General Recommendations
HVAC New Construction

Program Year, 2024

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Contents

DESIGN GUIDELINES FOR ENERGY EFFICIENT HVAC SYSTEMS

Thank you for your interest in energy efficiency! Energy-efficient heating, ventilation, and air conditioning (HVAC) equipment can significantly reduce operational costs and environmental impacts. Our recommended guidelines for HVAC equipment, applicable to both retrofit and new construction applications, are based on the International Energy Conservation Code (IECC) 2021.

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

HVAC Equipment Efficiencies

HVAC equipment, according to the Department of Energy, accounts for 40-60 percent of a building's energy use. This implies that substantial savings can be achieved by implementing energy-efficient measures. The minimum recommendations for air conditioners and heat pumps are derived from the International Energy Conservation Code (IECC) 2021, one of the most progressive energy codes published to date.

Given the importance of your bottom-line savings, it is crucial to evaluate higher efficiency equipment based on a life cycle cost analysis. This allows you to determine whether the initial cost is justified by the energy savings over the expected life of the equipment.

If you are considering an upgrade, it's advisable to choose HVAC equipment that meets or exceeds the minimum efficiencies outlined below. To compare the costs of efficiency upgrades, we recommend obtaining add-alternate bids for different efficiency options.

RECOMMENDED AIR CONDITIONER EFFICIENCIES				
Equipment Type	**Size Category**	**Heat Type**	**System Type**	**Minimum Efficiency**
Air Conditioners (Air Cooled)	< 65,000 Btu/h	All	Split system	13.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023
		All	Split system	14.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance	Split system and Single package	11.2 EER 12.9 IEER before 1/1/2023 14.8 IEER after 1/1/2023
		Other		11.0 EER 12.7 IEER before 1/1/2023 14.6 IEER after 1/1/2023
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance	Split system and Single package	11.0 EER 12.4 IEER before 1/1/2023 14.2 IEER after 1/1/2023
		Other		10.8 EER 12.2 IEER before 1/1/2023 14.0 IEER after 1/1/2023
	≥ 240,000 Btu/h and <760,000 Btu/h	Electric Resistance	Split system and Single package	10.0 EER 11.6 IEER before 1/1/2023 13.2 IEER after 1/1/2023
		Other		9.8 EER 11.4 IEER before 1/1/2023 13.0 IEER after 1/1/2023
	≥ 760,000 Btu/h	Electric Resistance	Split system and Single package	9.7 EER 11.2 IEER before 1/1/2023 12.5 IEER after 1/1/2023
		Other		9.5 EER 11.0 IEER before 1/1/2023 12.3 IEER after 1/1/2023
Source: 2021 International Energy Conservation Code (IECC) Table C403.3.2(1)				

RECOMMENDED HEAT PUMP EFFICIENCIES				
Equipment Type	**Size Category**	**Heat Type**	**System Type**	**Minimum Efficiency (Cooling)**
Heat Pump (Air Cooled)	< 65,000 Btu/h	All	Split System	14.0 SEER before 1/1/2023 14.3 SEER2 after 1/1/2023
		All	Single Package	14.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance	Split system and Single package	11.0 EER, 12.2 IEER before 1/1/2023 14.1 IEER after 1/1/2023
		Other		10.8 EER, 12.0 IEER before 1/1/2023 13.9 IEER after 1/1/2023
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance	Split system and Single package	10.6 EER, 11.6 IEER before 1/1/2023 13.5 IEER after 1/1/2023
		Other		10.4 EER, 11.4 IEER before 1/1/2023 13.3 IEER after 1/1/2023
	≥ 240,000 Btu/h	Electric Resistance	Split system and Single package	9.5 EER, 10.6 IEER before 1/1/2023 12.5 IEER after 1/1/2023
		Other		9.3 EER, 10.4 IEER before 1/1/2023 12.3 IEER after 1/1/2023
Source: 2021 International Energy Conservation Code (IECC) Table C403.3.2(2)				

“PATH A” And “PATH B” Chillers

In large chiller plants, some chillers may be designed to operate primarily at part-load. These chillers boast high part-load efficiencies and adhere to compliance "Path B" in an energy code. On the other hand, typical chillers are designed for full-load efficiency and follow code compliance "Path A." It's important to note that a chiller must meet the minimum requirements for both full-load efficiency and Integrated Part Load Efficiency (IPLV) for either Path A or Path B to comply with a specific building code.

