#6496

COOLING

Air Conditioner Efficiency in the Real World

by Leon Neal

Tighten up the ducts and what do you find? Central air conditioning systems operating at much lower than rated efficiencies. Field research shows that the price of neglected air conditioner maintenance can be high bills and less comfort.

Any device will last longer, perform better, and provide more owner satisfaction if it is properly maintained. Some of the devices we depend on, however, are so reliable and dependable that most of us seldom consider routine maintenance. We see the results only indirectly in high utility bills or in reduced service life. Meanwhile, a crippled machine may continue to operate without any other noticeable handicaps for eight, ten, or more years.

In short, all mechanical and electronic devices need routine maintenance. This is no truer than for the larger refrigeration equipment found in many homes—a central air conditioner or a heat pump which provides central air conditioning. These appliances are large, complicated, expensive to replace, and can have a large impact on electric costs. The installation and service parameters discussed in this article for central air conditioners apply "doubly" to heat pumps because the refrigeration cycle equipment is used to provide both cooling and heating.

Where To Find 'Lost Efficiency'

The North Carolina Alternative Energy Corp. (AEC) has become very interested in the "lost" energy efficiency of central air conditioners. This lost energy efficiency is the difference between the "manufactured energy efficiency," which is found through government ratings and testing by Air-conditioning and Refrigeration Institute (ARI) and what owners of systems actually experience in their houses.[1,2] In one field study, AEC measured the instantaneous capacity (in Btu per hour) and the power (in watts) required by 10 units. We translated these measurements into a form compatible to ARI standard empirical test conditions and compared the results (see Table 1). The causes of lost efficiency ranged from dirty compressor coils

Don't Split Replacements

Homeowners purchasing high-efficiency central air conditioners as replacements for old units will not get the energy efficiency and lower electric bills they expect if the indoor coil is not replaced at the same time as the outdoor unit. Most residential central air conditioners and heat pumps are split systems where one heat exchanger (or coil) and the compressor are located outdoors and one heat exchanger is located indoors. Most of the existing indoor coil units are not suitable for matching with a new high-efficiency outdoor compressor unit. The result of this mismatch is often a combination that performs little or no better than the old unit.

The efficiency of a central air conditioner is rated by its SEER. The average SEER for all units shipped by manufacturers in the United States in 1990 was 9.31. The higher the rating, the more efficient the unit. A homeowner who purchases a unit with a 9.3 SEER, for example, may end up with a unit whose SEER turns out to be an 8 or less if the indoor coil is not replaced with a new coil that is properly matched with the outdoor unit.

Some homeowners may choose to replace their old units with those carrying a 10 SEER or higher. New DOE standards require that manufacturers produce split-system air conditioners and heat pumps with a minimum SEER of 10.

Those who opt for purchasing even higher efficiency units should ask their installing contractors to:

- Replace the indoor coil with a high-efficiency indoor coil.
- Match the new indoor coil with the manufacturer's specification for the installation of the unit.
- Verify the efficiency of the combination to be installed by showing the SEER rating in a listing such as the Air-conditioning and Refrigeration Institute certification directory.

From "How to Keep Your Cool and Save Cold Cash," Air-Conditioning and Refrigeration Institute, Dept. U-171, P.O. Box 37700, Washington, DC 20013. Tel: (703)524-8800; Fax: (703)528-3816.

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Table 1. Rated versus Measured Performances of Air Conditioners

Unit	Manufacturer's Rated Performance: Capacity		EER	Measured Performance: Airflow	Capacity		EER		Life, Efficiency-Related Problems
	Btu/hour	Nominal Tons[3]	(Energy Efficiency Ratio)	Cubic Feet per Minute Ton[3]	Btu/hour	Percentage of Rated Capacity	Measured	Percentage of Rated EER	
1	35,660	3	7.2	390	36,266	102%	9.1	126%	Overfused, lightning problem
2	36,225	3	6.9	290[1]	42,282[4]	117%[4]	9.8[4]	142%[4]	Inadequate airflow
3	35,400	3	7.1	460[2]	34,222	97%	7.0	99%	Comfort complaint
4	24,150	2	6.2	505[2]	31,329[4]	130%[4]	8.3[4]	134%[4]	DANGER! Serious overcharge problem
5	50,193	4	6.7	330[1]	40,331[4]	80%[4]	6.1[4]	91%[4]	Inadequate airflow
6	42,607	3.5	7.0	354	31,755	75%	6.45	92%	Undercharged
7	33,000	2.75	7.5	395	10,555[4]	32%[4]	2.0[4]	27%[4]	Compressor bad, very serious
8	33,000	2.75	7.5	432	22,453	68%	5.23	70%	Probably overcharged
9	38,200	3	8.0	420	37,179	97%	8.83	110%	Slightly overcharged
10	39,960	3	6.0	438	29,052	73%	6.5	108%	Very undercharged, dirty coils

[1] Airflow too low [2] Airflow too high [3] Ton = 12,000 Btu

[4] Calculated figure doesn't reflect useful value because air flow was outside the limits specified by the manufacturer.

