Air Conditioning Capacity

From ASHI@HOME by Carson Dunlop

Most home inspectors give their clients some indication as to whether the air conditioning system is sized properly even though it's not required by the ASHI Standards of Practice. Let's look at the cooling capacity.

INTRODUCTION

A ton of ice

flie cooling capacity of air conditioners is usually measured in tons. One ton eqals 12.000 BTUs (British Thermal Units) per hour. The term one ton comes from the amount of heat required to melt a block of ice that weighs one ton.

One ton of cooling

Cooling is typically measured in tons

One ton of cooling is equivalent to 12.000 gIUIhour

ı 2.000 31 If/hours is the amount of heat required to melt onet ton of Ice in 24 hours

"Despite all these variables, most people like to have guidelines. Home inspectors are no exception."

Factors affecting cooling load

The amount of cooling required depends on a large number of factors. These include the climate; outdoor temperature; the outdoor humidity; the level of insulation in the house; the amount of air leakage in the house; the amount of south, east and west facing glass in the house; whether this glass is single-, double- or triple-glazed; whether the glass is a low-emissivity glass or gas-filled; and whether window treatments (curtains or blinds) are kept closed or open. Other factors include the amount of shading from trees, roof overhang, awnings or buildings and how much heat is generated in the house by the people and equipment inside.

Guidelines

Despite all these variables, most people like to have guidelines. Home inspectors are no exception. In the southern United States, 450 to 700 square feet of floor area per ton of cooling is considered appropriate. In the more moderate climates, such as the northern United States and southern Canada, 700 to 1,000 square feet per ton may be adequate. Speak to air conditioning installers and designers, as well as other inspectors in your area, to find the appropriate range for your area. (Note: These guidelines assume 8-foot ceilings.)

Duct capacity problems

the capacity of the equipment is only one part of the equation. Many air conditioners that under-perform are a result of a duct system incapable of circulating the conditioned air adequately through the system. This is particularly true where air conditioning has been added to a house with ducts that were designed for a heating system only.

Moving heavy air with more obstructions

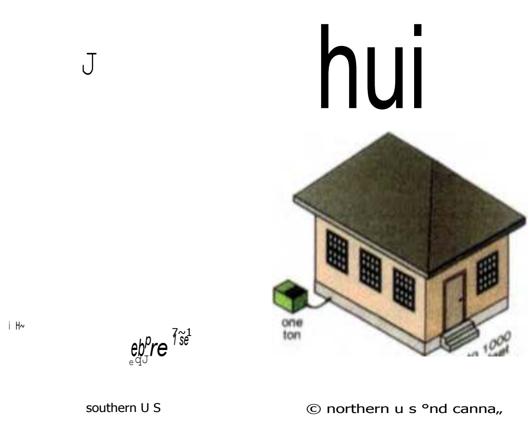
Adding central air conditioning to an existing furnace system may lead to inadequate air distribution for several reasons. Firstly, the evaporator coil presents an additional obstruction to airflow and reduces the rate of air movement through the system. Secondly, during the cooling season, we are moving air that is as cool as 55°F rather than air that is at 140°F (which is what we see from some furnaces in the heating season). The cooler air is denser (heavier) and more difficult to move through the ducts. We also have to move more air since the difference in temperature between the conditioned air and the room air (about 15°F to 20°F) is less than with a conventional furnace (60°F to 70°F), for example.

A larger fan is helpful only up to a point. We don't want to increase the air speed beyond 500 feet per minute (about 5 miles per hour) or we'll get excessive noise and uncomfortable drafts in the home.

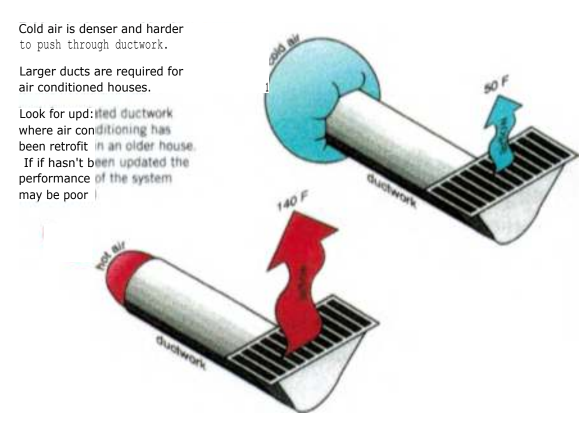
Air conditioning systems typically move 400 to 450 cubic feet of air per minute per ton through a system. Heating systems only need to move about half this much. ▸▸

Ducts *in an older home* may *not be adequate for an air conditioning system.*

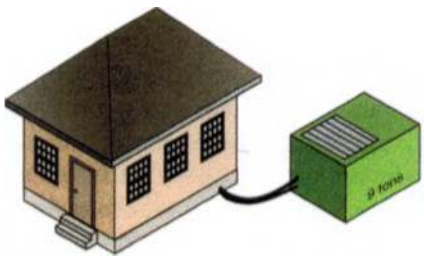
How much area can one ton cool?



