horizontal applications and, though somewhat different for each orientation, the objective of all condensate drain pans is to thoroughly collect and then direct the condensate water to a condensate drain.

When you look at a coil box or the air handler's service panel installed in front of the coil, you will notice several ¾-inch pipe openings. Some will be used; some will not. The unused, sometimes plugged openings likely are for drain connections to be made when the coil is used at different orientations. Many coil boxes and air handlers can be used in both vertical and horizontal applications.

By simply repositioning the cooling coil and condensate pan and then orienting the panel to fit the correct openings, the manufacturer can use one piece of equipment to do many jobs. Inspectors should be wary of any drain connections made above the two lowest fittings on the air handler or coil box you're inspecting. This could indicate that the installer has made connections to the wrong fittings. When this is done, the pan can fill to overflowing before the water can drain away.

A condensate pan serving cooling coils installed in vertical applications usually will encapsulate the lower end(s) of the coil assembly and often obstructs much of actual pan surface from view, making it difficult to inspect. Condensate pans used in equipment positioned horizontally usually are more accessible, simple to service and easy to inspect. The condensate pan for vertical installations can be seen under the "A" coil and is labeled 5 in the image at the bottom on the opposite page. The condensate pan for a horizontal installation can be seen at the left side on the air handler and also is labeled 5.

Illustration: The condensate pan for vertical installations can be seen under the "A" coil and is labeled #5 in this illustration. The condensate pan for a horizontal installation can be seen at the left side on the air handler and also is labeled #5. Illustration from Carrier Literature.



Today, the major equipment makers use different plastic materials to build a smooth-surfaced, rust-proof condensate pan. To assist drainage and prevent pooling, some slope the base of the pan toward the drain openings. However, since many of these changes are recent, you'll still find many of the older galvanized steel pans under cooling coils.

Inspectors should be aware that the older steel pans have a much rougher, even pitted, surface that can collect sludge. Manufacturers relied heavily on installers to tilt this type of pan in the direction of flow. Failure to do so may have contributed to years of pooling.

Older pans can be more difficult to thoroughly clean and when there is visible evidence of a little slime in the pan, there can be much more blocked from view.

A dirty pan can be especially harmful to people with allergies and weakened immune systems. Breathing the air circulated across an unclean condensate pan can cause eye irritations, headaches, sinus issues and serious respiratory ailments. Although I'm aware that accessing the cooling coil and the pan can be beyond the scope of a home inspector's duties, I would encourage inspectors to notify their clients if they have not accessed the coil and the pan, and point out the importance of an annual professional inspection and cleaning.

Unlike the newer plastic pans, which can be cracked or broken, areas of the steel pans can rust away. When this happens, water leaking through the pan can be mistaken for an overflowing blocked drain. Mistaking a rusted-out pan for a simple blocked drain can be costly. Unless you're certain of the integrity of the condensate pan, don't call out the evidence of moisture damage around the cooling coil as a mere blocked drain. Replacing the condensate pan often requires a total coil replacement and starts at several hundred dollars. If you are uncertain, note what you observed, recommend further professional evaluation and leave it at that.

Trapping

Probably the most misunderstood portion of a condensate drain system is trap installation. The primary purpose of a condensate trap is to prevent air from moving in or out of the coil box or air handler during operation. Traps must be installed in a manner that will stop the air from passing through, but still allow the condensate to drain from the condensate pan.

Without a trap, this doesn't happen. Air that is lost through the condensate drain in blow-through systems primarily is an efficiency issue. Failure to install a trap on a blow-through system can be likened to drilling a hole in the ducts for each drain connection. As for draining away condensate, the pressure around the pan on a blow-through system almost guarantees the pan will drain, trapped or not.

Trapping is a major issue on draw-through systems. Untreated air can be drawn into the airstream while the system is running. If the coil is located in an attic or other warm space, there is even greater reason for concern. As on a blow-through system, an untrapped drain on a draw-through system is an efficiency issue. But more importantly, the air being sucked through the drainpipe can prevent the pan from draining, causing it to run over.

Without proper trapping, air pulled back into the equipment can lift the water up from the condensate pan much like an aerosol spray. Often, this results in a good soaking of the liner material and many of the components located nearby. As I noted earlier, if a condensate pan is contaminated it can become a health issue. If the pan water becomes airborne as a result of improper trapping, it is even more likely to be one.

