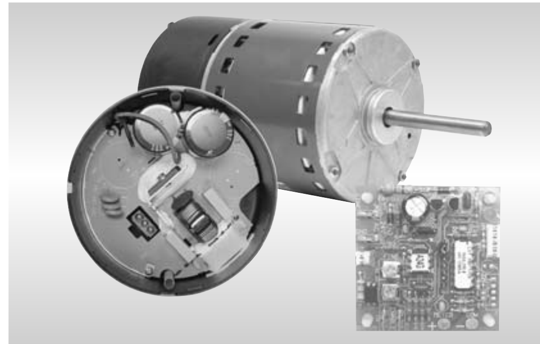
EPIC™/ECM FAN TECHNOLOGY
SIGNIFICANT ENERGY SAVING

EPIC™/ECM FAN TECHNOLOGY

- **Significant energy savings (67% average compared to PSC motors)**
- **Unique factory pre-set air volume capability (+/- 5%)**
- **Pressure independent fan operation**
- **LED for visual indication of air volume**
- **Field adjustable fan air volume controller**
- **Remote fan air volume adjustment capability from BAS**
- **Larger turn down ratios mean more flexibility for tenant changes**



Since 1985, equipment manufacturers have used GE ECM™ motors in residential air conditioners and furnaces. These motors have made it possible to achieve SEER ratings of 12 and higher. Until more recently though, they were only manufactured in 120 and 240 VAC, which precluded their use in commercial applications. Following two years of research and development and the availability of a new 277 VAC version, Engineered Comfort was first to introduce the GE ECM™ motor to the commercial HVAC market (Ashrae Journal, April 1997) as an option for use in commercial fan coil unit applications.

WHAT IS AN ECM MOTOR?

The ECM (Electronically Commutated Motor) is an ultra high efficiency programmable brushless DC motor utilizing a permanent magnet motor and a built-in inverter. DC motors are significantly more energy efficient than AC motors and much easier to control. The major weakness of commercial fan coil units until now, has been their low fan motor efficiency. The widely used three speed fractional horsepower shaded pole and permanent split capacitor (PSC) induction motor in combination with a 3 speed switch or an electronic SCR speed controller is extremely inefficient at typical operating conditions. Due to acoustical considerations, the fan motor is usually adjusted to operate at considerably less than full load (where PSC motor efficiencies may be as high as 62%). PSC motor efficiency drops off dramatically when turned down; typically by at least half. Installed PSC motor efficiencies are therefore typically in the range of only 12 – 45%. ECM motors in contrast, maintain a high efficiency of 65 – 72% at all speeds.

In addition to lower operating costs, EPIC™/ECM motor technology allows Engineered Comfort to pre-set the fan airflow volume at the factory.

The graphs below show the lower watts per cfm (translating into lower operating costs as shown on the next page) and wider operating ranges of commercial fan coils employing EPIC™ Fan Technology versus PSC induction motors.

FEATURES AND BENEFITS

Soft starts and slewed speed ramps are programmed into the ECM motor eliminating stress transmitted to the mounting bracket or hardware. They incorporate ball bearings providing permanent lubrication unlike sleeve bearings requiring a minimum rpm operation for oiling. The wider operating range of the ECM motor allows each model to actually replace two models using induction motors. This feature alone provides several benefits: a simpler product line to choose from, little or no equipment changes necessary when tenants change, more similar sized units on the job, decreased spare parts inventory and increased contractor flexibility. The low operating temperature of the ECM motor (essentially ambient) requires very little energy to offset the heat gain from the motor versus PSC motors which run hot (typically around 90 – 150ºF).

EPIC™/ECM FAN TECHNOLOGY

EPIC™/ECM fan technology provides an average 90,000 hours of operation (versus 50,000 hours for a typical PSC motor). This translates into about 10 years for a typical fan coil as opposed to 8 for a one using a PSC motor. In addition to these standard features are two primary benefits, energy savings and the ability to pre-set the fan airflow volume at the factory.

WHY AND HOW DO YOU PRE-SET FAN AIRFLOW?