In the following tables, we recommend the chiller efficiencies advocated by the International Energy Conservation Code (IECC) 2021, one of the most progressive energy codes published to date. For minimum efficiency recommendations for other types of HVAC equipment, please consult IECC 2021.

RECOMMENDED MINIMUM AIR-COOLED CHILLER EFFICIENCIES					
Equipment Type	Size Category	Path A		Path B	
		Full Load Efficiency (EER)	IPLV (EER)	Full Load Efficiency (EER)	IPLV (EER)
Air Cooled with Condenser	< 150 tons	10.1	13.7	9.7	15.8
	≥ 150 tons	10.1	14.0	9.7	16.1
Source: 2021 International Energy Conservation Code (IECC) Table C403.3.2(3)					

RECOMMENDED MINIMUM WATER-COOLED CHILLER EFFICIENCIES					
Equipment Type	Size Category	Path A		Path B	
		Full Load Efficiency (kW/ton)	IPLV (kW/ton)	Full Load Efficiency (kW/ton)	IPLV (kW/ton)
Water Cooled, Centrifugal	< 150 tons	0.61	0.55	0.695	0.44
	≥ 150 tons and< 300 tons	0.61	0.55	0.635	0.40
	≥ 300 tons and < 400 tons	0.56	0.52	0.595	0.39
	≥ 400 tons and< 600 tons	0.56	0.50	0.585	0.38
	≥ 600 tons	0.56	0.50	0.585	0.38
Water Cooled, Non -Centrifugal	< 75 tons	0.75	0.6	0.78	0.5
	≥ 75 tons and < 150 tons	0.72	0.56	0.75	0.49
	≥ 150 tons and < 300 tons	0.66	0.54	0.68	0.44
	≥ 300 tons and < 600 tons	0.61	0.52	0.625	0.41
	≥ 600 tons	0.56	0.50	0.585	0.38
Source: 2021 International Energy Conservation Code (IECC) Table C403.3.2(3)					

Recommended System Features

The following system features have proven to enhance energy efficiency in most HVAC systems, and we recommend incorporating these features into the mechanical system design. It's important to note that while chillers, air-cooled air conditioners, and heat pumps qualify for simple deemed savings in most energy efficiency program jurisdictions, many of the following features only qualify for incentives in a retrofit scenario where measurement and verification have been performed to quantify energy savings.

1. **Programmable Thermostats/Setback Controls:** Setback controls adjust space setpoint temperature and reduce or eliminate ventilation during unoccupied periods. Controls should include optimum start controls that allow conditioning to begin before scheduled occupancy time, ensuring the setpoint temperature is met at the time of occupancy.

2. **Demand Control Ventilation (DCV):** DCV allows for accurate building ventilation through feedback from carbon dioxide (CO2) sensors. It offers significant energy savings in areas with variable or irregular occupancy, such as meeting rooms, studios, theaters, and educational facilities. CO2 controls should enable a reduction in outside airflow when occupancy is low and an increase in outside airflow beyond the minimum set points when occupancy is high.

3. **Economizer Controls:** All units supplying fresh outdoor air should be equipped with enthalpy-based economizing for "free" cooling. These controls monitor indoor and outdoor air temperature and humidity, switching the system into "economizer" mode when outdoor air enthalpy falls below indoor air enthalpy and the zone is in cooling mode. In economizer mode, the system draws sufficient outdoor air to offset the cooling load.

4. **Energy Recovery Systems:** These systems transfer heat between conditioned air exiting the building and incoming outdoor air. Options include heat pipes, air-to-air heat exchangers, and heat wheels. Depending on the climate, Energy Recovery Ventilators (ERV) are recommended in ventilation systems with a high percentage of outside air.

5. **Underfloor Ventilation:** Consider underfloor ventilation in large rooms and spaces with high ceilings to deliver conditioned air where it is needed, saving energy compared to overhead ventilation systems.

6. **Variable Frequency Drives (VFDs or VSDs):** Install VFDs on any motor larger than 1 horsepower in situations such as supply fans in variable-air-volume air handling units, pumps operating under variable load in the primary loop of a chiller system, and cooling tower fans.

7. **Part-Load Chillers:** In large chiller plants, some chillers may be designed to operate primarily at part-load, utilizing multiple-stage compressors, variable frequency drives, and/or magnetic frictionless bearings to achieve superior part-load efficiency.

