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Waterside Economizer

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Pre-Rulemaking Workshop
Imbrecht Hearing Room
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Acknowledgements

California Statewide Codes and Standards Team

CASE Authors:

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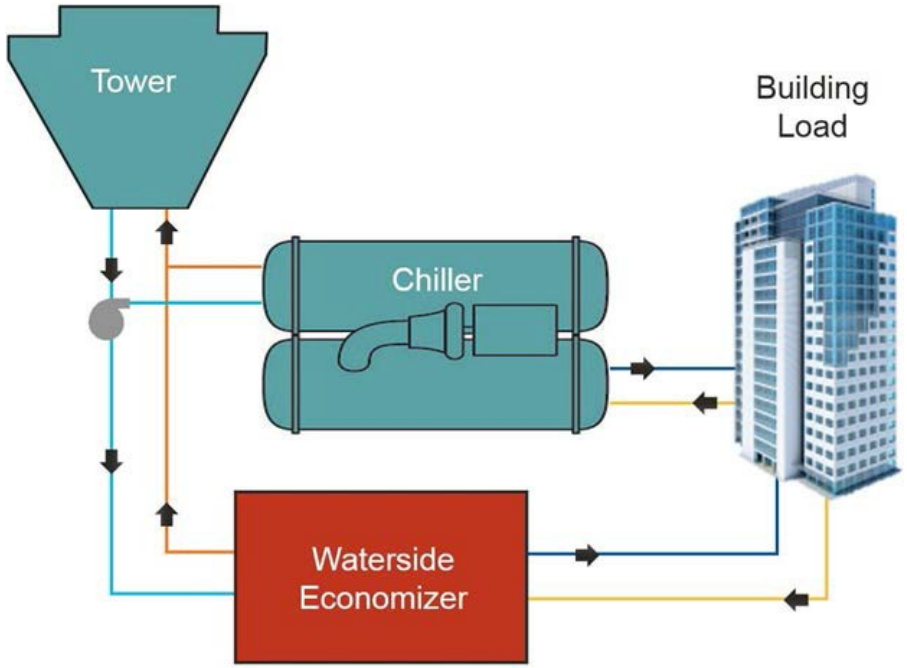
Background

Waterside Economizing:

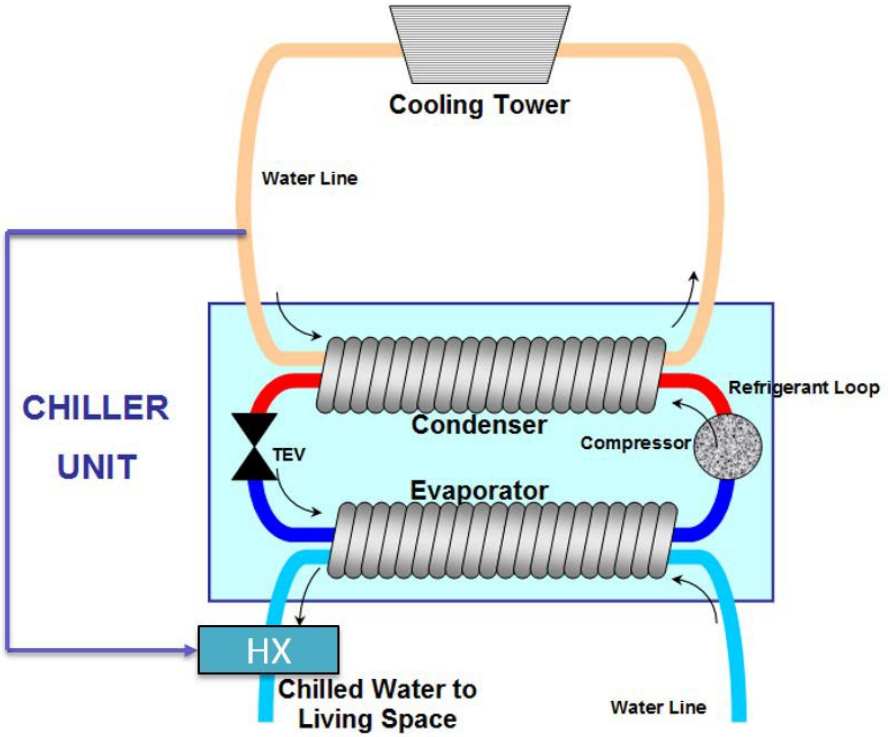
A method of using a chilled water plant's cooling towers to directly provide cooling for the chilled water plant, bypassing or working in series with the chiller.



