MEASURE 2.2.1 Keep the chilled water supply temperature as high as possible.

Keeping the chilled water temperature as high as possible provides major energy savings. Manufacturers' technical literature shows a saving of approximately two percent of input energy per degree Fahrenheit (or about four percent per degree Celsius) that the chilled water temperature is raised. This number applies to all types of chillers, with minor variations. Figure 1 shows how COP improves with increasing chilled water temperature, for a typical chiller.

This simple procedure applies to virtually all chilled water systems. Raising the chilled water temperature generally does not create any risks to equipment. And, it costs little or nothing to accomplish.

The amount that you can increase the chilled water temperature is limited only by the need to satisfy the cooling load. Most of the work of accomplishing this Measure consists of determining the maximum allowable chilled water temperatures over the range of cooling loads. The two subsidiary Measures offer manual and automatic methods, respectively.

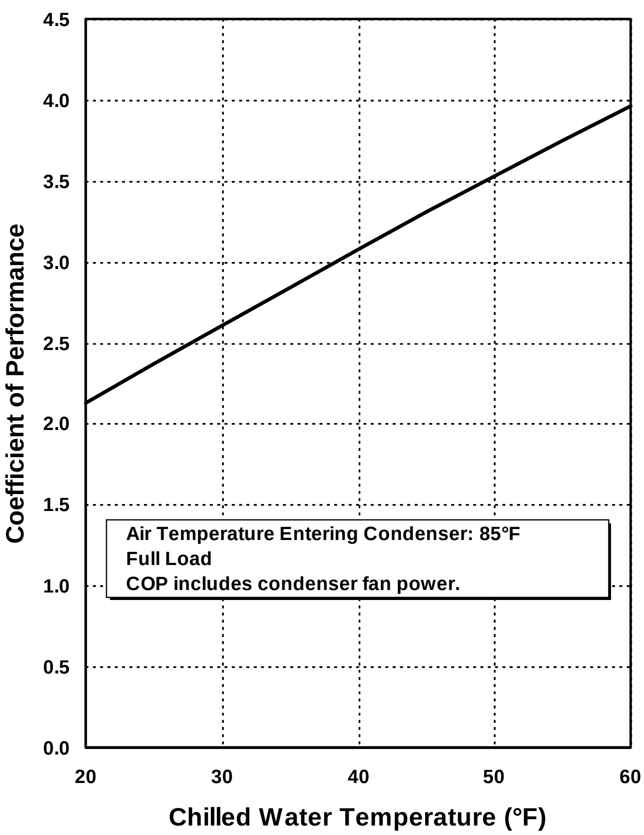


Fig. 1 Improve chiller COP dramatically by raising the chilled water temperature This curve is for a typical centrifugal chiller. Similar improvement is available with other types of chillers.

The Potential for Raising Chilled Water Temperature

Chilled water systems are commonly designed to provide full cooling load with a chilled water temperature of about 42°F. Plant operators typically leave the chilled water temperature fixed at this value or some other. This is inefficient for most applications, such as air conditioning, where the load is well below its maximum most of the time. Typically, you can raise the chilled water temperature by 5°F to 10°F for much of the time. Even at full load, the typical oversizing of airside components (air handling units, fan-coil units, etc.) usually allows some increase in chilled water temperature.

A single space or a small number of spaces may require colder chilled water than is needed by the rest of the facility. In such cases, determine the limiting factor (e.g., inadequate air flow to the space) in the offending spaces. Consider spending some money to eliminate the problem in order to reap the savings that result from higher chilled water temperature.

Compromise with Fan Power in VAV Systems

In a variable-air-volume (VAV) air handling system, space cooling is controlled by varying the supply air flow, and the supply air temperature is nominally kept constant. Raising the chilled water temperature may raise the air temperature, which will cause the fans to operate at higher power.

Typically, more energy is saved in the chiller than is lost in the fans, so the best efficiency is usually produced by raising the chilled water temperature as much as possible. However, this may not be true in all cases. In case of doubt, calculate the optimum compromise between chiller power and fan power.

Compromise with Pump Power in Variable-Flow Chilled Water Systems

A variable-flow chilled water system saves pump energy by distributing chilled water only in the quantities needed by the air handling systems and older equipment. (Older conventional design bypassed unused chilled water around the user equipment.) In a variable-flow system, increasing the chilled water temperature increases the amount of chilled water that must be pumped, for a given cooling load.

Typically, you save more energy in the chiller than you lose in the pumps, so you get the best efficiency by raising the chilled water temperature as much as possible. However, this may not be true in all cases. In case of doubt, calculate the optimum compromise between chiller power and pump power.

MEASURE 2.2.1.1 Reset chilled water temperature manually.

RATINGS

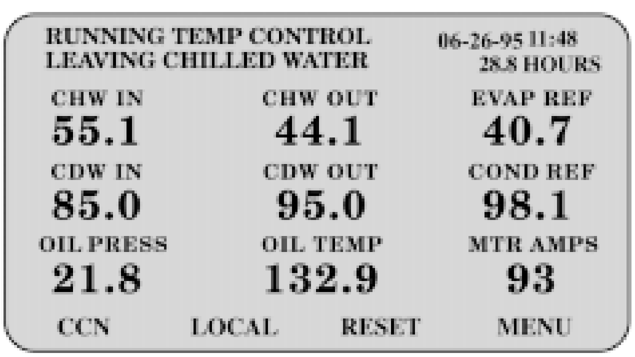
New Facilities	Retrofit	O&M
		A

This is the first of two subsidiary Measures that optimize the chilled water temperature. The simplest and cheapest method is to set it manually at the chiller control panel. See Figure 1.

