



# General HVAC Recommendations

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## DESIGN GUIDELINES FOR ENERGY EFFICIENT HVAC SYSTEMS

Thank you for your interest in energy efficiency! Energy efficient heating, ventilation, and air conditioning (HVAC) equipment reduces operational costs and environmental impacts. Our recommended guidelines for HVAC equipment, intended for use in both retrofit and new construction applications, are based on those from the Consortium for Energy Efficiency's (CEE) and New Building Institute's (NBI) Core Performance Guides. CEE is a nonprofit public-benefits corporation that develops initiatives to promote the manufacture and purchase of energy-efficient products and services, and NBI is a nonprofit organization that seeks to improve energy performance of commercial buildings by advocating advanced design practices.

Through your electric utility's energy efficiency programs, CLEARResult helps building owners, architects and engineers evaluate the benefits of energy efficiency. Building owners are encouraged to assess and address their energy use through a variety of program-related services, including energy performance benchmarking, energy master planning, technical assistance and even public relations support. This document offers objective, third-party recommendations on best practices in the areas of energy usage and energy efficiency. These services are provided free of charge through your electric utility and are not intended to substitute for the services of paid professionals.

# HVAC Equipment Efficiencies

HVAC equipment consumes 40-60 percent of a building's energy use, according to the Department of Energy, meaning that significant savings can be realized through implementing energy-efficient measures. The following minimum recommendations from CEE and NBI are the most efficient yet cost effective recommendations published by a third-party non-profit group to date. Your bottom-line savings is important, so higher efficiency equipment should be evaluated on a life cycle cost basis to see if the first cost is justified by the energy savings over the expected life of the equipment.

Keep in mind that if you're looking to upgrade, you should consider HVAC equipment that meets or exceeds the minimum efficiencies outlined below. To compare efficiency upgrade costs, we recommend soliciting add-alternate bids for the different efficiency options.

## RECOMMENDED CHILLER EFFICIENCIES

Equipment Type	Size Category	Full Load Efficiency (kW/ton)	IPLV (kW/ton)
<b>Air Cooled with Condenser</b>	all sizes	1.23	0.94
<b>Water Cooled, Centrifugal</b>	≤ 150 tons	0.61 (0.63*)	0.62 (0.40*)
	> 150 tons and ≤ 300 tons	0.59 (0.60*)	0.56 (0.40*)
	> 300 tons and ≤ 600 tons	0.57 (0.58*)	0.51 (0.40*)
	> 600 tons	0.55 (0.55*)	0.51 (0.40*)
<b>Water Cooled, Non-Centrifugal</b>	≤ 90 tons	0.78	0.60
	> 90 tons and ≤ 150 tons	0.73	0.55
	> 150 tons and ≤ 300 tons	0.68	0.51
	> 300 tons	0.60	0.49

\*Efficiencies in parentheses are required efficiencies for chillers with variable frequency drive (VFD) 0.49

### Notes:

- Compliance with full load efficiency numbers and IPLV (part-load efficiency) numbers are both required.
- VFDs are optional in multiple-chiller applications. A single-chiller application requires VFDs.
- Water-cooled centrifugal chillers provide higher efficiencies at lower tonnages.
- Water-cooled centrifugal water-chilling packages that are not designed for operation at ARI Standard 550/590 test conditions of 44<sup>0</sup>F leaving chilled water and 85<sup>0</sup>F entering condenser water shall meet applicable full load and IPLV requirements.

## RECOMMENDED AIR CONDITIONER AND HEAT PUMP EFFICIENCIES

Equipment Type	Size Category	Full Load Efficiency	Part Load/Seasonal
Air Conditioner (air cooled)	≤ 5.42 tons	12.5 EER	15.0 SEER
	> 5.42 tons and ≤ 11.25 tons	12.2 EER	14.0 IEER
	> 11.25 tons and ≤ 20 tons	12.0 EER	13.2 IEER
	> 20 tons	10.8 EER	12.3 IEER
Heat Pump (air cooled)	≤ 5.42 tons	12.5 EER	15.0 SEER
	> 5.42 tons and ≤ 11.25 tons	11.3 EER	12.1 IEER
	> 11.25 tons and ≤ 20 tons	10.9 EER	11.7 IEER
	> 20 tons	10.3 EER	10.7 IEER

## Recommended System Features

The following system features are proven to enhance energy efficiency in most HVAC systems. **We recommend that these features be incorporated into the mechanical system design.**

### PROGRAMMABLE THERMOSTATS/SETBACK CONTROLS

Setback controls adjust space setpoint temperature and reduce or eliminate ventilation during unoccupied periods. Controls should consist of *optimum start controls* that will allow for conditioning to begin prior to scheduled occupancy time, such that the setpoint temperature will be met at the time of occupancy.