Source: North Carolina Alternative Energy Corp. field test.

to lightning surge damage, all compromising the efficiencies of the units. These measurements represent only the performance across the indoor coil, not how well air conditioning is delivered to the space.

The losses in the delivery and distribution system obviously combine with the equipment performance losses. However, no simple statement can be made that exactly describes how these losses interact (see "A Million Miles of Ducts: Duct Sealing Update," *HE*, Mar/Apr '92, p.14). For example, an air conditioner system may move 400 cubic feet per minute (cfm) per ton of air flow over the indoor coil, the capacity across the indoor coil may be exactly the ARI rating, the system may be properly charged, but when the leaks in the return duct are sealed, it may be impossible to move the 400 cfm through the now "tight" ductwork. The resulting capacity across the indoor coil would be severely reduced and this would simply mean that the air return duct was inadequately sized. The solution, of course, is to enlarge the return duct and achieve the proper air flow for the entire system (equipment plus distribution).

Perhaps 30% or more of the potential energy efficiency of the cooling equipment in the United States may fall into the "lost" category. A study by Trinity University for Austin Electric Utility supports this figure. It documented a case where the air conditioner was rated at an Energy Efficiency Ratio (EER) of 6.7, but found it actually had an EER of 4.7, a 30% difference.[3]

More Cooling Studies

Interest in measuring, documenting, and improving the actual, in-house efficiency of central air conditioners is a fairly recent development. This interest will obviously accelerate as customers have to pay higher prices for systems with higher rated efficiencies. Consequently it's almost certain that researchers will collect much more and better data on this subject over the next few years.

A field study conducted over an 18-month period by Air Conditioning Training and Consulting (ACT) and Murphy Engineering of Phoenix, Ariz., included low-tonnage air conditioners seven to 25 years old.[4] The results showed the culprits contributing to lost energy efficiency:

- 75% of the condenser coils were dirty.
- 70% of the units had improper refrigerant charge.
- 55% of the evaporator coils were dirty.
- 45% had dirty blower wheels.
- 10% had a wrong motor or fan installed.
- 35% had significant duct leakage

This study was completed prior to current blower door techniques devised to test duct leakage, so 35% for duct leakage is an obsolete figure. Most recent studies of residential duct systems indicate that almost 100% have "significant duct leakage."

Central air conditioners don't simply provide cold air to a home but provide *comfort* for the occupants as well. Several factors in the final assembly of a home that can have a large impact on the ability of the device to deliver comfort stand quite apart from its ability to operate efficiently. What are some of these critical final assembly parameters? What should a final assembly quality control inspector look for?

Cooling Design

Equipment sizing

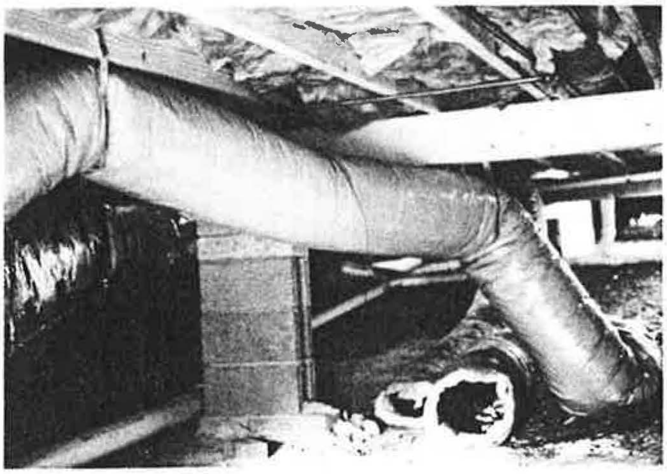
It is extremely important to maximize efficiency by properly sizing a central air conditioner to the actual load of a house. Here are a number of real, practical, *wrong* reasons why a heating, ventilation, and air conditioning (HVAC) contractor may be inclined to oversize an air conditioner:

- just "to be sure" that it will keep the house cool,
- to "cool the house" even if all work is not necessarily done perfectly,
- to avoid service calls on a new installation, and
- to avoid placing trust in his or her heat loss and heat gain calculations—if any were actually done.