The practical limitation with manual resetting is that the cooling load changes continuously. Don't expect operators to keep the chilled water temperature fine-tuned on a continuing basis. Therefore, manual adjustment is practical primarily in response to seasonal changes in cooling load. This limits savings to perhaps less than half the potential maximum savings, which can be achieved only with automatic reset controls (recommended by subsidiary Measure 2.2.1.2, coming up next).

If your budget limits you to setting the chilled water temperature manually, give your chiller operators a table of chilled water temperature settings to follow. You have to develop this table from experience over a period of time. As conditions change, raise the chilled water temperature until cooling capacity becomes inadequate at some location in the facility, and note the conditions (the time of day, the outside air temperature, the percentage of occupancy, etc.). Repeat this until you have covered all conditions.

For convenience, schedule chilled water temperature adjustments at the same time as condenser water temperature adjustments. See Measure 2.2.2.1 about this.



Carrier Corporation

Fig. 1 Critical temperatures This display on the control panel of a modern chiller shows you the critical temperatures that determine the efficiency of the machine. However, you have to figure out the specific temperatures to set.

SUMMARY

Usually as simple as turning a knob. The main weakness of manual control is inability to track continuously changing cooling load.

SELECTION SCORECARD

Savings Potential .... $ $ $

Rate of Return .... % % % %

Reliability .... ✓ ✓

Ease of Initiation .... ☺ ☺

ECONOMICS

SAVINGS POTENTIAL: *4 to 10 percent of the average annual chiller energy consumption. The saving is partially reduced by increased fan power in variable-air-volume (VAV) air handling systems, and by increased pump power in variable-flow chilled water systems.*

COST: *Minimal.*

PAYBACK PERIOD: *Immediate.*

TRAPS & TRICKS

DILIGENCE: *This activity is easy to neglect. The optimum chilled water temperature takes some effort to find. Also, it is tempting to lower chilled water temperature in response to cooling complaints that have not been adequately diagnosed. Provide effective instructions, and schedule periodic checks of the procedure in your maintenance calendar.*

MEASURE 2.2.1.2 Install an automatic chilled water temperature controller.

RATINGS

New Facilities	Retrofit	O&M
A	B	

SUMMARY

The preferred way to control chilled water temperature.

SELECTION SCORECARD

Savings Potential .... $ $ $

Rate of Return, New Facilities % % % %

Rate of Return, Retrofit .... % % % %

Reliability .... ✓ ✓

Ease of Retrofit..................... ☺ ☺ ☺

This is the second, and preferable, method of optimizing chilled water temperature. Wherever it is economical to do so, reset the chilled water temperature using an automatic control. This is a simple, common control function that can be accomplished with a few standard control components. You can also use your energy management computer system for this purpose, if you have one. Some manufacturers offer specialized chiller controllers that perform this function.

The challenge with automatic controls is designing them to maintain the most efficient relationship between the chilled water temperature and the cooling load. Failing to do this accurately wastes some of the savings potential of the Measure, or causes comfort problems. The cooling load relates to several conditions, including the outside air temperature, the humidity, the amount of sunshine, the number of occupants, and the heat emitted by equipment.

The most accurate way of responding to the cooling load is to use the signals from the space thermostats. When the signal from any one thermostat indicates that the airside unit is unable to satisfy the load in that space, the chilled water temperature is lowered incrementally. See Reference Note 14, Control Signal Polling, for methods of selecting the critical thermostat signal.

A cruder method of controlling chilled water is to sense the load at the chiller, for example, by sensing the difference between the supply and return chilled water temperatures. This method is less accurate than sensing space loads directly, but it is simple, cheap, and reliable.

With either method, do not let a single space or piece of equipment force the entire chiller system to operate at a much lower chilled water temperature. See Measure 2.2.1 about this.

ECONOMICS

SAVINGS POTENTIAL: *5 to 15 percent of annual chiller energy consumption. The saving is partially reduced by increased fan power in variable-air-volume (VAV) air handling systems, and by increased pump power in variable-flow chilled water systems.*

COST: *Several thousand dollars, typically, for a specialized reset controller. The cost of programming an energy management computer system to perform this function is typically about the same, but may be much higher.*

PAYBACK PERIOD: *Typically less than one year, with larger chiller systems. Up to several years, with small systems.*

TRAPS & TRICKS

DESIGN: *If the cooling system is complex, for example, if it includes variable-flow chilled water pumping or VAV air handling units, optimizing the chilled water temperature to achieve the lowest overall system energy consumption may be complex. Make sure that the control design is correct, keep the control as simple as possible, and make it easy to diagnose.*

OPERATION AND MAINTENANCE: *Select a control system that is compatible with the people who operate the chiller plant. For example, a common response to cooling complaints is to defeat any automatic chilled water controls and manually lower the chilled water temperature. Make sure that this sort of thing does not occur.*

DOCUMENTATION: *The purpose of the controls is not obvious. Put a clear description of the controls in the plant operating manual. (You do have a book of operating instructions for your plant, don't you?) Install an effective placard at the controls.*

MONITOR PERFORMANCE: *Failure of this kind of non-critical control is invisible. Schedule periodic checks in your maintenance calendar.*