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Impact of the 2006 Federal Air Conditioner Efficiency Regulations on Apartment Firms

By Harvey M. Sachs, Ph.D.

- As of January 23, 2006, central air conditioners and heat pumps manufactured or imported for use in residential buildings must meet a new, higher energy-efficiency standard, from a 10 Seasonal Energy Efficiency Ratio (SEER) to a 13 SEER. This is a major change for the air conditioning industry and will require a redesign of its offerings as the market makes the transition to the new 13 SEER standard.
- This White Paper addresses apartment firm concerns about:
  - (1) the continued availability of spare parts and refrigerants for SEER 10-rated equipment;
  - (2) the size of the new SEER 13-rated equipment; and
  - (3) the cost of the new SEER 13-rated equipment.
- It explains what apartment owners must do to comply with the new standards and identifies best practices and design considerations for new and existing construction to maximize efficiency and minimize costs.
- It concludes with Frequently Asked Questions on equipment issues, regulatory issues and business considerations.
- Recommended Distribution:
  - Property Managers
  - Construction Managers
  - Acquisition Managers
  - Maintenance Managers

About the National Multi Housing Council and National Apartment Association

The National Multi Housing Council (NMHC) and the National Apartment Association (NAA) represent the nation's leading firms participating in the multifamily rental housing industry.

Based in Washington, DC, **NMHC** represents the interests of the nation's largest and most prominent firms in the apartment industry. NMHC members are engaged in all aspects of developing and operating apartments, including ownership, construction, management, and financing. The Council was established in 1978 as a national association to advocate for rental housing and to provide a source of vital information for the leadership of the multifamily industry. Since then, NMHC has evolved into the industry's leading national voice. The association concentrates on public policies that are of strategic importance to participants in multifamily housing, including finance, tax, property management, environmental and building codes. NMHC benefits from a focused agenda and a membership that includes the principal officers of the most distinguished real estate organizations in the United States. For more information on joining NMHC, contact the Council at 202/974-2300 or www.nmhc.org.

NAA, based in Alexandria, VA, is a federation of 168 state and local affiliated associations representing more than 32,000 members responsible for more than 5 million apartment homes nationwide. It is the largest broad-based organization dedicated solely to rental housing. NAA members include apartment owners, management executives, developers, builders, investors, property managers, leasing consultants, maintenance personnel, suppliers and related business professionals throughout the United States and Canada. NAA strives to provide a wealth of information through advocacy, research, technology, education and strategic partnerships. For more information, call 703/518-6141, e-mail information@naahq.org or visit www.naahq.org.

About the Author

Harvey M. Sachs, Ph.D, is the ACEEE's Director of Building Programs. His responsibilities include a wide range of efforts focused on standards and market transformation for the residential and commercial sectors. This includes building codes, equipment standards, and a large effort on market transformation to increase utilization of better products and practices. Market transformation activities include evaluating emerging technologies as candidates for sustained market transformation programs, and specific programs to spur the market acceptance of energy-saving technologies and practices such as efficient transformers and better furnace fans, commissioning of existing buildings, and improved air conditioner installation and maintenance practices.

Sachs has a broad background in technology, field studies, and policy work. He trained as a geological oceanographer, but turned his attention to indoor air pollution and energy efficiency while on the Princeton University faculty. He worked on radon distribution and diagnostics, asbestos, and formaldehyde. In the late 1980s, Sachs served as Assistant Commissioner in the New Jersey Department of Commerce, Energy and Economic Development, where he was responsible for energy policy, demand-side management programs, and power plant siting. He was Policy Director of the Center for Global Change, University of Maryland, and helped EPA set up its ground source heat pump programs. More recently, he was technical director of the Geothermal Heat Pump Consortium, responsible for its R&D, environmental programs, and education and training. He is active in ASHRAE and other research activities.

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Please understand that the information discussed in this guidance is general in nature and is not intended to be legal advice. It is intended to assist owners and managers in understanding this issue area, but it may not apply to the specific fact circumstances or business situations of all owners and managers. For specific legal advice, consult your attorney.

SUMMARY

As of January 23, 2006, central air conditioners and heat pumps manufactured or imported for use in residential buildings must meet a new, higher energy-efficiency standard, from a 10 Seasonal Energy Efficiency Ratio (SEER) to a 13 SEER. This is a major change for the air conditioning industry and will require a redesign of its offerings as the market makes the transition to the new 13 SEER. There are limited exemptions, for very small niche classes (such as small diameter, high velocity systems and a lower standard for "through-the-wall" equipment prior to 2010 (see discussion on pages 2 and 10.)

Apartment owners are especially concerned about:
(1) the continued availability of spare parts and refrigerants for SEER 10-rated equipment;
(2) the size of the new SEER 13-rated equipment; and
(3) the cost of the new SEER 13-rated equipment.

The natural expectation would be that SEER 13 equipment will be much larger and much more expensive than the current SEER 10 equipment. ACEEE believes that these concerns are exaggerated because they implicitly compare the costs of today's premium SEER 13 products with the pre-2006 "commodity" products. ACEEE predicts that the newly-designed 2006 SEER 13 units will be somewhat more expensive (at first) than today's SEER 10 minimum efficiency units, but much less expensive than today's SEER 13 products. Manufacturers are also trying to provide SEER 13 equipment that will fit in place of existing models. Replacement units are a big part of their business, and they want to continue to be able to serve this consumer need. More stringent energy efficiency requirements, combined with the real prospect of higher energy prices, offers owners an opportunity to consider adjustments to design and construction procedures that will optimize the value proposition for the operation and maintenance of their properties.

