De-Mystifying HVAC

Why is my air conditioner dripping on my customers?

By Ron Prager

One of the most frequent emergency service requests is a call for an air conditioner leaking water into the store. These leaks (called condensate leaks,) damage merchandise, equipment, ceiling tiles and make it extremely difficult to do business. They can also create a hazard for customers and store staff.

What is condensate?

An air conditioner cools the air by passing it over a finned coil that is maintained at approximately 45º F. As the tempature of the air is lowered, it reaches a temperature known as the dew point. At this temperature, the air reaches its limit as to the amount of water vapor it can hold, and the excess water vapor condenses on the cold fins of the indoor coil. This condensed moisture is called condensate.

The condensate runs down the fins of the coil and falls into a drain pan located under the bottom of the coil. As the pan fills, the condensate flows through an outlet in the pan into the condensate piping. The piping usually contains a device called a **P** trap that separates the air in the blower compartment from the outdoor air. The function is similar to that of a sink trap which separates the air in a building from the sewer gases in the drainage piping. In both cases, a column of water within the trap forms a barrier that separates the air on one side of the water column from the air on the other side of the water column.

The condensate piping may drain into a building drainage system or it may drain directly onto the roof. If the unit is located indoors, the condensate may discharge into a receptacle or sump that contains a small pump. The condensate is then pumped to a building drainage system.

Why does it leak?

There are four basic causes of condensate leaks. These are:

1. Restricted or missing drainage components.
2. Incorrect pitch of equipment or piping.

3. Coil icing.
4. Carry-over of moisture.

1. Restricted drainage components:

Restricted drainage components are by far the leading cause of condensate leaks. As air passes over the cooling coil, droplets of water condense on the coil. Although the air is filtered it still contains dust particles. These particles adhere to the wet coil surface and most are carried down into the drain pan under the coil with the condensate. Eventually, a thick gunk forms in the drain pan. During extended cooling periods (months) algae and mold can grow on the gunk. During intermittent cooling and heating periods, the gunk dries out and forms clumps of scale in the drain pan. As the gunk or scale is carried through the drainage piping it builds up in sufficient quantities to restrict the piping or the drain pan outlet. When the piping becomes restricted, the water level in the drain pan rises until the pan overflows into the base pan of the unit and eventually into the store. In most cases, it's the P trap or the pan outlet that becomes clogged. A technician responding to this type of situation will use pressurized nitrogen or carbon dioxide to blow through the drain line from the pan outlet, removing the clog. He should then clean the gunk out of the condensate pan and flush the piping and pan with water. In areas where algae or mold growth is a problem, he should place use an algaecide and detergent to clean the pan and place chemical tabs in the drain pan that prevent future growth.

In some cases, the installing contractor neglects to install a P trap at the outlet of the pan. Sometimes, during the winter, water freezes in the trap and the trap breaks away from the pan outlet. With no trap in place, outdoor air is sucked into the pan outlet and this prevents the water from draining out. Once again, the unit drips into the store as the pan overflows.

If one trap is required, two traps are a problem. We see more and more local codes requiring condensate to be piped from the unit to a drainage system. This is to prevent standing water ponding on the roof that can encourage the growth of Legionella (the cause of Legionaire's Disease,) as well as algae. All too often, the drainage piping consists of PVC pipe strapped to 4x4 sleepers laid on the roof. As the sun bakes the plastic piping it sags between the sleepers. When the sag becomes deep enough it forms a second trap albeit an un-vented trap. At best, the velocity of the water slows at this trap and restrictions develop over time. At worst, because the trap is not vented, it prevents water from flowing completely. The pan overflows and leaks into the store.

Proper drainage requires that the condensate piping have a minimum continuous pitch of ¼" per foot away from the unit. A vented P trap must be installed, and the drainage components must be kept clean

2. Incorrect Pitch

All air conditioning units are designed to be installed dead level in both directions. Failure to level a unit can impede the flow of condensate. In extreme cases condensate can overflow the drain pan before it reaches the pan outlet that is now located at a higher point than the edge of the pan. The roofs on the buildings we occupy are pitched to a greater or lesser degree to provide drainage of rainwater. The curb a rooftop unit sits on is designed to sit on a level steel frame. If the steel frame is installed directly on the steel that supports the roof, or the curb sits directly on the corrugated steel decking which forms the roof, the unit will be pitched to the same degree the roof is pitched. Depending on the direction the unit is facing, the pitch of the roof, and the location of the drain pan outlet, this situation can lend to condensate leaks. A unit that is installed on a pitch, rather than being installed level, also exacerbate carry-over, which will be discussed later in the article.

Condensate piping must be installed with a continuous pitch of ¼" per foot away from the unit. Keep in mind that many times the condensate piping is laying on sleepers on a pitched roof. If the piping runs opposite to the pitch of the roof, it must be inclined enough to make up for the roof pitch plus 1/4" per foot. When the piping is not pitched sufficiently, the velocity of the condensate slows, and dirt particles that were carried in the condensate collect forming a restriction.

3. Coil Icing:

Air conditioning equipment that employs mechanical refrigeration (a compressor) for cooling contains an indoor coil that operates at a temperature of approximately 40ºF. The actual coil temperature is dependent on the refrigerant pressure within the cooling coil and the heat load being transferred to the coil. If the operating pressure within the coil drops too low or the heat load transferred by the coil drops too low, the coil temperature drops below 32ºF. When this occurs, the condensate that forms on the coil as water droplets turns into ice. Eventually this ice covers the entire face of the coil, which further decreases the amount of heat being transferred to the coil and causes the operating pressures to drop to the point where the unit shuts down on its low pressure safety control. When the unit shuts down, the block of ice covering the coil defrosts. The ice overhangs the drain pan and the water from the defrosting ice falls into the store.