For specific houses, climate, and equipment, seasonal cooling energy calculations show that if an air conditioner varies from the absolutely correct size, it is more efficient to be slightly undersized than to be oversized. Also, although no one wants the nuisance of service calls, it is better to have a way to know that the air conditioner has a problem than to keep operating it with a potentially damaging condition.

Oversizing a residential central cooling unit not only can directly affect the energy efficiency, but it can have a dramatic impact on the cooling comfort of the residence. An oversized unit can reduce the temperature inside the house, but not run long enough to remove enough moisture to keep the humidity down. At relative humidities above 70%, mildew will grow and comfort is unlikely.

Field surveys find most air conditioners are oversized. For example, in the same study performed for the Austin Electric Utility Department, researchers found that all of the units in the area were oversized by a consistent 60%. The City of Austin concluded that proper sizing of central air conditioners could provide major peak reductions.



AEC

Field examination of new and existing houses turns up a variety of ductwork problems, which have a profound effect on overall cooling system performance.

Ductwork design—supply and return grille locations

The best equipment manufactured cannot provide comfort and efficiency with a bad duct system. A major factor in shortening the life of central air conditioners is inadequate volume of return air back to the indoor coil. Too little air across the indoor coil can potentially lower the coil temperature to the point of ice formation. An indoor coil covered with ice puts a central air conditioner into "destruction mode." Shutting the dampers on supply registers or closing unused rooms is not a good strategy with central air.

Field examination of ductwork in new and in existing houses provides an abundance of "horror" stories:

- supply grilles from which no air is supplied,
- ducts detached from the boots of grilles, supplying only the crawlspace or attic with conditioned air,
- rooms with supply grilles but no access to an air return,
- air noise so great that the occupants have difficulty sleeping or talking,
- supply ducts with holes large enough to stick a human head through, and
- flex duct in a crawl space that a dog has chewed through.

The residential conservation field wants to make ductwork actually move air from one point to another without leaking. Accomplishing this will bring forth the next performance-related problem—duct systems not properly sized and unable to move the amount of air required for the equipment to work at its rated efficiency.

Sensible/latent cooling ratio

Often in residential air conditioning, the dealer and the homeowner never think of their choices in selecting the sensible cooling ratio of the equipment purchased. This

Sizing

Dealers, contractors, or architects sizing central air conditioners should do it properly—by using the method prescribed in Air Conditioning Contractors of America (ACCA) *Manual J*. Many computer programs are available that use this method and make the calculations much easier.

Many dealers feel that such calculations are "too much trouble" and "always give the same answer anyway." They are known to rely on some old rule of thumb or worse, an old joke sizing sheet that someone published with holes cut out for the house size when viewed through the sheet from the curb in front of the house. A "moldy, oldy" rule of thumb used for houses built prior to our current energy awareness was 400 ft^2 of house per ton of cooling (12,000 Btu).

The City of Austin, Texas—in a pretty hot climate—now requires calculations for all new central air conditioning installations and they find an average of about 650 ft^2 per ton of cooling. If the calculation shows a need for more than a ton for 600 ft^2, the installer must provide special proof of the accuracy of the calculations.

The ACCA *Manual J* calculations use ASHRAE 97.5% design temperatures—which means that the conditions will be exceeded about 2.5% of the year. Very few air conditioning contractors will agree to use the *Manual J*'s specified temperatures for sizing air conditioners because they say, "I know that it gets hotter than that around here, so I will use a higher temperature." They like to use the maximum temperature anyone can remember plus a degree or two. The indoor design temperature is also a bone of contention. Dealers may use indoor temperatures as low as 70°F under the reasoning that "this client likes it cold, even at extremely high temperatures outside." Both extremes point toward lowered efficiency, and possibly less comfort.

ratio tells how much of the cooling capacity in tons (12, 000 Btu = 1 ton) at the rating condition is in the form of sensible cooling and how much capacity is in the form of latent cooling. Sensible cooling reduces the room's dry bulb temperature. Latent cooling removes the moisture in the room (dehumidifies), and thus removes the heat in that moisture (see box "Human Thermal Comfort"). The sensible heat ratio (SHR) is the percentage of total cooling that is sensible.

Until the rather modern marketing emphasis on a single ratings number (Seasonal Energy Efficiency Ratio, SEER), essentially all residential equipment used an indoor coil temperature of 42°F as the design condition (see box "Seasonal Energy Efficiency Ratio"). This design constraint meant that the sensible/latent ratio of all cooling equipment fell in a fairly narrow band. Relaxing the 42°F design condition to achieve higher SEER has meant that some equipment no longer removes as much latent heat. This can be very critical in humid, hot climates found across the United States. (See "Efficiency versus Comfort with the New Air Conditioners," *HE*, July/Aug '89, p.28–31.)