Trap problems

When a trap seal is too shallow, it can be sucked or blown dry at each cooling cycle startup. Running traps are prone to fail in this way. Some manufacturers specifically recommend against the use of running traps.

If the seal is too deep, it actually can cause condensate to be held in the pan. A trap with an excessively deep seal also is prone to clogging. Because fan speed, duct size, coil condition or other issues that affect the static pressure around a cooling coil can be as varied as each HVAC system installation, trap design should be as varied as well. Based on my experience as an installer and service tech, I believe little consideration actually is given to static pressure issues, and though traps might appear to be somewhat different from unit to unit, this almost certainly is from happenstance and almost never by engineering or design.

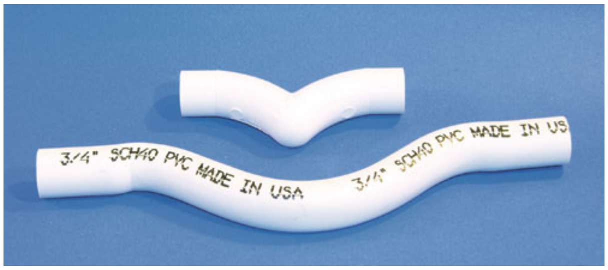
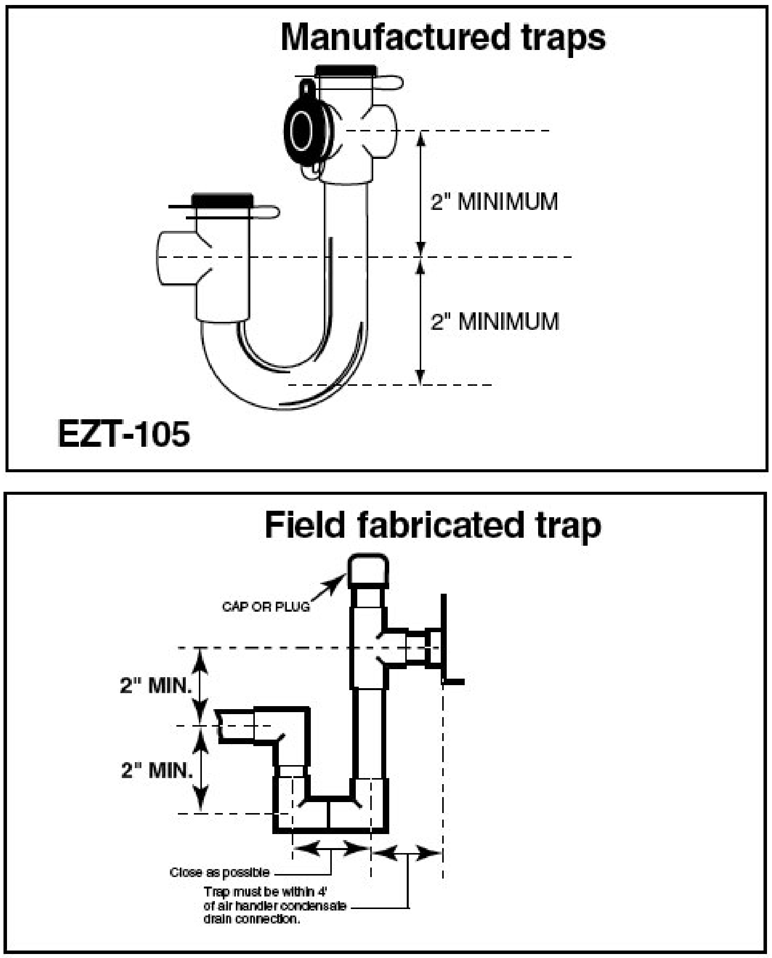


Photo: Running traps. Photo TS Hart.



Recommended trap configurations. Illustration from Trane installation manual.