INTRODUCTION

January 23, 2006 opens a new era for residential central air conditioners and heat pumps. As of that date, all such equipment manufactured or imported for sale in the United States must meet higher minimum efficiency levels. A 13 SEER (Seasonal Energy Efficiency Ratio, the federal standard) will be required, instead of a 10 SEER, which has been the requirement since the early 1990s.

This paper outlines the background of this regulatory change and explores the implications for the multifamily industry. Many aspects of building construction are subject to regulation. As a results of the 1970s energy crises, the Department of Energy is required to issue minimum, cost-effective performance standards for many residential appliances, including refrigerators, clothes washers, water heaters, furnaces and air conditioners, as well as some commercial products. The law further requires that the standards be updated every five years; missed deadlines in the past have resulted in lawsuits filed by 15 states and others to force compliance with these energy efficiency goals. By requiring equipment to be more efficient, Congress intended to offset increased demand for energy and the subsequent need to build more generating capacity. Indirectly, the legislation mitigates dependence on foreign energy supplies and reduces the pressure to increase energy prices.

SEER 10 minimum performance requirements for central air conditioners and heat pumps took effect in 1992 and 1993, respectively. The new national minimum SEER 13 standard applies to equipment manufactured beginning on January 23, 2006. There are a few exceptions from this standard for specialized "niche" products that are used to a limited extent in apartment properties. Manufacturers can still produce parts for repairing older units of all types, even if those systems have lower efficiency than new models.

This paper reviews the implications of the new regulatory requirements for central air conditioners (cooling only) and heat pumps (heating and cooling) for the apartment industry. For convenience, the term air conditioner includes both categories, except where heat pumps are specifically noted. The most direct impact on the apartment sector concerns the price and size of SEER 13 units. Some 2006 SEER 13 units may be larger in size than the current less efficient SEER 10 models. No one yet knows what the long-term purchase price implications will be, particularly given escalating prices associated with the manufacturing sector. Unquestionably, the nation is currently experiencing a dramatic increase in the cost of energy that will ripple through the economy. This will increase both the prices of manufactured goods and the cost of operating consumer equipment. Less efficient air conditioners will cost much more to operate than this new generation of more energy efficient products.

The paper is organized into two parts. The first section provides context, describing the regulation's background, its implications for apartment providers and design suggestions that can be used to take advantage of the SEER 13 requirements. For those who want quick guidance on specific sections, the second section consists of Frequently Asked Questions.

REGULATORY REVIEW: SEER 13 AND SPECIAL CASES

Complying with its legal obligation to review and update energy efficiency requirements every five years, in January 2001, the Department of Energy conducted the required analyses and legal processes and issued a rule mandating SEER 13 for residential air conditioners and heat pumps. The rule contains exceptions for certain limited applications such as through-the-wall units and small diameter, high velocity equipment. In 2002, the Bush Administration withdrew the rule and issued a less stringent SEER 12 rule. In May 2002, the Bush Administration proposed reducing the target SEER to 12 from 13, spurring a lawsuit by the Natural Resources Defense Council and 10 states. In January 2004, the U.S. Court of Appeals for the Second Circuit restored the 13 SEER standard. The Administration and the air conditioning manufacturers chose not to appeal to the U.S. Supreme Court, and agreed to implement the SEER 13 regulation beginning in January 2006.

A. What must apartment owners do to comply with the new standards?

The SEER 13 efficiency regulation, effective January 23, 2006, does not require apartment owners to do anything to their existing HVAC equipment. Owners can continue to use, maintain and repair the equipment currently in use on their properties. The federal law only governs what can be manufactured or imported for use, not what can be installed. Distributors can continue to sell the remaining "old" SEER 10-12 units they have in their inventory. Even if lower efficiency models can still be found into early 2006. However, property owners and managers should consider the cost advantages of opting for the new higher efficiency SEER 13 models.

The expected life of residential air conditioners is 18.4 years, according to the U.S. Department of Energy (DOE).[1] This implies that at least one equipment change-out will be required during the accounting life of a property. Properties currently in the design phase should specify minimum SEER 13 equipment. Properties that are seeking certain green tax credits or LEED certification may need to adhere to higher design criteria for HVAC systems. Developers building a property in phases are advised to update building plans and specs in order to insure that SEER 13 equipment is specified and able to be installed in the area allotted to the equipment.

B. Are there any exceptions to the SEER 13 rule?

One "special case" in the regulations concerns "through-the-wall" units that are sometimes installed in multi-story, apartment buildings.[2] Typically installed in a utility closet, through-the-wall equipment uses air drawn in from outside to cool the condenser. The air is then returned through an opening in the outside wall. DOE has promulgated a separate standard for this type of equipment manufactured

[1] [TSD] 2001.Technical Support Document: Energy Efficiency Standards for Consumer Products: Residential Central Air Conditioners and Heat Pumps Including: Regulatory Impact Analysis. United States Department of Energy. Assistant Secretary, Energy Efficiency & Renewable Energy, Office of Building Research and Standards, Washington, DC 20585.
[2] *Op cit.*.

before January 23, 2010[3]. This standard, SEER 10.9 for split systems and SEER 10.6 for single-package units,[4] is designed to meet the near-term needs of the replacement market. Higher efficiency through-the-wall units would otherwise incur significant costs for exterior wall modifications to install larger ducts for the outside air supply and returns for cooling the indoor condenser. Thus, developers planning new projects using through-the-wall equipment should consult with contractors about opening sizes for SEER 13 equipment. NOTE: This equipment category differs from "packaged terminal air conditioners," or PTACs which are also installed through exterior wall penetrations. These types of units are typically unducted, and thus largely confined to single-room applications.