Graduate students under Dennis O'Neal of Texas Agriculture and Mining University have calculated how often a simulated house will not be comfortable for various sensible/latent ratios.[5] Using TRNSYS computer simulation, the ASHRAE comfort zone definition, and climate conditions for Houston, Texas, the results showed:

- The percentage of time outside the comfort zone consistently decreased as sizing decreased.
- Sightly undersized units posted the minimum energy use.
- Both percent of time outside the comfort zone and power consumed increased as the SHR varied from 66% to 90%.
- At an SHR of 90%, the time outside the comfort zone reached 40% or more.

Inability of a unit to dehumidify air adequately becomes apparent when an occupant wakes up sweating, usually during the 3 am–6 am time period. A humidity meter can help regulate cooling in a home. Properly done, cooling load calculations utilizing Air Conditioning Contractors of America's (ACCA) *Manual J* provide the latent cooling requirement. However, many who attempt these calculations purposely err on the conservative side by using a higher outdoor dry bulb temperature. This higher temperature, without comparable changes in the rest of the calculations, results in a smaller latent/sensible ratio than the real, correct value and in comfort problems for the occupants.

Unit Installation

Location outdoors

Some very practical considerations in locating the outdoor unit of a central air conditioner can have important

Human Thermal Comfort

Although human beings differ widely, scientists have defined and tested a thermal "comfort zone" where 80% of the population indicate that they are "comfortable." According to *1989 ASHRAE Fundamentals*, six factors determine thermal comfort:

- clothing,
- activity,
- dry bulb temperature (ambient air temperature),
- wet-bulb temperature (relative humidity),
- mean radiant temperature, and
- air movement.

Wet-bulb temperature is the thermometer reading with the sensing bulb covered with a wet wick and located in the air. *Relative humidity (rh) is* the amount of moisture in the air, given as a percentage of the amount of moisture the air can possibly hold at the same dry-bulb temperature. Thus wet-bulb temperature equals dry bulb temperature at 100% rh. *Mean radiant temperature* is temperature recorded by a special device that accounts for the radiant energy at the location. An example of the contribution of mean thermal temperature to thermal comfort is that one feels hotter in the sun than in the shade.

The standard conditions for the thermal comfort zone used by researchers and equipment designers include lightly clothed, sedate activity such as sitting at a desk, air movement of less than 40 ft per min (less than ½ mph), and a mean radiant temperature the same as the dry bulb temperature.

The "comfort zone" concept was first advanced by P.O. Fanger prior to 1970. He produced a "Fanger Chart" for comfort.[1] *ASHRAE Fundamentals* discusses thermal comfort in Chapter 8, and has represented thermal comfort graphically as a comfort chart where a region of acceptable relative humidities and ambient (dry-bulb) temperatures define the thermal comfort zone (see Figure 1).

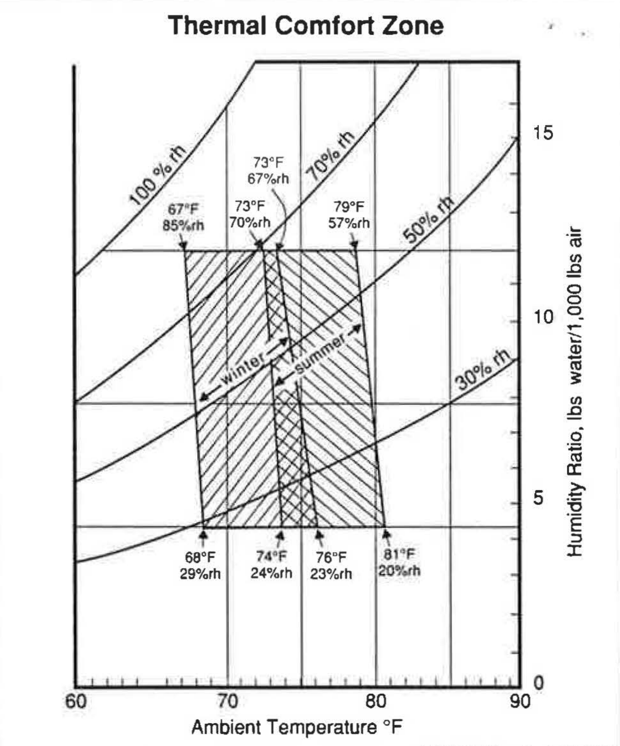


Figure 1. The "comfort zone," defined by relative humidity (rh) and ambient, dry-bulb temperature. Note: Relative humidity coordinates are interpolated approximations.