Today in my area, many installers seem to favor manufactured traps, but site-built traps still are common. Home inspectors should know that equipment makers often recommend a drop from the pan at a minimum of 2 inches and then a minimum of a 2-inch trap seal *(see illustration above)*. Anything outside of these parameters, either excessively short or long, should cause a home inspector to look more closely for signs of moisture concerns in or around the equipment. Without the supporting evidence of an overflow or similar failure, you might not want to call out the system as defective, but do suggest monitoring. Be sure the secondary measures employed to prevent moisture damage are in order, too.

Photo: Opened clean-outs or vents between the trap and coil should be covered. An easily removable cap or plug should be installed. Photo TS Hart.

There are a number of piping mistakes made when installing a condensate trap. In my opinion, an open clean-out between the trap and coil is the number one mistake. I believe it's made because installers think leaving the pipe open will help the system drain, working much as a vent does on the house plumbing. When in fact, an open clean-out at this location allows air to bypass the trap altogether. This mistake is easily corrected by placing a cap over the clean-out pipe and only removing it for cleaning purposes. It should be easy to remove, so gluing is unnecessary *(see photo above)*.

Connecting multiple units to one trap often allows air to be pulled through one or more of the units, bypassing the trap as well. Each unit should have its own individual trap, and some equipment makers recommend against installing the trap more than 4 feet away from the coil. Many manufacturers and trap makers recommend using removable caps on tees and crosses for cleaning purposes. Although I wouldn't call out the lack of a clean-out a defect, I would suggest to your client to have one added during the next servicing *(see photo below)*.

Photo: Recommended by some equipment makers, the translucent EZ Trap® Kit includes a tee and a cross with removable caps and ise packaged with a flexible brush for cleaning.
Photo Gerry Spanger, Airtec Products Corporation & Marketair, Inc.

Commercial equipment sometimes is operated in the cooling mode, producing condensate even during winter. When temperatures drop below freezing outside, traps may freeze and break. Rooftop units and similar equipment can be especially susceptible to trap freezing. In most residential applications, there tends to be enough time between freezing weather and the need to operate the HVAC equipment in the cooling mode for water in the trap to evaporate before it has a chance to freeze. But, if freezing is a concern in your area, recommend freeze protection for the trap in the inspection report.

The pipe

My personal experience has shown me that condensate drainpipes get little attention during system installation. They often are thrown in place as if they were an afterthought or were of little consequence to the overall operation of the system. This, of course, could not be further from the truth. Keeping this in mind, home inspectors should pay close attention to the pipe and fittings during their work.

Over the years, PVC pipe has become the condensate drain material of choice for residential applications in many areas. The 2006 International Mechanical Code (IMC) also allows cast iron, galvanized steel, copper, polybutylene, polyethylene, ABS and CPVC to be used. Though it's rare to see plastic pipe insulated, sometimes it does need to be wrapped close to the equipment where the coolest water is exiting the pan to prevent it from sweating. With metal drains such as copper, failure to insulate the pipe and trap almost can guarantee a complete soaking of the surrounding surfaces from the secondary condensation generated by the cool water flowing through the drainpipe.

According to the IMC, the pipe should not be less than ¾ inches in diameter and should not be decreased in size from its connection at the condensate pan to the point where the condensate water finally clears the pipe. Drains always should be installed pitched toward its discharge point. Manufacturers often recommend a drop of about ¼-inch per foot; the code allows for 1/8-inch per foot. Good strapping is important to prevent sags, as sags lead to clogging.

Inspectors need to be careful crawling over these pipes in attics and in crawl spaces because joints that rarely are pressure-tested before they are put into service have been known to pull apart. What's more, when subjected to extreme cold, some plastic pipes and fittings such as those made of PVC become brittle and break easily.

Secondary and auxiliary drain systems

Equipment manufacturers emphasize that along with a good primary drain installation, additional measures should be taken to prevent an overflow from damaging the building. The 2006 IMC requires this and gives installers several options. According to the IMC, a second overflow drainpipe, connected to a higher fitting on the primary condensate pan, is one option. When this is done, the code says, "the overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage." The rationale is when the primary drain becomes blocked and causes water to suddenly drip from a normally dry pipe, someone will notice and call for service.

In my area for attic-installed equipment, we like to discharge the overflow drain from the soffit above a major window. We have many attic units. Water dripping in front of the window alerts someone that the HVAC system needs attention.