Background

Non-Integrated

When outdoor wet- bulb temperatures are sufficiently low, cooling towers are able to provide water at temperatures below the chilled-water setpoint.

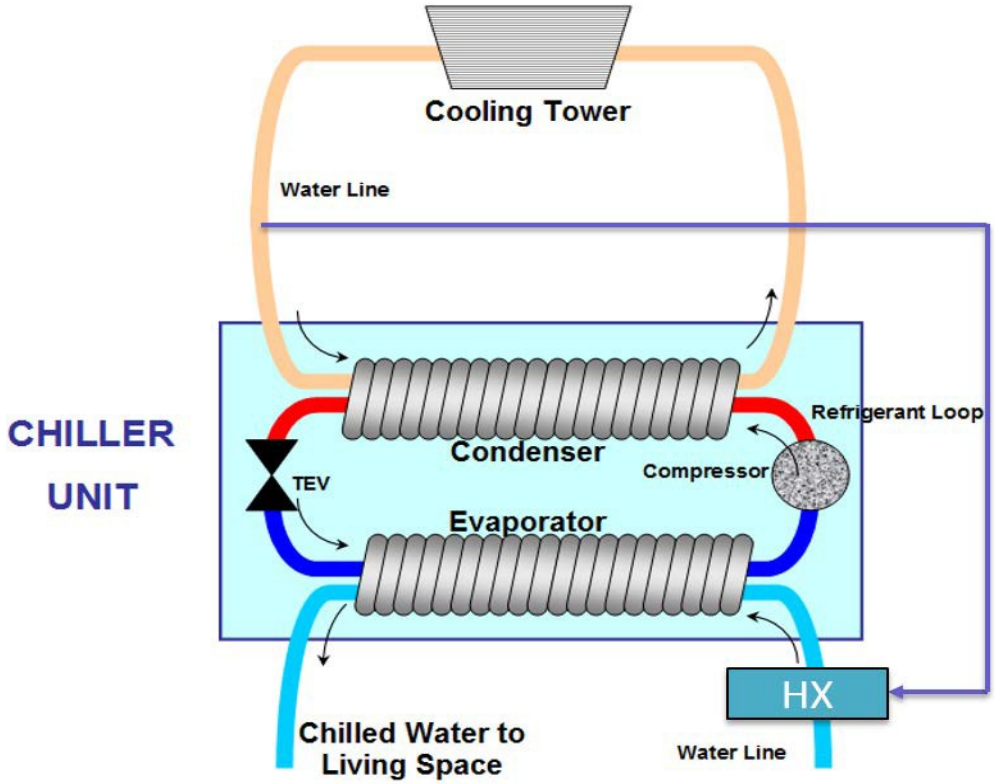


Background

Integrated

Integrated waterside economizer allows additional savings compared to non-integrated.

Cooling towers can be used to pre-cool the return chilled water prior to it entering the chiller.



Background

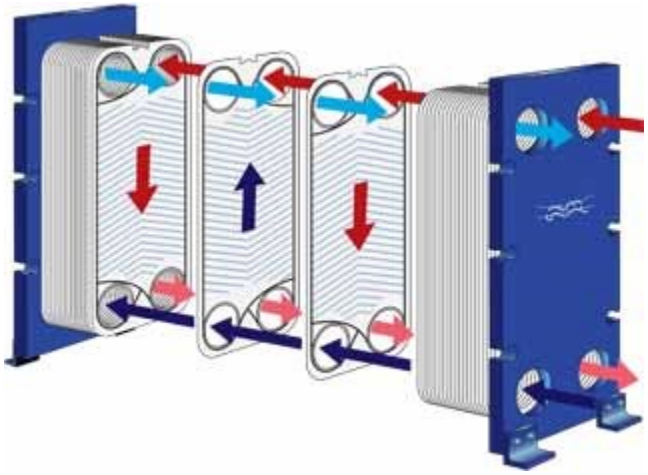
Both integrated and non-integrated economizers are comprised of the same components