1 Fanger, P. O., *Thermal Comfort*, Robert E. Krieger Publishing Co., 1982.

COOLING

consequences for efficiency and equipment life. Most dealers and homeowners know that they simply do not want the noise of the outdoor unit near a patio, a den, or a bedroom. But other considerations can loom large. One apartment complex located the outdoor units near the exhaust from the clothes dryers and the chlorine residue from the water and laundry products in the vent air simply ate away the outdoor coils. Lint from a clothes dryer vent can completely stop the air flow through the outdoor coil and has resulted in proven cases of failed compressors. Homeowners like to hide outdoor coils and tend to plant shrubs around or near them, but the units are designed to operate correctly only if surrounded by a clear area of at least 2 ft. California builders are notorious for locating the outdoor coil under a deck. The deck floor does a great job of recirculating the air through the coil, resulting in lower efficiency.

Ductwork air flow

All residential central air conditioners are designed for a specific volume of air flow across the indoor coil inside the ductwork in the house. Almost universally this volume of required air flow is 400 ft^3 of air per minute per nominal ton of cooling. Unless the ductwork design and the blower speed provide this volume of air, there is no way that the device can provide the rated capacity and energy efficiency.

Causes of low duct air flow can be dirty filters, a dirty coil, or closed registers, but perhaps the most frequent cause is inadequate return duct sizing. Again, be aware that the indoor coil may receive the correct volume of air simply because the air is being pulled through return "leaks." Properly sealing a leaky return duct, thus reducing air flow, will seriously degrade the performance of the coil. Installers don't seem to realize that blockage on the return (low-pressure) side of a fan has a much larger impact on the air flow volume than a restriction on the supply side (high pressure). The result is that they "cheat" on the return duct by using house chases, panning a joist, or trying to save closet space. Also installers who use flex duct do not take into account the friction loses for this corrugated air surface, which are about three times as large as for a smooth wall duct.

Buddy Wolfe of Klassic Air Conditioning in Houston reports, "Going from lower seasonally adjusted energy ratings (SEERs) to higher SEERs, we were ducting in a 16in.[2]

Seasonal Energy Efficient Ratio

A new round of standards from the National Energy Efficient Appliances Act went into effect at the beginning of 1992. Central air conditioner manufacturers can no longer build split central air conditioners with a Seasonal Energy Efficiency Ratio (SEER) of less than 10. The majority of air conditioning buyers have never even heard of SEER. The ones who know a little about SEER believe that "higher is more efficient" and that annual cooling bills will decrease in direct proportion to the higher SEER. Are these correct thoughts? What is SEER really?

No, these are not totally correct thoughts. Despite claims that SEER provides a better measure than the old workhorse Energy Efficiency Ratio (EER), it "does not predict actual energy consumption, but serves as a comparative rating between various air conditioning units." [1] In fact, SEER is really just the steady-state performance of the unit at 82°F outdoors, 80°F indoor dry-bulb temperature, and 67°F indoor wet-bulb temperature, multiplied by a "cycling factor."[2]

The test that renders a SEER for a given unit assumes the unit cycles of 24 min on and 6 min off. Thus SEER is simply a test devised by the Department of Energy (DOE) to compare units, and has certainly not been proven to be an absolute guarantee of what cooling costs will be. Prior to SEER, the industry used EER, the ratio between the cooling output (in Btu per hour) and the electrical power input (watts). The EER rating of an air conditioner is simply the steady state performance at a specified "high temperature condition"— 95°F outdoors, 80°F indoor dry-bulb temperature, and 67°F indoor wet-bulb temperature. EER may be a better indicator for electric utilities interested in reducing summer peak demand.

Current techniques for calculating seasonal cooling energy are a long way from the accuracy we would like to have. However, if we were to compare the EER of one unit and the SEER of another, anyone who is familiar with these calculations can easily see that it's impossible for SEER to indicate seasonal cooling energy unless both sizing and the sensible/latent ratio of the two air conditioners are the same and that the two thermostats act identically and, on average, the summer cooling cycles of both run 24 min on, 6 min off.