### DEMAND CONTROL VENTILATION

Demand control ventilation (DCV) allows for accurate building ventilation through feedback from carbon dioxide (CO<sub>2</sub>) sensors. Outside air is expensive to condition, especially in hot, humid climates. DCV offers a potential to save significant energy in areas where occupancy is highly variable or irregular such as meeting rooms, studios, theaters, and educational facilities. CO<sub>2</sub> controls should allow for both a reduction of outside air flow when occupancy is low and an increase in outside air flow beyond minimum set points when occupancy is high.

### ECONOMIZER CONTROLS

All units supplying fresh outdoor air should be equipped with enthalpy-based economizing for “free” cooling. Such controls monitor both indoor and outdoor air temperature and humidity, and switch the system into “economizer” mode when two conditions are met: 1) outdoor air enthalpy falls below indoor air enthalpy and 2) the zone is in cooling mode. In economizer mode, the system draws sufficient outdoor air to offset the cooling load

### ENERGY RECOVERY SYSTEMS

Energy recovery systems transfer heat between conditioned air exiting the building and incoming outdoor air. Energy recovery systems include heat pipes, air-to-air heat exchangers, and heat wheels. Heat wheels are sometimes treated with desiccants, which transfer humidity and are especially useful in hot, humid climates when attempting to condition latent air. Depending on climate, Energy Recovery Ventilators (ERV) are recommended in ventilation systems with a high percentage of outside air. ERV should only be considered on ventilation systems with more than 70 percent of their designed supply air consisting of outside air.

## UNDERFLOOR VENTILATION

Ventilation systems that deliver conditioned air from overhead require much mixing of air within a space before occupants can reap the comfort benefits. Underfloor ventilation can save energy by delivering conditioned air where it is needed. Consider employing underfloor ventilation in large rooms and spaces with high ceilings.

## VARIABLE FREQUENCY DRIVES

Variable frequency drives (VFDs or VSDs) modulate the speed of motor rotation. Install VFDs on any motor larger than 1 horsepower in the following situations:

- Supply fans in variable-air-volume air handling units
- Pumps that operate under variable load in the primary loop of a chiller system
- Cooling tower fans—control VFDs on cooling tower fans such that all coupled cooling towers ramp up and down as one large cooling tower

# Example HVAC Specifications

## NEW CONSTRUCTION AND RETROFITS

- A. The HVAC system shall be commissioned after construction has completed. The commissioning agent will ensure all equipment is operating as designed in a properly functioning system.
- B. All cooling equipment shall meet any applicable building and energy codes and shall comply with the efficiencies recommended in this document.
- C. Retrofit designs shall be based on new load calculations for the entire facility as it currently functions.

## CONTROLS

- A. HVAC controls will incorporate setback temperatures during unoccupied periods. The controls may determine occupancy through either occupancy sensors or time clocks.
  - a. Occupied Mode: the cooling setpoint shall be 74°F (adjustable), and the heating setpoint shall be 68°F (adjustable).
  - b. Unoccupied Mode: the cooling setpoint shall be 79°F (adjustable), and the heating setpoint shall be 63°F (adjustable).
- B. When the outside air temperature drops below 74°F (adjustable) and the HVAC system is in cooling mode, the HVAC system will go into economizer mode—the outside air dampers will open 100%, and the cooling coils will be set to off.
- C. Large rooms with highly varying occupancy shall employ demand control ventilation (DCV) system to monitor CO<sub>2</sub> concentration within the space and outside.
  - a. CO<sub>2</sub> setpoint shall be 500parts per million (PPM, adjustable) higher than outdoor CO<sub>2</sub> levels.
  - b. CO<sub>2</sub> levels shall not be allowed to exceed 1,000 PPM.