8. **Ductless Mini-Split:** "Mini-Splits" are ideal for small areas with unusual or constant loads that do not require fresh outdoor "make-up" air, commonly used in data server closets and large electrical rooms in new buildings.

9. **High-Volume Low-Speed (HVLS) Fans:** HVLS fans, also known as "circulation fans" or "destratification fans," are recommended for large spaces that are not air-conditioned. As of

2022, Texas incentivizes these fans in agricultural applications only, with potential inclusion in other applications in future versions of the Texas Technical Reference Manual.

Unusual System Types

Water-Source Heat Pumps: Water is generally a more efficient heat sink than air, allowing HVAC condensers to be water-cooled instead of air-cooled. Water-cooled air conditioners and heat pumps utilize a building water loop with its own set of pumps. In a typical water-source heat pump system, the water loop passes through a cooling tower. In a geothermal heat pump system, the water loop goes through ground wells or submerged heat exchangers to reject system heat. Due to the thermal properties of water, these systems can be highly efficient. It's important to note that a custom measurement and verification approach is required for assessing energy savings within most energy efficiency incentive programs.

Variable Refrigerant Systems (VRF, VRV, Multisplit): HVAC systems with variable-flow refrigerant compressors, known as "Multi-Splits," Variable Refrigerant Volume (VRV), or Variable Refrigerant Flow (VRF) systems, are relatively new in the US market but gaining popularity domestically and abroad. Unlike typical air conditioner or heat pump systems, one condenser connects to multiple indoor fan coil units through refrigerant lines. These systems can provide simultaneous heating and cooling to different zones within a building. However, it's essential to note that Variable Refrigerant systems typically require supplemental conventional HVAC units to provide fresh "make-up" air. Custom measurement and verification are necessary for assessing energy savings within most energy efficiency incentive programs.

Evaporative Pre-Cooling: In dry climates, evaporative (swamp) cooling can be used to reduce the outside air temperature before cooling the condenser coil on DX air conditioners and chillers. Evaporative cooling occurs when incoming air passes through water-saturated media or a mist wall, lowering the air’s dry-bulb temperature. Colder condenser air increases the condenser’s heat rejection capacity, enhancing the air conditioner's efficiency. As of 2022, this type of system qualifies for incentives in Texas.

Applicable evaporative pre-cooling product types include:

- Evaporative media panels that incoming air must pass through.
- Misting-based systems that spray fine droplets into the air in front of the air intake area.

Eligible systems must include:

- Chemical or mechanical water treatment (with periodic purge control for sump-based systems).
- A control system (temperature controls for sump-based systems, enthalpy controls for mist-based systems).
- All air to condenser coils must pass through the evaporative pre-cooling system.
- Installation by a qualified contractor, along with commissioning.
- Evaporative effectiveness performance of at least 75% for the average dry bulb temperature and humidity during peak hours.

- Operation manuals provided.

Computer Room Air Conditioners (CRAC): A CRAC unit monitors and maintains temperature, air distribution, and humidity in a network room or data center. Due to the distinct cooling needs of data centers and network rooms compared to people-occupied spaces, a dedicated CRAC system can often save significant energy compared to using comfort cooling for these spaces. As of 2022, efficient CRAC systems are eligible for deemed savings in Texas.

Example HVAC Specifications

New Construction and Retrofits:

A. The HVAC system shall undergo commissioning after the completion of construction. The commissioning agent must ensure that all equipment operates as designed within a properly functioning system.
B. All cooling equipment must meet applicable building and energy codes and comply with the efficiencies recommended in this document.
C. Retrofit designs should 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 must determine occupancy through either occupancy sensors or time clocks.
   a. Occupied Mode: The cooling setpoint shall be 74^{o}F (adjustable), and the heating setpoint shall be 68^{o}F (adjustable).
   b. Unoccupied Mode: The cooling setpoint shall be 79^{o}F (adjustable), and the heating setpoint shall be 63^{o}F (adjustable).
B. When the outside air temperature drops below 74^{o}F (adjustable) and the HVAC system is in cooling mode, the HVAC system shall enter 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 a demand control ventilation (DCV) system to monitor CO2 concentration within the space and outside.
   a. The CO2 setpoint shall be 500 parts per million (PPM, adjustable) higher than outdoor CO2 levels.
   b. CO2 levels shall not be allowed to exceed 1,000 PPM.