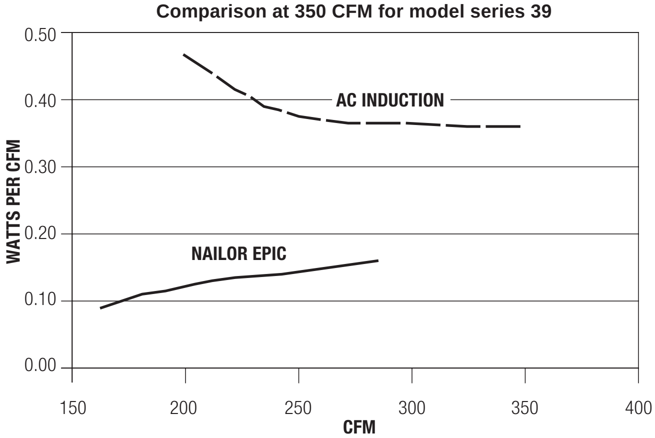
Pre-setting the fan airflow (cfm) has not been an issue with fan coil manufacturers because these units were either on at full load or off in normal operating conditions. With EPIC fan technology™, the fan coils can now be run as a VAV device with all of the requisite savings that VAV brings to other commercial jobs. (See control sequence for further explanation.)

AC motors are not synchronous machines and the rpm, and consequently the unit cfm, changes when static pressure changes. The difficulty in pre-setting the fan lies in estimating the motor workload required at the job site in actual working conditions. The fan operated by an AC motor will not produce the same volume of air as it did at the factory without the duct work or loaded filter. Because there is no way to accurately predict the downstream static pressure as it would exist at the job site, it was impossible to pre-set the fan cfm. The ECM motors are DC and inherently synchronous machines. The motors are programmed to calculate the work they are doing and then compare the work accomplished to the cfm requirement. The integral microprocessor based controller automatically adjusts the speed and torque in Engineered Comfort commercial fan coil units Engineered Comfort fan coil units incorporate our own custom EPIC™ fan controller. An electronic PWM volume control device that allows adjustment of airflow volume. Minimum and Maximum airflow can be pre-set on the assembly line. It is field adjustable either manually using a screwdriver and voltmeter locally at the fan coil or with the Engineered Comfort thermostat and controller or remotely using a 0 – 10 VDC analog output from a digital controller via the BAS or Engineered Comfort's standard thermostat and controllers. A fan volume versus DC volts calibration chart is provided. The importance of this feature is the energy that is saved due to controlling the fan airflow as well as the large reduction in noise generation. This also removes the uncertainty of diffuser flow measurement with hoods. Laboratory tests show the fan cfm to be accurate within +/- 5% of the factory set point. This is a huge benefit to the owner, the occupant, the controls contractor, and the mechanical contractor.

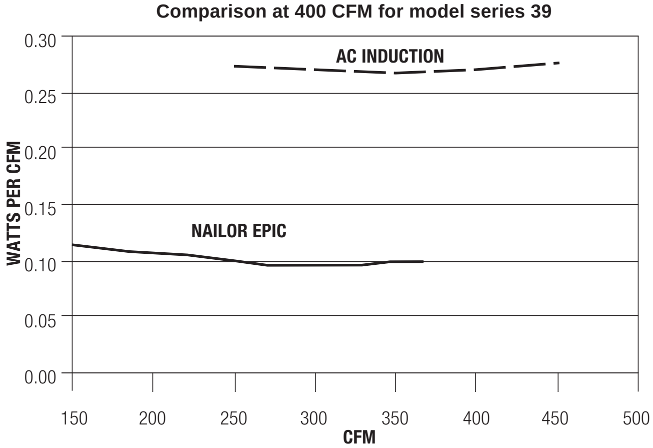
ENERGY SAVINGS

The following graphs show the energy savings of units with EPIC fan technology™ compared to units with PSC motors. The Engineered Comfort airflow are shown at lower set points due to lower set points due to lower temperature air (See control sequence for further explanation).

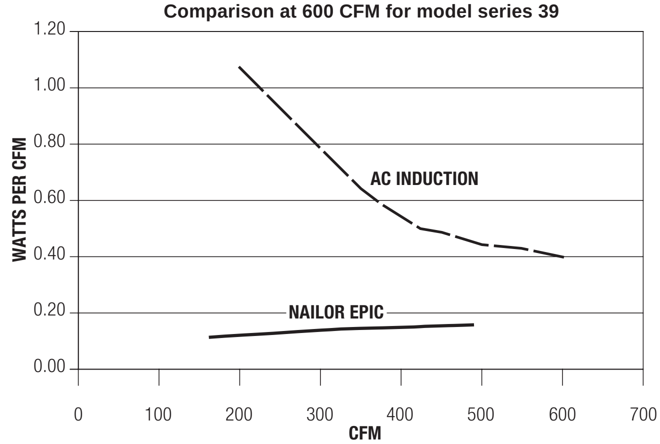
Comparison at 350 CFM for model series 39