Larger ducts are required for air conditioning



Bigger is not better



An air conditioner that is **too large** will
Cycle on and oft more frequently -- potentially causing premature compressor failure
Cool the house too quickly- (satisfying IIre thermostat and shutting down) before the house cana be sufficiently dehumidified.

Guessing the size

ALA 21 **amps**
ACME 0 conditfoning lid

21 amps divided by h to 8 amps per Ion equals about 3 tons (a good guess at the capacity you don't have specificinformation about that particular manufacturer)

The model number may help verify your guess - for example, 36 probably means 36,000 BTUs or 3 tons

What constitutes good performance

Most air conditioning systems are designed with a slightly different goal than heating systems. During the heating season, our goal is typically to keep the house at roughly 70°F regardless of how cold it is outside. During the cooling season, while it may be ideal to drop the temperature to 75°F, remember that the air conditioning system is also dehumidifying the air. As long as a 15°F differential between the outdoor temperature and indoor temperature is achieved, the house will feel relatively comfortable if the air has been dehumidified properly. When it's 100°F outside, an indoor temperature of 80°F to 85°F may be acceptable. Clients should understand that this temperature differential indicates good performance.

Uneven cooling

One of the common complaints with air conditioning is that different levels of the house are cooled with different effectiveness. For example, it may be 75°F on the main floor, but 85°F on the second floor. This is usually a function of the distribution system rather than the capacity of the unit.

Better to undersize than oversize

Many air conditioning manufacturers and installers recommend slightly undersizing an air conditioning system rather than oversizing. The reason for this is two-fold. First, air conditioners that are slightly undersized tend to have longer running periods. This means fewer stops and starts, and potentially a longer compressor life.

House is cold and damp

Second, and perhaps more importantly, the risk in oversizing a unit is an uncomfortable climate. Oversized air conditioners come on for short periods and drop the air temperature quickly. Because of their large capacity, they satisfy the thermostat before the system has a chance to do much dehumidification. This can lead to a cold, clammy environment inside the house.

CONDITIONS

These are the common capacity issues: undersized and oversized.

UNDERSIZED

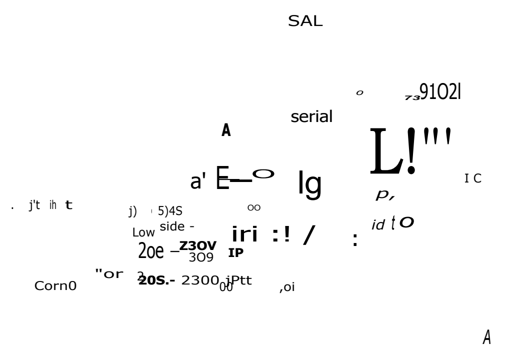
Causes: Undersized air conditioners may result from poor installation practices that do not include a heat gain calculation or do not adequately recognize the characteristics of the home. Undersized units may also be a result of house changes or additions. For example, the addition of skylights or the removal of mature trees can increase the heat gain dramatically.

Implications: During moderate weather, the air conditioner may function adequately, but during hot weather, the air conditioner may not be able to achieve a 15°F to 20°F temperature differential between indoors and outdoors.

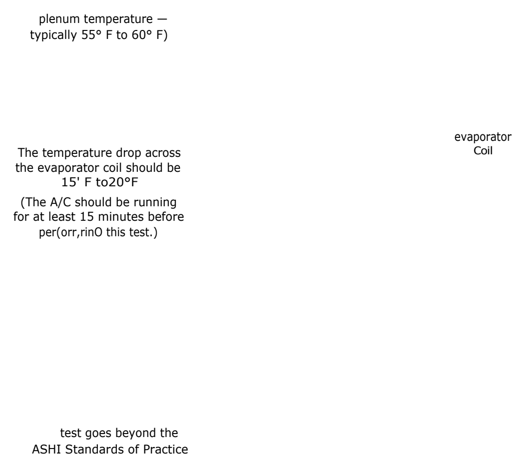
Strategy: The first step is to determine the size of the air conditioning system. This can often be done by reading the model number on the data plate. Typically, it is located on the outdoor (condenser) unit. The size may be recorded in thousands of BTUs per hour or in the number of tons.

Technical Reference Guide: Sometimes it i's difficult to translate a model number into a system capacity. *The Technical Reference Guide* available through ASHI or Carson Dunlop is an excellent resource to determine the capacity and age, based on the model and serial number, of many residential air conditioning systems.

Guessing the size: If the size cannot be determined from the model number on the data plate, the size can be approximated from the Rated Load Amperage (RLA) on the data plate. A typical reciprocating compressor will be rated at 6 amps to 8 amps per ton of cooling. The high-efficiency units and scroll compressors will draw less electrical current, more like 5 amps per ton. Be clear that this is an approximation only if you report the capacity based on current.



Measure temperature drop across inside coil



Use house square footage: The next step is to roughly calculate the above-grade square footage of the home. Divide the square footage into the number of tons and determine the number of square feet per ton.

If the number of square feet per ton exceeds the ranges we discussed, it is probably best to describe this as marginal or suspect capacity and to recommend further investigation. There may be factors in the home that cause the guidelines not to apply.