There is also a very ambiguous SEER 12 provision for "space-constrained" air conditioners and heat pumps no larger than 30,000 Btu. The definition (§430.2) is vague and problematic enough that the Air-conditioning and Refrigeration Institute (ARI), the manufacturers' trade association, has asked DOE to remove the "space-constrained" product class from the regulations.[5] Manufacturers are working to provide SEER 13 equipment for all market segments. ACEEE does not expect recognized manufacturers to attempt to use this exemption to meet the relatively small demand for "space-constrained products." Since SEER 13 compliant equipment will be manufactured, stocked and sold in much larger numbers, it will have economies of scale that keep costs and prices low. Thus, there will be little incentive for manufacturers to offer a product that does not meet the new specifications.

C. Are manufacturers prepared for SEER 13?

Beginning January 23, 2006, HVAC manufacturers can only produce SEER 13 and higher rated equipment for sale in the U.S. market. Since the SEER 13 rule was issued in 2004, manufacturers have been aggressively redesigning products and manufacturing processes.[6] From all indications, they will be ready, although short timeline for modifications has made it a very challenging process. Based on discussions with manufacturers, articles in the trade press and other knowledgeable sources, ACEEE is confident manufacturers will meet the SEER 13 standard for their mainstream products. However, not every manufacturer and brand will have a full complement available immediately. For example, some firms might not have very small units available on January 23. It will be important to keep in touch with your vendors.

Owners should note that the 2006 SEER 13 products will generally differ from the pre-2006 SEER 13 equipment. Generally speaking, the pre-2006 equipment includes extra "bells and whistles" that increase consumer value and add to the price. The 2006 SEER 13 offerings will include an abundant supply of "baseline" or "builder" commodity products engineered for very competitive, price-sensitive markets, because that is where the vast majority of sales will take place. Another way to consider this is that this year's SEER 10 market will be next year's SEER 13 market. From this, ACEEE draws two conclusions:

1. **Size.** The new SEER 13 units will generally be smaller than present SEER 13 products, but somewhat larger than current SEER 10 units. This will reduce the amount of increasingly expensive materials used in their manufacture. Even more importantly, builders and contractors are more likely to select smaller units because they are easier to install. One manufacturer[7] claims

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3 50998 Federal Register, Vol. 69, No. 158 / pp. 50997 – 51001. Tuesday, August 17, 2004. The standards for through-the-wall air conditioners and heat pumps, which fall within the definition of ''space constrained product,'' were set in the May 23, 2002, final rule, and are: 10.9 SEER, 7.1 HSPF for split systems and 10.6 SEER, 7.0 HSPF for single package systems. The definition of ''through-the-wall air conditioner and heat pump'' in § 430.2 provides that this product class exists only for products manufactured prior to January 23, 2010. After that date, the standards for space constrained products will apply to these through-the-wall air conditioners and heat pumps.

4 "Split systems" are characterized by two separate "boxes." The condensing unit is outside, and the evaporator with air handler is installed as part of the ducted air distribution system. In contrast, "single-package" units combine all of the elements in a single unit, typically roof-mounted.

5 Karim Amrane, ARI, to Michael J. McCabe, DOE, June 7, 2005.

6 For example, Carrier/Bryant has announced a $250 million investment in one Tennessee plant.

7 Bryant, ACHR News.

that his 2006 SEER 13 models will be 20 percent smaller than the pre-2006 models. Most of the size increase over the 2005 SEER 10 equipment will be in the outdoor unit (condenser), not the indoor unit, because this is the most cost-effective approach to meeting the 2006 high efficiency standards.

2. **Pricing.** It's too early to have a solid feeling about prices in 2006. The escalating price of raw materials and fuel imply increased costs of manufacture. Most manufacturers will release prices for 2006 models to their distributors before the end of 2005. Based on the financial analyses used by DOE to establish the higher efficiency requirement, equipment costs may be somewhat higher than for SEER 10 models today because the 2006 units use more materials and better components. On the other hand, based on costs of SEER 10 before and after the 1992 standards took effect, ACEEE expects the cost of 2006 SEER 13 equipment to be much lower than today's SEER 13 models.

BEST PRACTICES FOR APARTMENT OWNERS

Apartment developers, owners and managers need to manage the conversion to higher efficiency equipment both to control capital and operating expenses and to maximize resident satisfaction. Strategies for new developments and existing properties will differ somewhat, but they will share key elements.

(OVER)SIZING

The first major issue is equipment capacity. Installing the correct size of equipment for each apartment is essential, and is discussed in the next section. Everyone worries about the undersized air conditioner that can't cool the apartment but this rarely happens. In practice, contractors worry about call-backs for inadequate cooling capacity. The system is biased toward delivering units that are "comfortably" oversized. The manufacturer's ratings are conservative, because the certification process requires that the unit have at least the capacity claimed. Even the industry-standard load calculation method for residential and light commercial buildings, ACCA Manual J, has tolerances that may result in a 15 percent greater load determination than calculated by sophisticated simulation methods.

As a result, almost everything in the residential market is oversized as a "safety factor." Oversized equipment has several implications, and almost none are good for the owner. The equipment costs more to purchase and more to operate. It is also likely to need bigger cabinets that take up more space or make retrofitting more expensive.