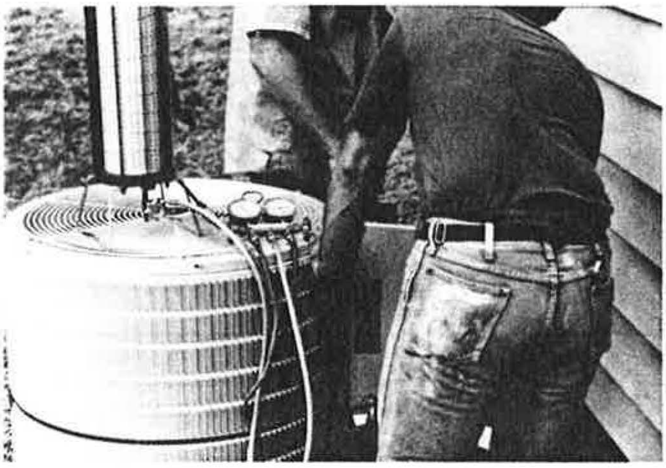
Anyone who is interested enough to dig into the technical literature will be surprised to find that both SEER and EER have definitions different than the current "primary" definitions given above. At least two studies measured the total cooling produced over a season and divided that by the total electricity consummed in watts to arrive at the true SEER.

Several reports by Oak Ridge National Laboratory have used measured steady-state performance of air conditioners in a DOE-2 simulation to calculate the seasonal cooling and seasonal electricity used. In these reports, these calculated values are divided to yield a number designated as "SEER."

To be fair, EER also must be examined carefully in any report where it appears. EER as a general term is the steady-state cooling divided by the power being consummed when the cooling is measured. The "common" assumption is that these measurements are made at the ARI Standard Rating Conditions given above. But an EER for a unit may be measured under any steady-state indoor and outdoor conditions. This means that EER is a much more useful engineering concept and graphs of EER for various "off-design" conditions—indoor temperatures (both wet-bulb and dry-bulb), outdoor temperatues (both wet-bulb and dry-bulb), refrigerant charge levels, and coil air flows—are very useful to engineers who wish to understand cooling energy performance. The fact that ARI no longer publishes EER in their directory is a handicap to those technicians who have been trained to measure air conditioner performance in the field.

1. Kuenzi, Cynthia A. and Byard D. Wood, "Evaluation of Energy and Cost Savings from Replacement and Maintenance of Residential Air Conditioning Equipment," Center for Energy Systems Research, Arizona State University, Oct '87, p. 3 (Contract for Salt River Project, Phoenix, Ariz.).
2. The official definition of SEER is given in Code of Federal Regulations, January 1, 1988, Vol. 10, Parts 400 to 499—Pt. 430, Subpt. B, App. M.

return air. That wasn't enough, so we started doubling our return air size. In some cases we tripled them and enlarged our copper (refrigerant lines). The result: Our systems work a hundred percent better. Complaints are down thirty-five to forty percent."[6] Enlarging the ducts also allows a lower fan speed and much lower fan noise as well.



AEC

Technicians use a charging cylinder to "weigh in" the charge for a new air conditioner. Charging by "feel" is always wrong.

Proper refrigerant charge

People tend to believe that if a little is good, then more is even better. Nothing could be further from the truth when adding refrigerant—"charge"—to a central air conditioner. Overcharging has serious consequences on efficiency, capacity, and especially the life of the compressor. A large percentage of the air conditioners in service today are likely overcharged. In the small (10-unit) field study by AEC, we found three units to be overcharged, with one of these so seriously overcharged that failure seemed imminent. A recent overcharge problem was solved when 10 lbs of refrigerant were removed leaving the correct charge of just 3 lbs 8 oz. In a 1990 California study, 27% of the central air conditioners were found to be overcharged and 27% undercharged (see "An Ounce of Prevention: Residential Cooling Repairs," *HE*, May/Jun '91, p. 23). Over half of all the central air conditioners were not correctly charged! (This result agreed with results found earlier for heat pumps. See "Heat Pumps: Tricks that Can Pump Up Efficiency," *HE*, Mar/Apr '91, p. 29). In every case investigated (located through high bill complaints) the problem originally attributed to the equipment was actually caused by:

- house construction defects,
- duct leakage, or
- poor quality of service.

Improper charge impacts capacity, power draw, EER, and SEER (see "Charging by 'Feel' versus by Spec"). Note that overcharge is doubly bad because not only does capacity diminish but the power draw goes up, which also tends to "stress" the compressor.

Charging by 'Feel' versus by Spec

Table 2. Relative Benefits of Correct Refrigerant Charge

	Capacity	Power	Efficiency	EER/ COP[1]	Equipment Life
Correct Charge	Max	Normal	High	High	Longest
Undercharge	Down	Down[2]	Low	Low	Short
Overcharge	Down	Up	Low	Low	Shortest

[1] Cooling Energy Efficiency Ratio (EER) = $\frac{\text{Btu Output}}{\text{Watt Input}}$

Heating Coefficient of Performance (COP) = $\frac{\text{Btu Output}}{\text{Btu Input}}$

[2] Lower power not in proportion with lower capacity.