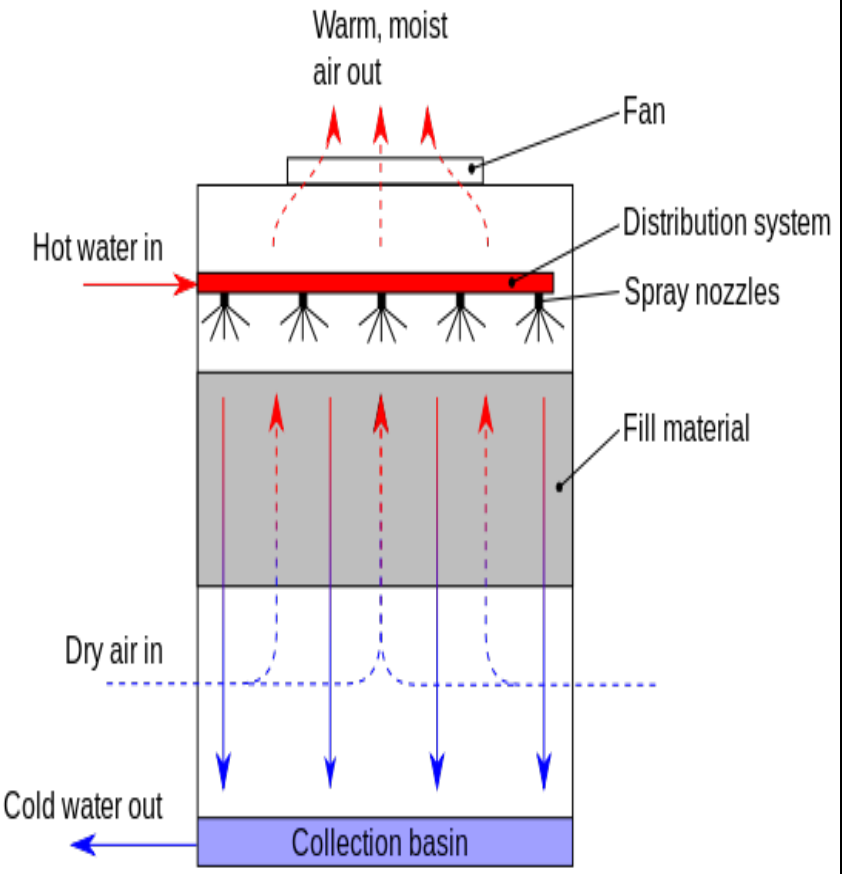
- Cooling Tower
- Heat Exchanger
- Pumps
- Sensors (temperature, relative humidity, etc.)
- Controls

Systems are rated by their approach. The approach determines what wet-bulb temperatures are required for the economizer to completely bypass the chiller.