Most important, though, oversized air conditioners don't work well, and they are associated with serious indoor moisture issues that can result in air quality problems such as mold. To understand why, you need to know what the air conditioner actually does: it pumps heat from inside to outdoors. Heat is generated in the apartment by people (roughly one lightbulb/person), lights, and everything plugged in. Usually, much more heat comes from outside, conducted through the walls, radiated through the windows and brought in with outside air (infiltration through the walls, as well as door openings, etc.)

An air conditioner that is exactly the right size to remove all this "heat gain" would run continuously during the hottest part of the hottest day assumed in the design calculations (for example, 91ºF for Washington, DC). If it is oversized, it will not run continuously even at these "design conditions." Cycling on and off frequently is inefficient and uses more electricity for the same amount of cooling. In addition, typical electrical and mechanical components run best when they run continuously, instead of starting and stopping frequently. Thus, oversized units may not last as many years as properly sized ones.

Even if the air conditioner is the right size for the design temperature, almost all air conditioners are single-capacity units. The only way they can control temperature when it is cooler than the design temperature outside is to cycle on and off. The cooler it is outside (less the heat coming in through walls, windows, etc.), the shorter the "on" cycles will be. The cycling causes problems. Air conditioners don't just cool the air; they also remove moisture (control humidity). For technical reasons, they do little moisture removal unless they run at least 10–15 minutes continuously in each “on” cycle. An oversized unit will cool the apartment so quickly that the evaporator coil never gets cold enough to condense much water, limiting its ability to remove moisture from the air. This leaves occupants feeling cold and clammy. If the apartment has any cold surfaces (for example, water pipes and exposed on-grade concrete), moisture will condense to water on the cool surfaces. These wet surfaces (and often the evaporator coil itself, if not maintained) are hospitable for mold growth.

In relatively humid climates, when a service call is initiated in response to a resident’s descriptions of “cold-clammy” air or increased relative humidity, the first step should be to check the thermostat fan switch. The switch should always be at “auto,” and *never* at “on.” “On” tells the fan to circulate air continuously resulting in re-evaporation of the moisture left on the inside coil when the air conditioner completes its cycle. Combined with short cycles, this guarantees near-zero humidity control, which can lead to excessive indoor moisture and can result in the growth of mold.

DESIGN CONSIDERATIONS

The reasons for proper sizing for load are compelling and particularly critical in regions with extended periods of high humidity. How do you, as an owner, assure proper sizing, and harvest the benefits? **The critical measure is to use the HVAC industry’s best practices to *calculate* loads for each different apartment type and orientation, instead of *estimating* them based on past experience.** This does not mean a full-blown engineering simulation. The easiest method is “ACCA Manual J,” developed, verified and published by the Air Conditioning Contractors of America. Good mechanical contractors have at least one of several commercial software packages that quickly do the Manual J calculations.

You do not need to do the calculations for *every* apartment unit in a building , but you do need them for each *differently* designed unit in each compass orientation. In this sense, for a given apartment building, or those in the same metropolitan area (so weather is the same), you need separate calculations for each major variation: size, floor plan, window plan (corner units), top floor (roof) or bottom floor (slab?) and compass orientation (solar gain through windows). That is because the calculations figure out the maximum amount of heat the apartment will gain from outside (and inside). Heat gains are determined by how the walls are constructed, the quality and construction of the windows, and even how much window area faces the sun during the summer. For example, walls built with 2x6 studs will conduct less heat than walls made with 2x4 studs (assuming both have full thickness insulation). An inch of foam insulation outside the studs will also help. ENERGY STAR windows[8] with two panes of glass and “low-E” coatings can greatly reduce heat loss and heat gain, and may cost as little as $10-$12 each over the cost of comparable low-performance windows. Together, such measures greatly decrease the building load. This, in turn, means that smaller, less expensive air conditioners will work and will increase resident comfort with less draftiness.

There may be an additional charge for a detailed set of computations to determine the optimal size for HVAC equipment, however, this is likely to be offset by the cost savings associated with purchasing the proper size equipment since the most common error is to over-size an HVAC unit. Additional benefits come from the fact that properly sized equipment is more efficient to operate, and that translates into lower utility bills and greater comfort for the residents and greater assurance of moisture control for the owner.

Second, proper installation may be even more important than proper sizing to obtain maximum quality and efficiency from an HVAC system. The first issue is getting the right amount of refrigerant in each air conditioner. Too little refrigerant, which unfortunately is very common, can lead to much lower capacity and efficiency than specified. Too much refrigerant has smaller effects statistically and can also damage equipment. The *majority* of systems that have been checked have charge errors big enough to

[8] http://www.energystar.gov/index.cfm?c=windows_doors.pr_windows.

significantly affect performance.[9] In the case of split systems (separate condensing unit and indoor coil), the installer has to evacuate the refrigerant lines (to eliminate air and moisture), connect the refrigerant lines between the two units, and then check that the refrigerant quantity is correct. This requires time and some skills and often seems to be done improperly.

Quality installations also deliver the right air flow across the coil. Most manufacturers recommend 350–450 cubic feet per minute (cfm) per ton of cooling capacity. In dry climates, efficiency can be improved by using values of 400–450 cfm/ton. Conversely, installations in humid climates will benefit from lower air flow, toward the 350 cfm/ton limit. This improves moisture removal and comfort and helps prevent mold. Air flow is, of course, related to the quality of the ductwork that distributes conditioned air to the apartment's spaces and returns it to the air handler.

