



PRJ39/98

District Cooling System Design with 34°F (1°C) Supply Water Saves on *First Cost* and *Operating Cost!*



Large chilled water systems such as those used in modern District Cooling Plants are now being designed and operated using 34°F (1°C) chilled water in their distribution systems. This colder supply water temperature beneficially results in systems that are much lower in both first cost and in operating cost compared to systems based on 44°F supply water. Lower energy consumption also results in a system that is environmentally friendly. The comparisons below will demonstrate how these benefits are achieved.

This Project Report presents a comparison of a traditional 44°F (7°C) chilled water system versus a system designed around 34°F (1°C) chilled water supply. Both systems have a design return temperature of 54°F (12°C). The data used in this report is taken directly from several large operating district cooling systems. This report also provides sufficient information to allow users to make their own comparison using local conditions.



	44°F (7°C) Supply Water System	34°F (1°C) Supply Water System
Design Parameters		
Peak Plant Output, Tons	16,000	16,000
Chiller System Type	R-134a Centrifugal Chillers	R-717 Rotary Screw Chillers
Peak Hourly Chiller Capacity, Tons	16,000	10,685
Peak Hourly Ice Generating Capacity, Tons	N/A	6,000
Design Thermal Storage Capacity, Ton-Hours	N/A	55,600
Peak Hourly Capacity from Ice Storage, Tons	N/A	5,315
Heat Rejection Tons	18,900	12,589
Roof Plan Area for Cooling Towers, Ft2	17,010	11,330
Required Chilling Capacity, Tons	16,000	10,690
Building Area, Square feet	7,600	11,759
Refrigerant Quantity, Lbs	58,000	98,718
Plant Water Flow at Peak, GPM	38,400	19,200
Installed Brake Horsepower	19,044	12,837
Plant Distribution Pipe Size	36"	24"
Street Distribution Pipe Size	30"	18"
Demand Charge, \$/kW	\$12.00	\$12.00
On-Peak Electricity Cost, \$/kWH	\$0.06	\$0.06
Off-Peak Electricity Cost, \$/kWH	\$0.04	\$0.04
Equivalent Full-Load Hours	1200	1200
Piping Distribution Length, Feet	6,000	6,000
Design Return Water Temperature, °F	54.0	54.0
System First Cost		
Building & General Construction	\$6,784,321	\$5,653,065
Electrical	\$2,475,742	\$1,835,634
Mechanical	\$9,581,301	\$12,574,715
Street Distribution Piping	\$7,680,000	\$5,340,000
Building Heat Exchangers	\$4,480,000	\$2,880,000
Total Capital Costs	\$31,001,363	\$28,283,414
System Operating Cost		
Peak Demand kW	15,985	10,135
Total Annual kWH	16,334,261	16,002,313
Total Annual Electrical Cost	\$1,580,000	\$1,190,000

District Cooling Plant Cost Comparison

Conclusion: The first cost of the $34^{\circ}F$ System is \$2.7 million, or 8.8% lower than the $44^{\circ}F$ System. The annual operating cost of the $34^{\circ}F$ System is \$390,000, or 32.7% lower than the operating cost of the $44^{\circ}F$ system. In addition, the $34^{\circ}F$ System produces substantially less CO2 emissions (a by-product of electric power generation from fossil fuels), and is therefore more environmentally desirable.

The following table lists the breakdown of budget costs for a typical district cooling plant. You may substitute the cost estimates for your own particular application to compare the beneficial effects of 34°F supply water temperature on your project.

	44°F (7°C) Supply Water System	34°F (1°C) Supply Water System
Plant Cost Estimate		
Chiller Equipment	\$2,960,000	\$2,865,250
Cooling Towers & Evaporative Condensers	\$623,725	\$588,838
Pumping Equipment	\$551,905	\$402,106
Thermal Storage Equipment	N/A	\$2,957,920
Equipment Rigging	\$206,781	\$289,666
Mechanical Piping	\$2,560,000	\$2,711,200
Mechanical Insulation	\$844,800	\$894,696
Refrigerant	\$224,000	\$73,132
Plant Ventilation	\$16,733	\$99,934
Automation System	\$993,218	\$1,085,987
Electrical Equipment	\$2,475,742	\$1,835,634
Building Cost	\$3,960,000	\$2,645,775
Sales Tax (equipment & material)	\$600,138	\$624,536
Construction Costs	\$16,017,042	\$17,054,764
Project Management & Engineering	\$1,927,113	\$2,053,249
Project Contingency	\$897,208	\$955,401
Total Plant Cost	\$18,841,363	\$20,063,414
Street Distribution Piping Cost Estimate		
6,000 Linear Feet: Trenching & Restoration	\$5,820,000	\$3,960,000
12,000 Linear Feet of Supply & Return Pipe	\$1,860,000	\$1,380,000
Total Street Piping Cost	\$7,680,000	\$5,340,000
Total Building Connections Cost Estimate		
Heat Exchangers	\$960,000	\$422,400
Control Valves & Monitoring Stations	\$560,000	\$480,000
Piping, Erection & Insulation	\$2,960,000	\$1,977,600
Total Building Connections Cost	\$4,480,000	\$2,880,000
16,000 Ton Cooling System Total	\$31,001,363	\$28,283,414

System Cost Summary



BAC Utility District Cooling Projects with Ice Storage			
Name	City	Ton-Hours	
Franklin & Van Buren	Chicago, IL	125,000	
Columbus & Randolf	Chicago, IL	97,000	
State & Adams	Chicago, IL	66,000	
Comfortlink #1	Baltimore, MD	48,000	
Public Service of Colorado	Denver, CO	37,500	
Northwinds Boston #1	Boston, MA	32,000	
Cosmo Square	Osaka, Japan	29,300	
Alamodome	San Antonio, TX	19,300	
Ravens Football Stadium	Baltimore, MD	13,000	
Chauffage Urbain	Lyon, France	8,538	
Windsor Ontario	Windsor, Canada	8,500	
BAC Non-Utility District Cooling Projects with Ice Storage			
Name	City	Ton-Hours	
Stanford University	Palo Alto, CA	93,000	
Software Park Office Complex	Taipei, Taiwan	32,000	
University of Pennsylvania	Philadelphia, PA	22,000	
University of MD Medical	Baltimore, MD	14,800	
Homesaving Office Complex	Los Angeles, CA	13,600	
Johns Hopkins University	Baltimore, MD	11,200	
JHU Applied Physics Lab	Laurel, MD	8,400	
George Mason University	Fairfax, VA	7,500	
Goucher College	Baltimore, MD	5,760	
Lee College	Baytown,TX	5,535	
USF&G Office Complex	Baltimore, MD	5,500	
University of Miami	Miami, FL	3,660	
Montgomery College	Rockville, MD	2,440	
Montgomery College	Germantown, MD	2,440	
Howard Community College	Columbia, MD	1,058	



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