Regardless of how this is done in your area, when you find a secondary drainpipe, try to determine its discharge point and explain the purpose of the pipe to your client. Also explain the potential consequence of inaction should water appear from the pipe.

An auxiliary or emergency drain pan placed under cooling equipment installed in attics often is used to protect the surroundings and is another method of protection allowed by the code. The pan can be supplied with its own independent drain or a water-level detection device that will shut off the equipment before the pan overflows. As with a secondary drain, if a drain is installed for the pan, it must discharge in a location that will alert occupants to a problem. No trap should be installed on the auxiliary pan drainpipe.

During an inspection, be sure overflow and auxiliary drains are independent of the primary drain. Installers often will tie the two drains together at or even several feet away from the equipment. Tying both drains together anywhere along their run negates much of the value of a secondary drain *(see photo below)*.

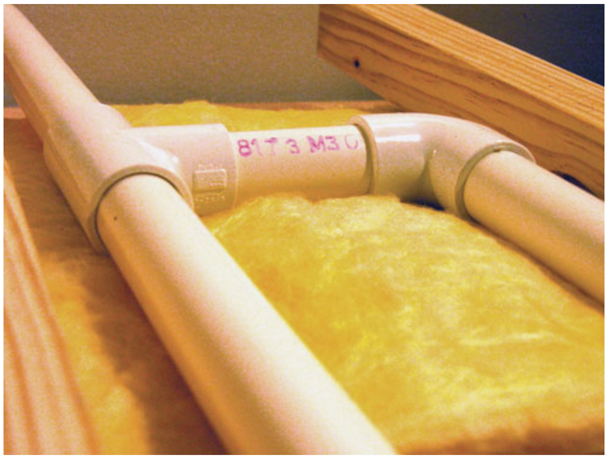


Photo: During this inspection, the primary and secondary drains were discovered tied together, negating much of the value of a second drain. Photo TS Hart.

For years, HVAC techs have been installing water level detection devices known as float switches in the auxiliary drain pan. But more recently, techs have begun installing float switches that will shut off the equipment if the primary condensate pan itself fails to drain. By properly positioning the device in the primary drain or secondary drain opening, it can react to the condensate before it overflows the condensate pan. The EZ Trap Switch can be easily installed in the secondary drain fitting, in the system's drain piping or trap. It also can be wired to not only cut off the cooling equipment to prevent an overflow, but it can be wired to simultaneously activate an alarm *(see photo below)*.

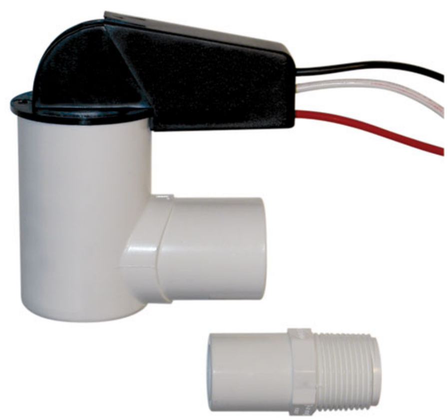


Photo: The EZ Trap Switch shown here can be easily installed in the secondary drain fitting, in the system's drain piping or trap. It also can be wired to not only cut off the cooling equipment to prevent an overflow, but it can be wired to simultaneously activate an alarm. Photo Gerry Spanger, Airtec Products Corporation & Marketair Inc.

Adding a float switch to a plumbed auxiliary pan provides a high level of protection, but the 2006 IMC is good with the switch alone. In some cases, especially during replacement or upgrade work, installing the actual plumbing to handle the condensate flow from a secondary drain or auxiliary drain pan can be difficult. The use of float switches instead of piping is becoming popular. Since it will shut off the equipment before an overflow occurs, and almost surely prompt a call for service or an up-close examination, it's a good alternative to running pipe.

Photo: The water sensor seen in the photo attaches to the side of the auxiliary drain pan and will shut off the cooling equipment as the pan fills with water. Photo courtesy Resource Conservation Technologies, makers of AquaGuard brand HVAC accessories.