DUCTWORK

Ductwork quality is very important. Conventionally-installed ductwork used in most construction, whether sheet metal, flex-duct or fiberglass, loses more than 20 percent of the air traveling through it to the wrong places, either inside or outside the building. In addition to the energy wasted in conditioning this air, the property owner may face additional costs in dealing with associated humidity issues. When large amounts of outside air are drawn in because of ducts leaking to and from the outside, it places an additional burden on the HVAC system to dehumidify additional volumes of air. In addition, leaks to and from the outdoors can create other air quality issues by bringing in large amounts of unfiltered air through the building's shell.

High resistance to air flow in the ductwork, due to excessive turns and take-offs, and ducts that are too small, can also create problems. The resistance is called "external static pressure (ESP)." High ESP leads to low air flow through the inside coil, which reduces performance by lowering capacity and efficiency.

Apartment developers and owners can insure that these issues are effectively addressed in their buildings by choosing a reputable contractor. Currently, because the large scale verification programs of contractors or building operations in California and some other areas do not include apartments, the most reliable course is to choose a quality contractor. Quality Contractor accreditation programs are not yet widespread, but quality contractors share many attributes. First, they employ certified technicians. The most popular program is North American Technician Excellence, or NATE.[10] ACEEE recommends that the contract and specifications call for verification of air flow for a sample of apartments (perhaps 20 percent). Fortunately, several "remote" services are now available that help the technician demonstrate installation quality.[11] Using either standard or proprietary tools, these services verify that the refrigerant charge, air flow and other key performance indices are correct for the specific equipment model installed in any application.

REFRIGERANTS

The HVAC industry is in the midst of a fundamental transition from one refrigerant to another. To protect stratospheric ozone, the Montreal Treaty requires moving to chlorine-free refrigerants for all new products manufactured in 2010 or later. Today's mainstay refrigerant for central air conditioners is chlorine-containing HCFC-22 (also called R-22), which will be phased out of production by 2010. **For long-term planning, the ideal equipment will contain a chlorine-free alternative like HFC-410a (also called R-410a).**

Most manufacturers already include models with R-410a in their product lines and the market share for this refrigerant is expected to increase as the SEER 13 re-engineered equipment becomes more common.

[9] Neme, C., J. Proctor, and S. Nadel. 1999. *Energy Savings Potential from Addressing Residential Air Conditioner and Heat Pump Installation Problems.* Report A-992. Washington, D.C.: American Council for an Energy-Efficient Economy.
[10] North American Technician Excellence, http://www.natex.org/.
[11] for example, http://www.proctoreng.com/checkme/checkme.html; the Verified™ Refrigerant Charge and Airflow (RCA) system from Robert Mowris Associates (800) 786-4130, and the Honeywell Service Assistant , http://www.acrx.com/ServiceAssistant.cfm.

Until 2010, however, apartment owners can choose to buy units that use either R-22 or the newer R-410a. R-22 refrigerant will be manufactured and/or imported until January 1, 2020 for servicing pre-2010 units.[12] However, its price is expected to climb as the only source of R-22 after January 1, 2020, will be from a dwindling supply of reclaimed (i.e., recycled) refrigerant.

When purchasing new HVAC equipment, owners and managers should be aware that <u>refrigerants are not interchangeable</u>. It is not recommended that an R-410a condensing unit be installed with R-22 evaporator (coil) and refrigerant lines. Designs differ, and performance is likely to be degraded. Equally important, changing refrigerants requires changing compressor lubricants, and R-410a is incompatible with the old lubricants. Thus, refrigerant lines should be changed, as well as the A-coil (evaporator).

EXISTING APARTMENTS

The expected life of residential air conditioners is 18.4 years.[13] Some owners use such information to plan replacement programs for apartment equipment. Others wait for the “sign” that comes when several air conditioners break down nearly simultaneously. This is taken to mean that it is time to replace all the units, because they are at the end of their reliable service life. In such a situation, the mechanical contractor’s first, second and third instincts will be to recommend replacement with units of the exact capacity of the old ones being replaced.

An informed decision concerning equipment replacement should consider other issues, however. First, owners should consider whether it is a good time to invest in some other upgrades. For example, if other considerations require window replacements, then consider high performance Energy Star-labeled windows—the incremental costs are small, and they may reduce the air conditioner size needed. (Note that the total cost of window replacements is rarely justified by the value of the energy savings.) If roof leaks have damaged ceiling insulation, upgrading the insulation might have the same effect as improving the windows. Second, whether or not you do other upgrades at the same time, you should assume from general experience that the existing HVAC units are too big. Manual J load calculations are just as important for replacement equipment as they are for new installations. The Manual J load calculations should be run for each unit type as discussed above for new installations.

With split systems (separate outdoor condenser and indoor evaporator or “coil”), the common question is whether both indoor and outdoor units must be replaced together. This question comes up because the condenser (outdoor unit), which is the more expensive part, usually fails before the indoor coil. For 2006 and beyond, the answer is generally that both should be replaced together, for four reasons.

(1) The evaporator coil is likely to be reaching the end of its service life, too. It will likely be easier to stage a one-time march through an apartment building or community changing out whole systems than to replace all the condensers and then have to come back for the evaporators (indoor units), one at a time.
(2) The disparity in performance between the new condenser and the old coil can lead to problems in refrigerant balance which might compromise the service life of the compressor, the most expensive part of the HVAC system.
(3) Overall cooling ability and energy efficiency of the system will be seriously compromised by pairing an obsolete evaporator with a new condensing unit.
(4) Refrigerants will most likely not be compatible.

