U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

FEDERAL ENERGY MANAGEMENT PROGRAM

The U.S. Department of Energy's (DOE) Federal Energy Management Program (FEMP) facilitates the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship.

PURCHASING SPECIFICATIONS FOR ENERGY-EFFICIENT PRODUCTS

Air-Cooled Electric Chillers

Legal Authorities

Federal agencies are required by the National Energy Conservation Policy Act (P.L. 95-619), Executive Order 13423, and Federal Acquisition Regulations (FAR) Subpart 23.2 and 53.223 to specify and buy ENERGY STAR® qualified products or, in categories not included in the ENERGY STAR program, FEMP designated products, which are among the highest 25 percent of equivalent products for energy efficiency.

Performance Requirements for Federal Purchases[a]

Compressor Type and Capacity	Part-Load Optimized Required IPLV[b]	Full-Load Optimized Required Full-Load
Scroll (less than 150 tons)	0.80 kW/ton or less[c] (15.00 EER or more)	1.19 kW/ton or less (10.12 EER or more)
Scroll (150 tons or more)	0.87 kW/ton or less (13.74 EER or more)	1.26 kW/ton or less (9.56 EER or more)
Screw (less than 150 tons)	0.96 kW/ton or less (12.50 EER or more)	1.26 kW/ton or less (9.56 EER or more)
Screw (150 tons or more)	0.94 kW/ton or less (12.75 EER or more)	1.22 kW/ton or less (9.84 EER or more)

a) Depending on the application, buyers should specify chiller efficiency using either full-load or integrated part-load values as shown.
b) Values are based on standard rating conditions as specified in ARI Standard 550/590-2003. Only packaged chillers (i.e., none with remote condensers) are covered.
c) Performance requirements are provided in both kilowatt (kW)/ton and energy efficiency ratio (EER) units for convenience. When comparing air-cooled and water-cooled chillers, kW/ton is a common metric. When comparing only air-cooled chillers, EER is a common metric.

Buying Energy-Efficient Air-Cooled Chillers

Buyers should decide whether to emphasize full-load or part-load efficiency for their application. Integrated part-load value (IPLV) is preferred for more variable loads and variable ambient temperature and humidity, a situation common for air-cooled chiller applications. However, buyers may wish to put more emphasis on full-load performance in installations with staged chillers, or in locations where peak demand and demand charges are a primary concern. When selecting an air-cooled chiller, specify an energy consumption rate (in kW/ton) that meets the recommended level for that compressor type. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) lists manufacturer catalogues and software with AHRI-certified ratings in its Applied Directory at *ahridirectory.org*.

When to Choose an Air-Cooled Chiller

When deciding on a chilled water system, designers must choose either an air- or water-cooled chiller. Air-cooled systems eliminate the need for a cooling tower, reducing installation and maintenance costs. However, air-cooled chillers are substantially less efficient than water-cooled models (see *FEMP Designated Product: Water-Cooled Electric Chiller*). To compare air- and water-cooled options, a detailed life-cycle cost analysis can be performed using Building Life-Cycle Cost (BLCC) software available through FEMP.

Environmental Tips

Refrigerants with ozone-destroying chlorofluorocarbons (CFCs) were common in older chillers but are no longer used in new equipment. The 1992 Montreal Protocol banned the production of CFCs in the U.S. beginning in 1996. More-recent equipment used hydrochlorofluorocarbon (HCFC) refrigerants, but these have also been eliminated for use in new equipment.

Owners and operators of chillers with CFCs are faced with three options: 1) continue to operate their chillers with CFCs, which exposes them to the high cost of obtaining the refrigerant from a dwindling reclaimed supply; 2) convert the chillers to use a non-CFC refrigerant, which usually results in some loss in cooling capacity (see "Sizing," below); or 3) replace the equipment, which requires a substantial capital outlay. These options should be evaluated using life-cycle cost analysis. A detailed life-cycle cost analysis can be performed using Building Life-Cycle Cost (BLCC) software available through FEMP.

It is important when considering the continued operation of chillers with CFCs to assess the process of refrigerant recovery, followed by recycling or reclamation, and to factor in the likely increase in the cost of obtaining replacement CFCs.

When retiring a chiller that contains CFCs or HCFCs, the Clean Air Act requires that the refrigerant is recovered on-site by a certified technician. (For more information, call the Stratospheric Ozone Information Hotline at 800-296-1996.)

Sizing

When selecting a chiller, careful attention to appropriate sizing is critical. An oversized chiller not only costs more to purchase but also wastes energy due to poor low-load performance and excessive cycling. Use the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) calculation procedure to determine the cooling load. It is often cost effective to combine a chiller replacement with other measures that reduce cooling load, permitting specification of smaller capacity chillers. Lawrence Berkeley National Laboratory's Cool $ense project provides guidance at *ateam.lbl.gov/coolsense*.

Cost-Effectiveness Example — 100-ton Screw Chiller

Performance	Base Model[a]	Required Level	Best Available
IPLV Efficiency (kW/ton)	0.96	0.80	0.72
Annual Energy Use (kWh)	192,000	160,000	144,200
Annual Energy Cost	$17,280	$14,400	$12,978
Lifetime Energy Cost	$268,704	$223,920	$201,806
Lifetime Energy Cost Savings	**—**	**$44,784**	**$66,896**

a) The efficiency of the base model is just sufficient to meet ASHRAE Standard 90.1-2004.

Cost-Effectiveness Assumptions

Annual Energy Use is based on 2,000 equivalent full-load hours per year. *IPLV Efficiency* is compared since air-cooled chillers are generally installed in applications with highly variable load conditions. The assumed electricity price is $0.09 per kilowatt-hour (kWh), the Federal average electricity price (including demand charges) in the U.S. Since this average cost does not incorporate the disproportionately large portion of demand costs that chillers usually contribute, the cost savings shown in the table may be conservative. *Lifetime Energy Cost* is the sum of the discounted value of the *Annual Energy Cost*, based on average usage and an assumed chiller life of 23 years. Future electricity price trends and a discount rate of three percent are based on Federal guidelines (effective April 2010 to March 2011).

Using the Cost-Effectiveness Example

In the example shown above, a 100-ton air-cooled screw chiller with an IPLV efficiency rating of 0.80 kW/ton is cost effective if its purchase price is no more than $44,784 above the price of the *Base Model*. The *Best Available* screw model, with an efficiency of 0.72 kW/ton, is cost effective if its price is no more than $66,896 above the *Base Model*. FEMP provides a Web-based cost calculator screening tool that simplifies the energy cost comparison between different air-cooled chillers. This cost calculator is available online at *femp.energy.gov/technologies/eep_ac_chillers_calc.html*.

For More Information:

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www.femp.energy.gov

FEMP Product Procurement
www.femp.energy.gov/procurement

Lawrence Berkeley National Laboratory
202-488-2250
www.lbl.gov

LBNL Cool $ense
ateam.lbl.gov/coolsense/

American Council for an Energy-Efficient Economy (ACEEE)
Guide to Energy-Efficient Commercial Equipment
202-429-0063
www.aceee.org

American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE)
Cooling and Heating Load Calculation Manual
800-527-4723
www.ashrae.org

Air-Conditioning, Heating, and Refrigeration Institute (AHRI)
Applied Directory and Prime Net
703-524-8800
www.ahrinet.org

E Source
Electric Chillers Buyer's Guide
303-440-8500
www.esource.com

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