The two causes of coil icing (low refrigerant pressure and low heat load,) can be further broken down into their component causes.

Low refrigerant pressure with a normal heat load is caused by an insufficient refrigerant charge, a restriction in the refrigerant circuit, or by operating the unit at outdoor temperatures that are lower than the temperatures the unit was designed to operate at. Low ambient temperature operation lowers the pressure in the unit condenser which lowers the operating pressure in the units cooling coil. Air conditioning units can be modified to operate at low outdoor temperatures by installing low ambient controls that maintain normal pressures in the condenser at reduced outdoor temperatures.

Reduced coil load can be caused by dirty air filters, a dirty indoor coil, restricted ductwork, a loose belt, or a faulty blower motor. In other words, anything that reduces the airflow quantity, causes the cooling coil to ice up. In addition, anything that causes the temperature of the air approaching the cooling coil to drop below 68°F can cause the unit to ice. If the unit is attempting to cool cold outdoor air, or if the return air from the store is too cold, the load is reduced and the coil ices. If a manager sets the thermostat in a store to 65°F and the temperature of the store actually gets down to 68°F, the load on the coil is reduced to the point where the unit can ice. When the coil is completely iced, the store gets hot, the unit shuts-down and the waterfall into the store begins.

For this reason, the cooling setpoint on a thermostat should never be set below 70ºF.

4. Carry-Over

As mentioned earlier, air passing over a cold cooling coil deposits droplets of water on the fins of the cooling coil. In a perfect world, the water droplets drop down the fins of the coil into the drain pan. Sometimes, the cooling coil is installed at an angle within the unit, but the water still drops down the fins into the pan due to an effect called surface tension. This works well as long as the velocity of the air moving through the coil does not exceed a particular threshold. (Usually

400 feet per minute). If we exceed the manufacturer's specified air flow quantity (volume) for the coil, we cause the velocity (speed) of the air moving through the coil to increase. Eventually, if the velocity is high enough the air passing through the coil carries the water droplets forming on the fins with it. Sometimes the high velocity air can even blow water out of the drain pan as it passes through the coil just above the surface of the water. The effect is similar to producing wind-driven rain inside your air conditioning unit. The result is a soggy ceiling. If the unit is not leveled properly, carry-over can occur at air velocities that are lower than the threshold set by the manufacturer. Units must operate below their maximum rated airflow and must be installed level in order to prevent carry-over.

Indoor Units:

Many retail locations are served by indoor HVAC units located above the ceilings of the stores. When you install a unit above a ceiling, you must assume that sometime during the units life, a condensate leak will occur and the unit will drip on whatever is located below it. Good practice dictates that all indoor units have a secondary drain pan installed below the unit. This is normally a galvanized steel pan that extends at least 2" beyond the perimeter of the unit. This pan is sometimes fitted with a water detector that shuts the unit down if water overflows into the secondary pan. An alternative method is to provide piping from the secondary pan to a safe location (sink) where people will notice the discharge of water and call a service technician.

Roof Leaks:

There are many situations where it is extremely difficult to distinguish between roof leaks and condensate leaks. To make matters more difficult, wind driven rain can find its way into a store through an air conditioning unit, and, condensate discharged onto a roof can find its way into the store through an opening in the roof membrane. Obviously, if the leak occurs during periods of rain, it's prudent to look for a roof leak. However, if there is no obvious area where water is getting through the membrane, there are several things that should be checked. Water can enter an air conditioning unit as wind driven rain or it can be sucked into the unit by the unit's blower. A technician should look for signs of wet insulation within the unit immediately after a rain to determine if rainwater is entering the store through the unit.

Manufacturers provide electrical knockouts for power and control wiring in an area of the unit that should never be exposed to rain. Sometimes electricians find these knockouts to be in an inconvenient location, and they bring the electrical service to the unit by penetrating the base pan of the outdoor portion of the unit. Rainwater invariably finds its way into the store though the hole the electrician made, even if the penetration was caulked to prevent leakage. Another

thing to keep in mind is that periods of rain by definition mean periods of 100% outdoor humidity. The higher the outdoor humidity, the greater the amount of condensate that the unit will remove from the air, and the greater the condensate load on the unit. It is possible to have condensate leaks occur only during periods of extremely high humidity.

The solution to unsolved ongoing leaks from above usually involves a meeting between your roofer and your air conditioning technician. They should be prepared to flood the roof around the unit and to spray all exposed surfaces of the air conditioner with a hose. This usually resolves the issue one way or the other.

While you will never eliminate all condensate leaks, to summarize the preceding paragraphs, there are certain steps you can take to minimize the number of leaks you experience.

1. Replace filters regularly.
2. Replace drive belts annually.
3. Inspect units and clean drain pans at least twice annually.
4. Make certain indoor coils and blower wheels are kept clean.
5. Make certain drainage lines have continuous pitch.
6. Make certain, all units have P traps connected.
7. Have a certified test and balance contractor measure and set the air flow when the unit is installed.
8. Make certain all HVAC units are installed completely level.
9. Perform full operational checks on HVAC units at least twice annually.
10. Make certain all indoor units are installed with secondary drain pans.
11. Make certain thermostat cooling set points are never set below 70ºF.

Or you can star selling umbrellas.