Figure 2. Effects of Refrigerant Charge on Capacity and Power Input (Simulated)

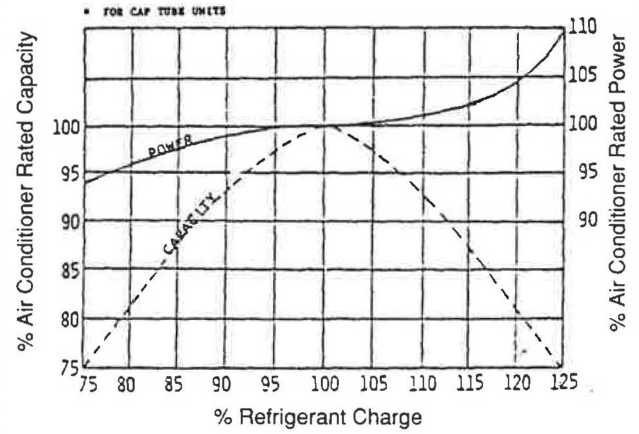
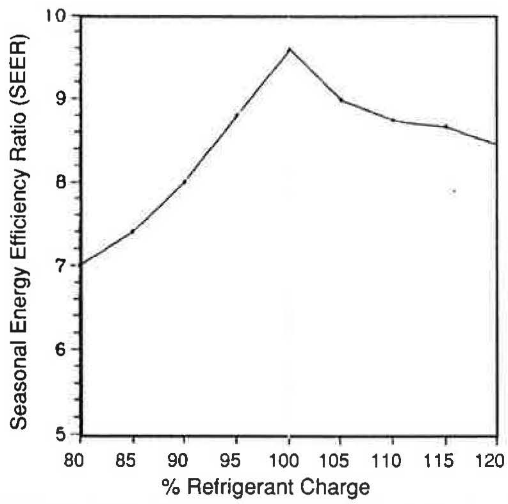


Figure 3. Seasonal Energy Efficiency Ratio Cyclic Test (Measured) for a TXV Air Conditioner



Note: Full charge = 140 oz. of refrigerant. Also, both graphs show about ±20% correct charge while field measurements frequently show a much greater swing.

Controls

Proper controls (thermostats) and location of these controls for central air conditioners can dramatically improve the efficiency of the device and the comfort of the occupants. Improperly located thermostats can cause problems, for example, a thermostat located in a spot where the sun can strike the thermostat or the wall near it, on an improperly insulated wall, or a wall with an air passage behind it, or in an entranceway isolated from the primary living area.

Service

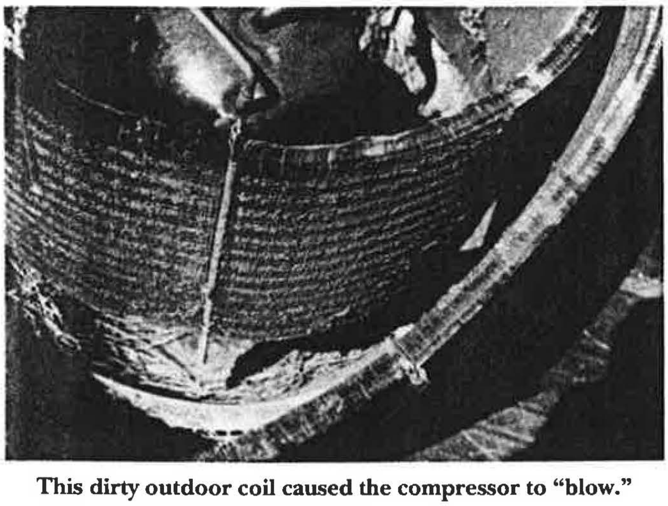
Filters

Filters are absolutely necessary to keep any duct system and indoor coil clean. A dirty filter allows less air to pass. A recent study of a continuously monitored air conditioner showed a drop in air volume of approximately 1% per week due to a gradually fouling filter (and the housekeeper was an especially diligent cleaner).[7] The result of less air is that not as much "coolth" is removed from the coil, so the coil reaches a lower temperature. This reduces capacity more than it reduces the required electricity to operate the equipment. The solution: filters should be changed *at least monthly* during the cooling season.