There is at least one other reason not to “mix and match.” Although unlikely, there could be legal consequences. All central air conditioning systems sold and installed in the U.S. must be certified as meeting efficiency and other requirements (such as capacity). Certification is a formal process that involves third-party testing. Certified models (including condensing unit–evaporator combinations) are listed in the ARI Directory, “Primenet.”[14] Informally, DOE staff has suggested that anyone who installs uncertified “mix

[12] http://www.epa.gov/ozone/title6/phaseout/hcfc.html.
[13] TSD, p. 5-67.
[14] http://www.ariprimenet.org/ari-prog/direct.nsf/fraAC?OpenFrameSet.

and match" condensing units and evaporators might be deemed a manufacturer who has violated the law by selling or installing uncertified units. No one expects DOE to go after individual contractors who do a few residential retrofits, but distributors and large developers might be cautious.

DESIGN CONSIDERATIONS FOR NEW CONSTRUCTION

Apartment heating and cooling loads are sometimes treated as afterthoughts, as the inevitable outcome of more basic decisions about apartment sizes, orientations, materials and construction methods. However, heating and cooling load calculations should be an integral part of the design process since properly designed and functioning systems can add to the value of the project by extending equipment life, decreasing operating expenses, reducing the utility costs borne by residents and providing greater building comfort.

In the initial design of a building there are many competing demands to maximize the development's value for the owner. Energy efficiency is less visible than some considerations, but deserves increased attention for its effect on the inherent value of a property. Among the efficiency measures to be considered in the design process are: orienting the building to take advantage of natural cooling/heating; shading the glass; and the type of window and amount of insulation in the walls, ceilings and floors. In cold areas, minimizing northern windows will reduce heating bills. In warmer climates, avoiding large south-facing windows will reduce air conditioning loads in a meaningful way. In other words, orientation matters to you as well as your residents. Another important but often overlooked area during the design and construction phase is the impact of air-leakage, which can be reduced by caulking and sealing of the joints and openings in the exterior envelope. In some cases developers may also want to consider installing an air-barrier around the building. The design of the air-barrier is critical to control air movement, but the placement and type of material used are even more important. An improperly designed air barrier can trap moisture and increase the chances of mold growth.

The next set of decisions deals with architecture and construction. Using the South again as an example, effective window overhangs will help limit heat gain through the windows in the summer, while allowing low-altitude winter sun to penetrate. Upgrading construction to meeting the ENERGY STAR levels for new homes (single-family and multifamily up to three floors),[15] will provide many benefits. More insulation and more care with construction details don't just save energy. They also yield quiet, which is highly valued by residents. Just upgrading to ENERGY STAR windows, at an incremental cost of $10-$12 per window, where they are popular already, may cost less than the savings from the air conditioner downsizing it allows. In general, downsized air conditioners may allow smaller duct sizes, which makes installation cheaper and easier and makes it easier to include noise-reduction features such as anti-vibration connectors.

DISCUSSION

Moving toward higher efficiency makes good business sense for now and the future; as electricity, natural gas and gasoline prices continue to escalate, operating costs will also continue to rise. Not only does it reduce operating costs, but it can also be a resident amenity. Spiraling energy prices may cause residents to place a higher value on a property that boasts low utility bills due to superior construction, systems and appliances. These investments also improve indoor air comfort for would-be residents.

ACEEE recognizes that the world is changing, and that the effects of investment decisions made today will be with us for decades. We believe that the low energy prices of the past are not likely to return, which makes the risk of investing in efficiency (and getting better comfort as a side benefit) small, and much lower than the risk of underinvesting.

[15] http://energystar.gov/index.cfm?c=new_homes.hm_earn_star.

FREQUENTLY ASKED QUESTIONS

EQUIPMENT QUESTIONS

1. **Do I have to replace my old HVAC equipment to conform to the new SEER 13 regulations?**
   No, the standards only apply to new equipment manufactured after January 22, 2006, not equipment already installed.

2. **Will replacement parts be available for older, less-efficient units after January 23, 2006?**
   Yes, for some years to come, depending on the business strategy of the manufacturer and any after-market specialists.

3. **If I have to buy a new unit, will the increased size of the condenser (outdoor) unit fit in the space that I have available? What if it doesn't?**
   There are tens of thousands of different central air conditioner models in the ARI directory, in many shapes and sizes. Many manufacturers are already promoting new designs that are not much bigger than existing equipment. Some condensing units may be short and wide, some taller, some tall and thin and some in between. In addition, there are ways to increase efficiency without making a unit very large. As a result of this and the competition between manufacturers, there will be a great variety of products. ACEEE expects there to be products available for nearly all applications. We are confident that good contractors will be able to find cost-effective certified, matched condensing units and evaporators for almost all situations.

4. **Will the new larger units be in compliance with building code requirements when they are located above the ground level in apartment buildings? Some owners have expressed concern that the weight (as opposed to the volume) of the units could result in having to re-locate the units.**
   The more efficient units will generally be a bit heavier than old units, although rarely will this extra weight come near to the load capacity of a building or deck. For the rare building that cannot support increased loads, it will often be possible to purchase units that meet the efficiency requirements through advanced compressors, controls or other improvements that do not add substantial weight. These units may carry a price premium, however. Additionally, units can be repositioned elsewhere (be sure to observe any 'long-line' requirements from the manufacturer for the inter-connected tubing).