Physical **size** doesn't **matter:** Physical size does not determine the capacity of the system. Many high-efficiency systems with high SEER (Seasonal Energy Efficiency Ratio) ratings are physically much larger than conventional systems while producing the same amount of BTUs per hour. Remember not to guess, but check the data plate.

Physical size does not determine capacity - check the plate

Guidelines: It's also possible to find a system that seems to be just fine with respect to capacity using your guideline and yet, it isn't really big enough. When considering the square footage of the house, the basement is not usually considered. However, if the basement has a walk-out with a large glass surface facing south, east or west, the air conditioning load may be far greater than contemplated. Numerous skylights can change things, too.

Measure temperature drop across indoor coil: If the system is adequately sized and is working properly, the air temperature entering the evaporator coil will be room temperature. Let's say it's 75°F. The air coming off the coil should be 14°F to 22°F cooler (some say 15°F to 20°F).

If the inlet temperature is 75°F, the air coming off should be 55°F to 60°F. This can be measured with a thermometer with a sharp probe that is pushed into a joint or hole in the supply plenum immediately downstream of (after) the evaporator coil.

If the temperature drop is different, the problem may be size-related or may indicate a need for servicing. This test should be compared with your approximation of the size of the air conditioner, based on the number of square feet per ton. Make sure the temperature drop is measured after the system has established equilibrium. The unit should run for at least 15 minutes before checking the temperature split.

Note: Measuring this temperature split at the equipment is beyond the ASH! Standards of Practice, but is mentioned because many inspectors do it.

OVERSIZED

An oversized air conditioner is susceptible to short cycling, inadequate dehumidification and large temperature variations in the house.

Causes: Oversized air conditioners are usually the result of a design or installation problem.

Implications: Oversized units will have a shortened life expectancy and will provide a less comfortable environment. The largest comfort issue is the lack of dehumidification. Because the temperature drops rapidly with an oversized unit, there isn't enough air movement across the coil to extract the water from the house air. This results in a house that is cool, but with a humid, swamp-like environment. Since compressors experience most damage on start-up, short cycles also mean more start-ups and a shorter life.

Strategy: Other than the rough guideline test, it is difficult to know whether and how much the unit is oversized. Some utilities indicate that a unit may be as much as 25 percent oversized without adverse effect. The temptation to oversize becomes irresistible to installers with respect to heat pumps. Since heat pumps have to deal with a much larger temperature differential from outside to inside, the tendency is to make the heat pump large enough to meet the heating demand. This makes it too large for the cooling load. There are some strategies to address this problem, but within this context, we are watching for oversized cooling units.

One way inspectors identify an oversized air conditioner is by sensing the cold, damp environment when walking into a house. Also, an air conditioner that short cycles (turns on and off every five minutes) is a suggestion that the unit may be oversized.

Two surveys have shown that one-third to one-half of all residential air conditioning systems are oversized.

Summary
While the Standards don't require it, most inspectors will red-*flag* systems that seem too big or too small. They will usually phrase it as a question rather than a conclusion.

LIFE EXPECTANCY

The Standards require that you identify whether the equipment is near the end of its normal life expectancy. Although air conditioners have many components, the compressor is the heart of the unit. It is, by a wide margin, the most expensive component to replace on an air conditioner or heat pump.

Checking the age: One can determine the age of the unit from the condenser unit data plate. *The Technical Reference Guide* is helpful in this regard. Since compressors are often replaced, the home inspector who goes above and beyond will check on a unit that is more than five years old to determine whether the compressor has been replaced. This involves removing the cover from the outdoor condenser unit and checking the compressor itself. There are only a few manufacturers of compressors and the date coding systems can be determined by contacting the manufacturers. It's common to find older systems with relatively young compressors. If you aren't going to go this far, when you see old air conditioners, you should allow for the possibility that the compressor has been replaced.

Life expectancy: Life expectancies vary. Many people in the southern United States consider eight to 10 years a typical compressor life expectancy. In more moderate climates, a 10- to 15-year life expectancy is typical, and in northern climates, life expectancies of 15 to 20 years may be appropriate.

Warranty: Many compressors are warranted for five years. This suggests a life expectancy range.

Cause: The cause of old equipment failing is simply time.

Implications: There may be no implication with respect to existing performance. We may simply be anticipating breakdown. However, older compressors may suffer compression ratio decreases as valves wear. They may also be more expensive to operate because they draw more electricity. Some people rec-

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ommend replacement of old compressors even if they are still operable as a way to reduce operating costs through enhanced efficiency.

Strategy: The age can be determined from the data plate on the condenser or, as discussed, from the compressor itself. Interpretation of serial numbers is sometimes required to verify age. The compressors typically have a date tag riveted or glued onto the shell of the unit.

Speak with manufacturers and installers in your area to get a sense of the common life expectancies for air conditioning compressors in your climate. If you are going to include life expectancy comments in your reports, make it clear to the client you are dealing with a probability and not a certainty. Many compressors will fail before their normal life is up and others will go well beyond what is expected.

You may also ask at what age it makes more sense to replace the whole system rather than just the comprecsor.