Emergency pans should be made of a rust-resistant material such as plastic or galvanized steel. They should extend beyond the air handler or coil box by 3 inches or more on all sides. If the coil is attached to a high-efficiency furnace without condensate protection, this should be taken into consideration when sizing and placing a pan under the equipment. The condensate produced by the furnace can damage the building if it overflows during the heating season. The IMC requires the auxiliary pan to be a minimum of 1½ inches deep.

Photo: Manufactured auxiliary drain pans, like the one in the photo, hold the air handler or furnace above the overflowing condensate. This is important as it can prevent damage to the equipment and make the pan easier to clean. Photo courtesy Resource Conservation Technologies, makers of AquaGuard brand HVAC accessories.

Condensate Pumps

A condensate pump is used when a gravity drain is impractical or impossible to install. They are common on some basement-installed systems or where cooling has been added to an existing heating system located within the interior walls of a slab-foundation home. The plumbing from the cooling coil to the condensate pump reservoir or tank should be installed with traps and float switches as if the coil was draining like a typical gravity drain.

With condensate pumps, the cooling coil drains to the pump's reservoir. As the water level rises, a float switch turns on the pump and water is pumped from the reservoir, usually through flexible plastic tubing, to a safe area. Should the pump fail or should the discharge line become blocked, a second switch will open a low-voltage circuit that shuts down the air conditioner and can even be wired to set off an alarm.

I find that the secondary or emergency switches are often ignored during installation or perhaps disconnected later. The wires are left dangling above the pump. Calling this out in the inspection report could save the client from some unnecessary moisture damage should the pump fail.

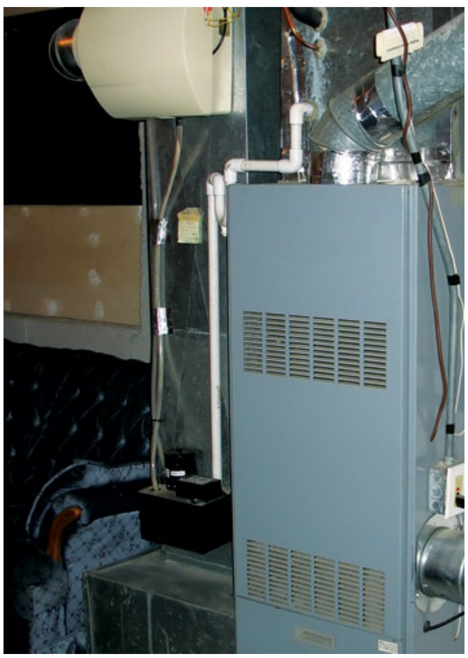


Photo: A condensate pump can be seen in the lower left of the photo. © Big Stock Photo.

According to the 2006 IMC, "Condensate shall not discharge into a street, alley or other area where it would cause a nuisance." With residential properties, it is commonplace to discharge condensate at the exterior of the house, generally near the foundation. This arrangement needs to be closely monitored because the water can flow into the crawl space or, as a discharging downspout, it sometimes can contribute to foundation settlement. Using a splash pan/block to kick the water away from the foundation usually will prevent problems and might be suggested in your report.

In many situations, it is acceptable and even preferable that the condensate drains into the domestic plumbing system. Codes and localities regulate the manner in which this is done. A solid connection between the condensate system and a building's DWV (drainage, wastewater and vent) system is prohibited by code. Draining a cooling coil located in an attic into a plumbing stack will get the condensate into the plumbing system, but is prohibited by code because of the potential for drawing in dangerous gases.

To properly direct condensate into the domestic drainage system, it should flow through a plumbing trap that is unlikely to lose its seal, even after the cooling season ends. Draining condensate to a sink, bathtub overflow or washing machine standpipe usually is acceptable.

Finally, new condensate control technologies such as waterless traps and other clever devices are being introduced all the time. You need only go to the Internet to see them. I suggest inspectors do just that from time to time to keep up with what's new in all areas addressed by the home inspection. But specifically regarding condensation removal, I believe it's important that the installers of cooling equipment be well versed in the proper methods of installing a well-functioning condensate collection and removal system. I believe the owners of the equipment should understand the importance of system maintenance. As for home inspectors, they should understand both.

I'd like to thank the companies that provided photos, illustrations and technical information for this article and, in particular, Gerry Spanger of Airtec Products Corporation and TS "Tim" Hart, for their help.