5. **Will the new evaporators (indoor coils) be compatible with older air handlers or as a practical matter will it no longer be possible to change out one of the components without replacing the entire system?**
   Many of the new evaporators will be slightly larger than the old ones and may require an adapter to connect with the old air handler or furnace. However, particularly for units of less than three tons capacity, all manufacturers seem ready to meet the present space requirements of the highly restrictive manufactured housing market. Several have stated that they will offer same-size units in capacities to five tons. However, if the outdoor unit (or its compressor) has failed, we strongly recommend replacing both the indoor (evaporator) and outdoor (condenser) air conditioner sections. Otherwise, efficiency (and possibly equipment life) will be affected. For a fuller discussion, see "Existing Apartments" on page 7 and Question No. 6 below.

6. **Will the new efficiency standards have the practical effect of requiring that both a condenser and evaporator be purchased because of incompatibilities between the old and new equipment?**
   It is prudent to assume that both units will need to be replaced, unless otherwise stipulated by the manufacturer. Several manufacturers have already warned that not replacing the indoor unit is likely to lead to AC failure within the warranty period and will lead to heat pump failure in the first year. In some cases there could also be incompatibilities between the component parts. For example, if the new unit uses an HFC refrigerant ("Puron" or other R410a refrigerant) instead of the current HCFC (R-22), then both the evaporator and the condensing unit (and the refrigerant lines) should be changed because

the lubricating oils are incompatible. (See “Refrigerants” on page 6 and Question No. 9 below.) There is also generally an efficiency advantage to replacing the indoor coil when the outdoor unit is replaced, as matched systems perform better than unmatched systems. It may not be *necessary* to replace the furnace or air handler, but replacement may save money in the long run if that unit is near the end of its service life.

7. How will gas furnaces need to be altered to work with the new equipment?
In general, same-size evaporators should be available. At most, they may require an adapter to match the evaporator case to the furnace and to the plenum. In exceptional cases, the contractor may recommend units of a different brand or series, if needed, to match space constraints or reduce the field sheet metal work required.

8. Will the new, larger evaporator coil units need more airflow for efficiency? If so, how will this be accomplished?
We do not expect a change. In general, manufacturers continue to design equipment so performance is optimized when the air handler delivers 350–450 cfm (cubic feet per minute) of air per ton of cooling (12,000 Btu/hr). See discussion of air flow in “Design Considerations” on page 6.

9. What refrigerants should property owners be looking for in terms of buying/replacing air conditioning equipment? How long can we expect inventories of older HCFC refrigerants to be available to service old systems?
In 2010, manufacture of air conditioners using the refrigerant R-22 will cease for the U.S. market. R-22 is an ozone-depleting HCFC chemical that contains ozone-depleting chlorine. We expect inventories of R-22, the HCFC used in residential air conditioners, to remain adequate through the life of equipment sold in this decade. But we expect prices to gradually rise after it is banned for new equipment in 2010.

Most new residential air conditioners will use R-410a, which contains no chlorine, instead of R-22. R-410a has been available for several years under names like “Puron” (Carrier and Bryant), and we expect its market share to rise quickly over the next four years as the deadline approaches. For owners there is the usual trade-off; R-410a equipment has a somewhat higher price now, but higher “sustainability” and lower maintenance costs in 2010 and beyond than R-22. R-410a certainly should be considered now, and ACEEE believes that many owners will choose it for 2006 and beyond.

REGULATORY QUESTIONS

10. Are any air conditioners and heat pumps exempted from SEER 13?
In general, the 2004 rule[16] prescribes SEER 13 for all split systems and conventional packaged units. However, it makes exception for certain “space-constrained” products. Until January 23, 2010, the rule allows reduced efficiency requirements for “through-the-wall” products. Through-the-wall equipment is typically installed in an exterior closet and ducted to the interior space, where a duct system distributes the air. It is primarily used in multifamily high rise apartment and condominium applications. Today, through-the-wall packaged units are targeted to new construction.

This equipment contrasts with “packaged terminal air conditioners.” These units, common in motel applications, also are installed with wall penetrations, but they are typically unducted, and thus largely confined to single-room applications. For the (ducted) through-the-wall equipment, DOE has promulgated a different standard, but *only* for equipment manufactured until January 23, 2010. This standard (SEER 10.9 for split systems, and SEER 10.6 for single-package units) is designed to meet the needs of the replacement market, which would face very high costs to enlarge openings in exterior walls for the larger air ducts required by more efficient units. ACEEE recommends that developers of

[16] 10 CFR Part 430, [Docket Number EE–RM–98–440], RIN 1904–AB46. Energy Conservation Program for Consumer Products; Central Air Conditioners and Heat Pumps Energy Conservation Standards: Final Rule. Federal Register, Vol. 69, No. 158, Tuesday, August 17, 2004, Rules and Regulations, p 50997-51001.

new complexes design and build with openings that fit forthcoming SEER 13 models, so worn-out HVAC equipment can be replaced in 2020s when low-efficiency through-the-wall units will no longer be available.

A separate exemption has been issued for "Small Diameter High Velocity" (SDHV) equipment typically installed in older residential units that are hard to retrofit with conventional ducts. These high air pressure systems are not applicable to typical apartments and tend to be much more expensive than conventional low pressure systems. For this reason, SDHV equipment is not discussed in this document.