Clean indoor and outdoor coils

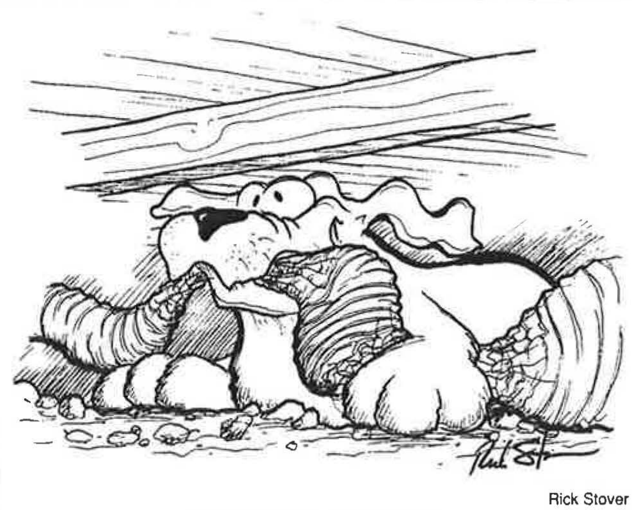
The indoor and outdoor coils of a central air conditioner are heat exchangers between the refrigerant and the air, just as a car radiator serves as a heat exchanger between the engine coolant and the air. A car radiator cannot do its job if it is covered or clogged with trash; it must be clean. So must air conditioner indoor and outdoor coils remain clean. The air conditioner indoor coil is cold. It condenses moisture and becomes one of the world's better filters. It is a much better filter than a grille filter or even an electronic filter. It must be cleaned frequently. A recent study by Honeywell indicated that the indoor coil with a standard grille filter loses about 8% efficiency each year due to dirt buildup.[8]

There is no "standard" method of cleaning the indoor coil but one thing is certain—to clean the coil one must be able to reach it with a hand or cleaning tool. It is certainly possible to locate a system air handler coil so that it simply cannot be accessed—and this happens all too often. In most cases access to the "front" of this coil requires that an access hole be cut in the return plenum and the access sealed after the coil is cleaned. My preferred cleaning technique requires a soft brush and warm, soapy water. Coils that have been neglected for years are possible to clean only by removing them from the system and taking them to a local steam cleaning establishment.



AEC

This dirty outdoor coil caused the compressor to "blow."



Rick Stover

It's a dog eat duct world.

The outdoor coil must also be clean, but fortunately it is easier to access. On the other hand, it is also easier to dirty it with grass clippings from lawn mowing, nearby shrubs, or the exhaust from a clothes dryer.

Proper charge

HVAC technicians must know the right procedures for charging an air conditioner not only at installation, but in the course of maintenance as well. Refrigerants do not wear out. The systems, if properly constructed, are totally sealed and do not need refrigerant added or changed. If a system is properly charged at installation and later needs more refrigerant, then there is a leak that should be repaired. Any leak in the refrigerant system will result in moisture entering the refrigerant loop, the major cause of electrical death of compressors.[9] The reason is that water combines with the fluorine and chlorine in the refrigerant to form acids. The refrigerant is circulated through the electric motor of the compressor to cool it and the acids etch away the insulation in the motor, resulting in a short-out.

The instrument that allows a trained technician to test a hermetically sealed compressor to determine the condition of the electrical insulation in the motor is a megohmmeter or "megger." This instrument has been used for many years to test large industrial and commercial compressors, but only recently have techniques been developed for the proper use of this tool with a residential central air conditioner unit. A megger reading taken each year with similar conditions is an easy, excellent technique to spot deterioration of compressor insulation at the earliest possible time.

The Right Stuff

If one fact stands out about central air conditioning systems, it is that a trained eye can find a significant discrepancy between the manufacturer's rated energy efficiency and the actual performance. That's why proper installation and maintenance of any air conditioner system are the only ways to achieve the system efficiency and the equipment endurance that the homeowner has the right to expect. The instruments, techniques, and knowledge to do these jobs properly are simply beyond the capabilities of almost anyone except highly trained service technicians. They almost all agree that they can perform a much more professional job for an annual service contract customer than they can for someone whose system has failed under the strain of hot weather usage.

A dealer or technician for whom an annual service fee can be justified should offer several services and qualifications:

- membership in Refrigeration Service Engineers Society (RSES),
- a written report with each maintenance visit,
- an outdoor coil cleaning with each visit and an indoor coil cleaning at least once each year,
- a report on measured air flow through the duct system,
- air conditioner refrigerant charge checked by the "superheat method," preferably when the weather is above 80°F,
- "meggering" the compressor,
- a measure of the air conditioner capacity, and
- an explanation to the occupant about latent and sensible cooling. ■

Endnotes

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