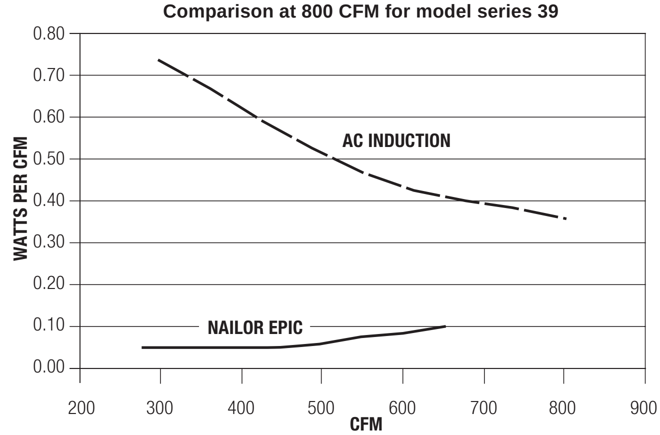
Comparison at 400 CFM for model series 39



Comparison at 600 CFM for model series 39



Comparison at 800 CFM for model series 39



WHAT IS THE PAYBACK PERIOD ON ENGINEERED COMFORT EPIC™ FAN?

The payback period varies. It depends on which unit you use, where you set the cfm, how much you run the equipment and what you are paying for electricity. The charts below are calculated assuming 24/7 operation of the Nailor unit vs. 80% run time on a competitive unit and $ 0.10 per kWh. If you run the equipment longer in your building or if you pay more for electricity, the payback will change proportionally. The charts consider only operating costs of the fan, other savings at the chiller and at the higher room set points can double the savings cutting the payback in half. On tall buildings, reduced riser sizes may offset the fan costs at the time of construction. Typically, you can run anywhere from 3 to 11 Nailor units for the same price as one of the competitions making the payback period as short as 6 months to as long as 36 months.

HIGH SPEED AIR FLOW (CFM)	COST TO RUN AC INDUCTION FAN 1 YEAR	COST TO RUN ENGINEERED COMFORT FAN 1 YEAR	NO. OF ENGINEERED COMFORT UNITS THAT CAN BE RUN FOR THE COST OF ONE COMPETITOR'S UNIT
350	$79.19	$15.77	5.02
400	$84.32	$17.04	4.95
600	$161.32	$21.81	7.40
800	$188.52	$16.51	11.42

Fan Coil Operation with Constant Discharge Air Temperature

The problems associated with high humidity at part load conditions will become a greater factor in the selection of equipment by design engineers in the future. Too much humidity and comfortable temperatures decrease to the point that occupants feel chilled or clammy. This also makes it more feasible for mold growth as the exterior walls may begin to sweat. The exterior walls of the fan coil unit may also sweat. Once again, in this condition, the occupant feels clammy, and that signifies that the optimum conditions for mold growth exist.

Relative humidity is defined as the amount of water by weight in a cubic foot of air divided by the amount of water in a cubic foot of the same air at a saturated condition. As air moves across a cooling coil, the temperature of the coil is normally below the dew point of the return air. This causes the water in the air to condense on the coil surface where it is gathered in a drain pan and disposed of through drain lines. The air leaving a coil is typically about 55 to 60ºF. Since the temperature of the coil is usually below the dew point of the entering air, water has been condensed from the air and the air is very nearly saturated. This nearly saturated air warms slightly as it moves through the duct to the diffusers. By the time it exits into the room, it has risen a degree or two in a typical system. It then mixes with the room air and is again warmed (typically to about 74 to 78ºF.)   . Both air temperature and water content are increased in the room; however, relative humidity levels decrease because the warmer air is capable of holding more water. The percentage compared to saturated air at the higher temperature has decreased. See line A-B on the attached psychometrics chart.

By lowering the discharge air temperature slightly, the humidity levels in the room can be lowered. See line C-D on the attached psychometrics chart. This causes the occupants to feel more comfortable at a slightly higher temperature. The room temperature required to maintain acceptable comfort can be raised by as much as 4ºF. Most occupants will be more comfortable at the increased temperature. This accomplishes 5 very important results in addition to the energy and reheat savings already provided by the EPIC motor.