The DOE Rule does have allowances for SEER 12 "space-constrained" central air conditioners and heat pumps no larger than 30,000 Btu. The definition (§430.2) includes stringent qualification criteria, but is ambiguous in its terminology. DOE asked equipment manufacturers to review the situation. Through their trade association, the Air-Conditioning and Refrigeration Institute (ARI), manufacturers have asked DOE to eliminate the "space constrained" product class definition.[17] Thus, prudent owners will not count on exempted equipment becoming available. The rule does include SEER 13 for "ductless" or "mini-split" systems. Finally, the rule does not cover room air conditioners.

11. What does the January 23, 2006 SEER 13 deadline actually control?
The standards apply to residential central air conditioners[18] manufactured for sale in the United States as of January 23, 2006 (whether produced in the U.S. or abroad).[19] The standard does not directly regulate sales or installation.

BUSINESS QUESTIONS

12. Are there any metrics available that would help a property owner evaluate the financials of upgrading their air conditioning system?
ACEEE recommends that owners check with the resources on the ENERGY STAR site. Start with the information on "Tools and Resources" for commercial projects.[20] On the site's residential pages there are also hints on choosing a well-qualified contractor.[21] For example, in most cases the existing air conditioner is grossly oversized. Downsizing in such cases *improves* comfort and efficiency, and reduces the purchase price. (See "(Over)Sizing" on page 4.)

13. How do you bid a project until the new standards take effect?
ACEEE expects "business (almost) as usual" for those bidding new apartment buildings or major retrofits. The owner will prepare the bid package for the general contractor (GC), and GC or the mechanical subcontractor will seek price information from the distributor or manufacturer. Of course, manufacturers vary in their state of readiness. Some have released 2006 price lists for the new products already, and others will follow very soon. Owners who insist on buying lower-efficiency SEER 10 units for new projects will have to commit very soon as manufacturers are now announcing their order deadlines and production stop dates for these models and are "clearing the decks" for the new equipment. Again, ACEEE expects baseline 2006 SEER 13 air conditioners to cost somewhat more than the obsolete SEER 10 units, but much less than today's feature-filled, premium, SEER 13 units.

14. Are there alternative HVAC systems that might offer advantages in terms of cost or comfort for new apartment buildings?
Yes. Here are three examples:

[17] Karim Amrane, ARI, to Michael J. McCabe, DOE, June 7, 2005.
[18] Residential means single-phase current and capacity less than 65,000 Btu/h.
[19] **Federal Register** / Vol. 66, No. 14 / Monday, January 22, 2001 / Rules and Regulations, p. 7170 – 7171.
[20] http://energystar.gov/index.cfm?c=tools_resources.bus_energy_management_tools_resources.
[21] http://energystar.gov/index.cfm?c=home_improvement.hm_improvement_contractors#2.

- *Air source heat pumps* eliminate the furnace section of the conventional unit. As noted above, the heat pump is basically a two-way air conditioner, providing heat in the winter as well as cooling in the summer. In the summer, it takes heat out of the relatively cool interior, "concentrates" it by compressing a refrigerant, and then rejects the heat to the outside. In the winter, it actually takes heat from the outside, "concentrates" it, and releases it to the building interior. Heat pumps are best suited in moderate to warm climates. While air source heat pumps should also work well in cooler climates, a variety of installation and operating issues usually degrade performance. In cold weather, they compensate by using resistive electric heating, which is generally expensive.

- *Water source heat pumps* are an alternative for new construction or "gut rehabilitation" and eliminate the conventional "outside" unit. These systems, generally applied in larger buildings, use a heat pump for each apartment, but one that rejects heat to, or takes heat from, a central water loop instead of directly from outside air. When the loop temperature gets cold because many units are calling for heat, a central boiler heats the loop. Conversely, when the temperature rises in summer, a central cooling "tower" rejects it and cools the loop. The bulk of the energy cost, for the heat pump electricity, can be metered with the apartment's individual load. In general, these heat pumps are compact and relatively inexpensive, but the "loop" plumbing, boiler, and cooling tower add substantial costs.

- *Geothermal (GeoExchange)* systems are a "green" and very efficient extension of this concept, rejecting and taking heat from the ground instead of the boiler and tower. In the multifamily market, geothermal systems have been economically attractive primarily to non-profits and government agencies with relatively long capital recovery horizons.[22]

For both water source heat pumps and geothermal systems, there are associated issues of water heating. For the water loop system, with some extra plumbing (hot water loop), the gas or oil-fired boiler can serve year-around for indirect water heating. However, hot water recirculating loops are notoriously inefficient; they radiate heat everywhere they go, and they use a lot of electricity to pump the water. Thus, both of these approaches often rely on small, apartment-sized resistive water heaters instead. These water heaters are inefficient to operate but have the advantage of low-cost installation since they avert the need to install gas service to each apartment.

Some owners who install apartment-size gas water heaters have taken a different direction, particularly in the South. Instead of a separate furnace, they build a "combination" system. They use a low-cost air handler that pushes air through the air conditioner evaporator and a hot water coil supplied with hot water by the water heater. This provides space heat (controls give priority for water heating before space heating). If the water heater is very efficient (federal Energy Factor (EF) of 0.80 or higher), these systems can be very energy efficient and compact. However, if conventional storage units with EF of 0.60 are chosen, these combined systems will use more gas than a modern furnace and a separate water heater. This is because of the very high "standby" heat losses these water heaters have when they are not firing. Because an experienced design professional is needed to size the respective units in a combination system, it may not be a cost-effective approach for small sized buildings.

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[22] See, for example, case studies at www.geoexchange.org.