1. If the air volume and water to the coil are modulated to maintain the discharge air temperature at all room conditions as described in Nailor’s control sequence, room relative humidity levels decrease by 10 to 20%, and there is less chance for wall sweating, which in turn lowers the chances of mold growth. See line A-B vs. C-D on the attached psychometrics chart

2. The lowered relative humidity allows the dry bulb temperature in the room to increase 1 to 4ºF. while maintaining acceptable comfort levels. This in turn saves energy due to higher room set points. (See CHART 1 printed from ASHRAE Handbook, Fundamentals 2001, chapter 8, page 8.12)

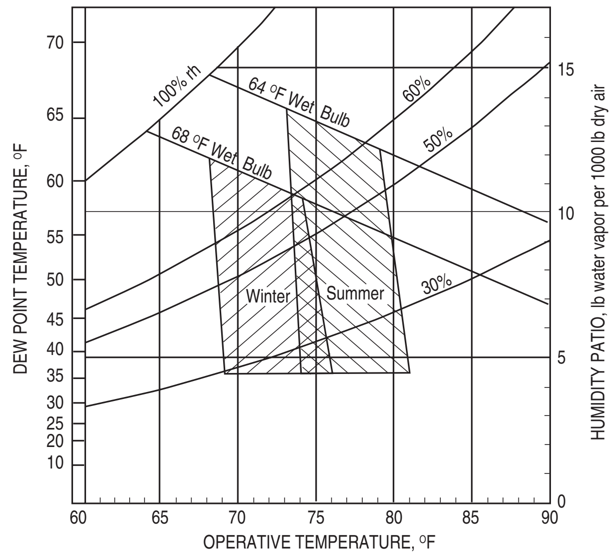


Chart 1: ASHRAE Summer and Winter Comfort Zones
(Acceptable ranges of operative temperature and humidity for people in typical summer and winter clothing during primarily sedentary activity.)

3. If the air volume and water to the coil are modulated to maintain the discharge air temperature at all room conditions, fan energy and pumping energy is saved by taking advantage of room diversity on both the water and air sides of the unit. Additionally, this causes the return water temperature to the chiller to increase and decreases the required pumping energy while increasing the efficiency of the chiller operation. Consequently, the pipe sizes needed for the risers and run outs are reduced as well as first cost. These reductions may offset any additional first costs of the equipment.

4. If the supply air temperature is lowered using Nailor’s control sequence, less air from the fan coil is needed to satisfy the room demand. Airflow can be lowered by approximately 18% reducing the EPIC energy at the fan by 20 to 50%, depending on setpoint, in addition to the input savings. (See TABLE 1.)

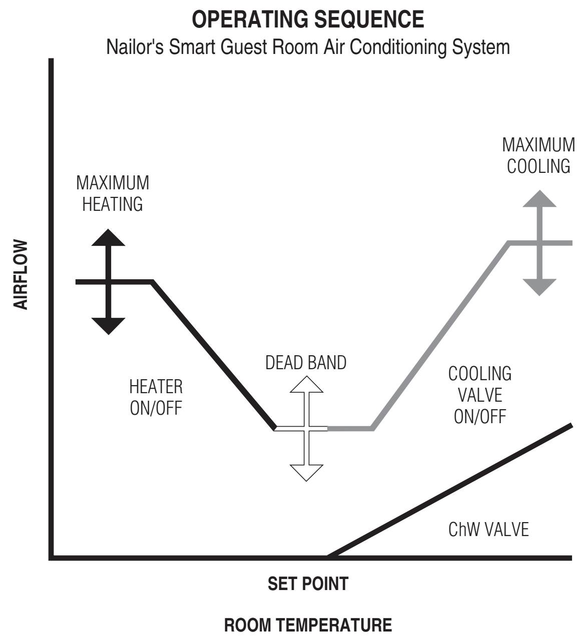
CFM_2 *$DELTA_2$ = CFM_1 * $DELTA_1$

CFM_2 = (DELTA T_1 / DELTA T_2) x CFM_1 for a fixed zone.

cfm2	delta t1		56	74	18		
cfm1	delta t2		53	76	23		
cfm2=	cfm1 X	0.782609					
cfm2	delta t1		56	78	22		
cfm1	delta t2		53	79	26		
cfm2=	cfm1 X	0.846154					
cfm2=	average	0.814381					
cfm1=	300	400	500	600	700	800	900
cfm2=	244	326	407	489	570	652	733
cfm1=	1000	1100	1200	1300	1400	1500	1600
cfm2=	814	896	977	1059	1140	1222	1303

5. If the air volume is modulated to maintain the discharge air temperature at all room conditions, the perceived comfort level in the space stays constant and the noise levels decrease. Also, the relative humidity is greatly decreased when compared to what happens without modulated air at part load conditions. See line AB' on the attached psychrometric chart. Under part load conditions, without controlled discharge air temperature, the relative humidity levels in the space can rise to as much as 70% because of reduced run time or lowered discharge air temperatures on the dehumidifying equipment. This would cause the room set points to be greatly reduced to satisfy occupant comfort, which increases operating costs at part load conditions. At these reduced set points, the room will feel clammy and mold growth potential increases.

The attached control sequence (See CHART 2) and psychrometric chart (See CHART 3) lay out how a system utilizing constant discharge air temperature would work in a typical space. See line C-D. Nailor has chosen 52ºF. as an optimum discharge air temperature for fan coil operation using the unique Nailor stand-alone temperature controls for fan coils.



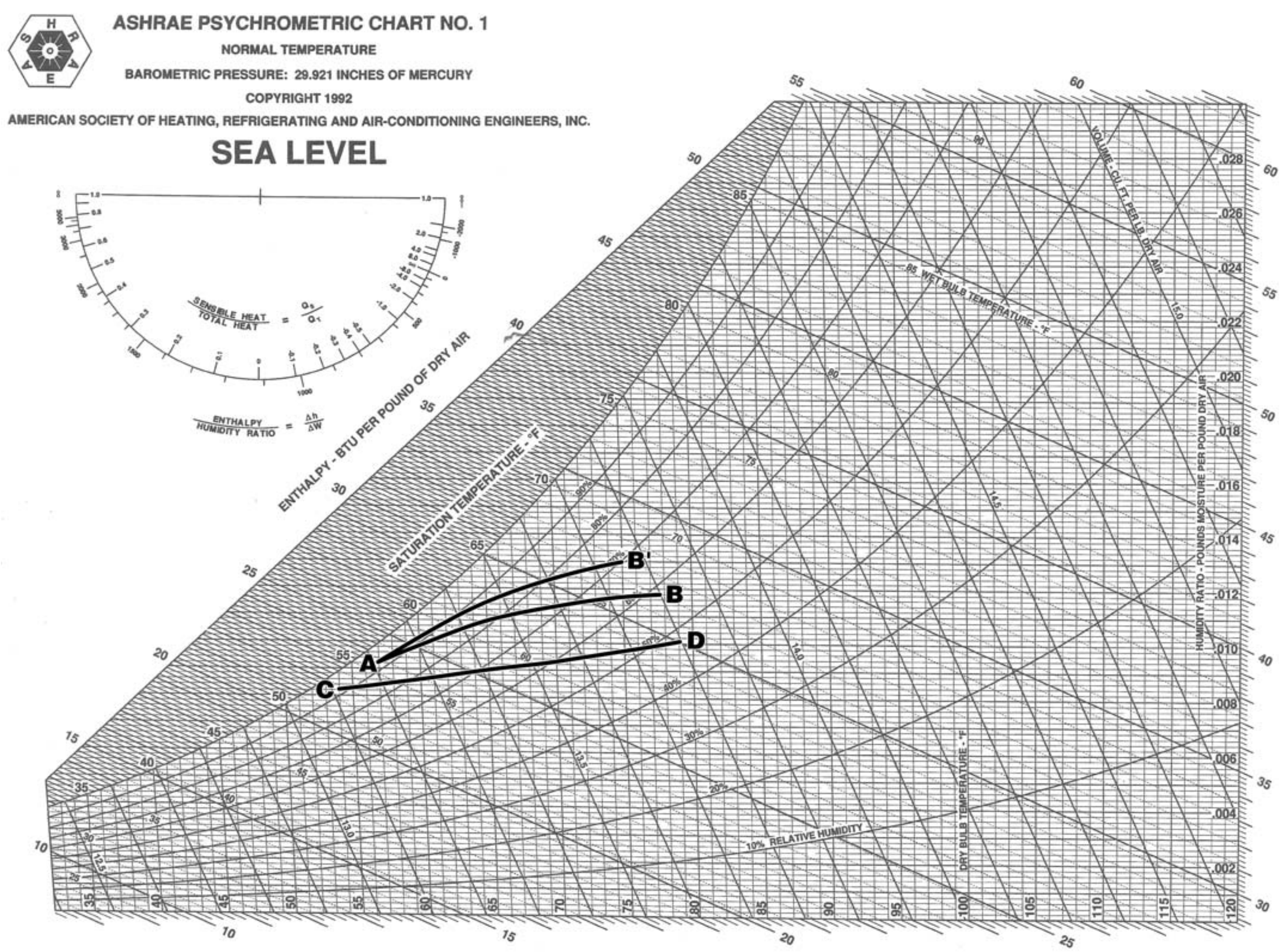


Chart 3: Psychrometric Chart

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