Background

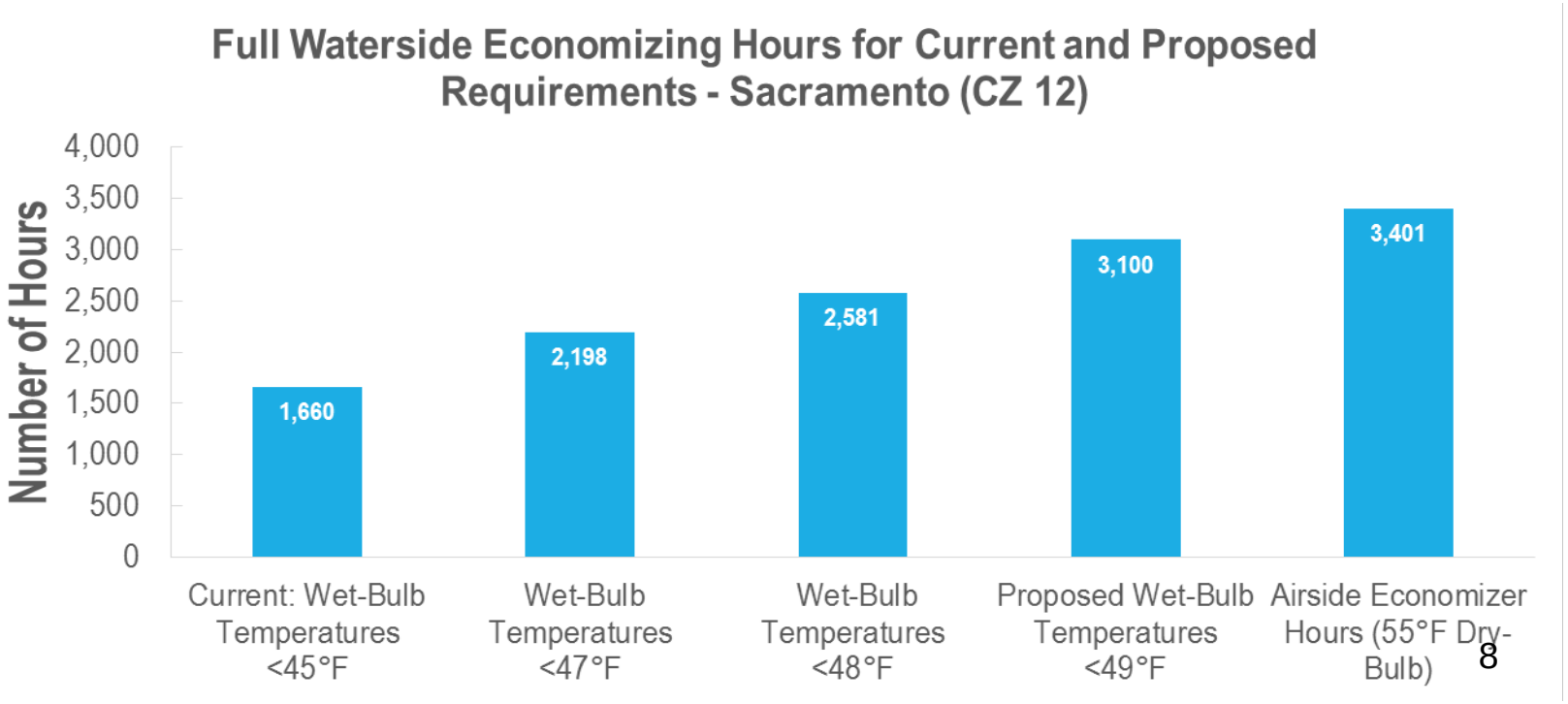
Plate heat exchanger





Background

Increasing the wetbulb temperature from 45ºF to 49ºF results in more hours of economizer operation



Proposed Code Change

- Expand on the current waterside economizer requirements of Section 140.4(e)
  - More stringent system approach
- Align with ASHRAE 90.1
  - Section 6.5.1 Integrated water economizer
  - Addendum du – max pressure drop for heat exchanger
  - Addendum du – water economizer for passive/hydronic systems

Energy Analysis

Prototype ID	Occupancy Type (Residential, Retail, Office, etc.)	Area (ft2)	Number of Stories	Statewide Area (million ft2)
Prototype 1	Office	500,000	13	1.27

Base

- Non-integrated
- 9 deg approach temperature
- Cooling tower efficiency 42.1 gal/hp

Proposed

- Fully integrated
- 5 deg approach temperature
- Cooling tower efficiency 80 gal/hp
- Simulates pre-cooling

Energy Analysis – Energy and Cost Savings per ft^2

Only electricity savings

Range TDV:

High 11.99

Low 2.69

Climate Zone	1 – Year Electricity Savings (kWh/yr)	1 – Year TDV Energy Savings (TDV kBtu/yr)	15-Year TDV Electricity Cost Savings (2020 PV$)
1	0.200	5.02	**$0.45**
2	0.204	5.02	**$0.45**
3	0.208	5.38	**$0.48**
4	0.240	5.83	**$0.52**
5	0.246	11.99	**$1.07**
6	0.131	3.18	**$0.28**
7	0.141	2.95	**$0.26**
8	0.163	3.32	**$0.30**
9	0.211	5.39	**$0.48**
10	0.259	6.56	**$0.58**
11	0.176	2.69	**$0.24**
12	0.197	4.94	**$0.44**
13	0.226	3.79	**$0.34**
14	0.279	10.39	**$0.92**
15	0.321	7.67	**$0.68**
16	0.130	3.82	**$0.34**

Lifecycle Cost Effectiveness per ft^2

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings1 (2020 PV$)	Costs Total Incremental PV Costs2 (2020 PV$)	Benefit-to- Cost Ratio
1	$0.45	$0.15	3.0
2	$0.45	$0.20	2.2
3	$0.48	$0.18	2.6
4	$0.52	$0.22	2.4
5	$1.07	$0.16	6.5
6	$0.28	$0.22	1.3
7	$0.26	$0.22	1.2
8	$0.30	$0.21	1.4
9	$0.48	$0.23	2.1
10	$0.58	$0.27	2.2
11	$0.24	$0.22	1.1
12	$0.44	$0.21	2.1
13	$0.34	$0.21	1.6
14	$0.92	$0.20	4.7
15	$0.68	$0.28	2.4
16	$0.34	$0.20	1.7

Statewide Energy Savings and Cost Impact

Climate Zone	Statewide Construction in 2020 (million ft2)3 4	First-Year Electricity Savings (GWh)	Lifecycle2 Present Valued Energy Cost Savings (PV$ million)
1	0.00	0.00	$0.00
2	0.03	0.01	$0.01
3	0.21	0.04	$0.10
4	0.07	0.02	$0.04
5	0.01	0.00	$0.01
6	0.13	0.02	$0.04
7	0.07	0.01	$0.02
8	0.19	0.03	$0.06
9	0.26	0.05	$0.12
10	0.07	0.02	$0.04
11	0.01	0.00	$0.00
12	0.14	0.03	$0.06
13	0.02	0.01	$0.01
14	0.02	0.00	$0.02
15	0.01	0.00	$0.01
16	0.04	0.00	$0.01
Total	**1.27**	**0.25**	**$0.54**

Water and Material Impact

	On-site Indoor Water Savings (gal/yr)	On-site Outdoor Water Savings (gal/yr)	Embedded Electricity Savings1 (kWh/yr)
Per Square Foot Impacts	-	3.24	0.01 kWh/ft2
First-year2 Statewide Impacts	-	4,120,000	14,689

	Impact on Material Use (lb/yr)					
	Mercury	**Lead**	**Copper**	**Steel**	**Plastic**	**Others (Identify)**
Impact (I, D, or NC)1				I		
Per Unit Impacts				2,000		
First-year2 Statewide Impacts				5,000		

Proposed Code Language

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(e) Economizers.

1. Each cooling air handler that has a design total mechanical cooling capacity over 54,000 Btu/hr shall include either:

   A. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside; or

   B. A water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of ~~50~~54°F dry-bulb and ~~45~~49°F wet-bulb and below.

Proposed Code Language

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(e) Economizers.

2. Each central chilled water system that has a design total mechanical cooling capacity over that listed in Table 140.4-D shall include a waterside economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of ~~50°F~~ 54°F dry-bulb and ~~45°F~~ 49°F wet-bulb and below.

TABLE 140.4-D CHILLED WATER SYSTEM COOLING CAPACITY FOR WHICH AN ECONOMIZER IS REQUIRED

Climate Zones	Total Building Chilled Water System Capacity, Minus Capacity of Cooling units with Air Economizers	
	Building Water-Cooled Chilled Water Systems	Air-cooled Chilled Water Systems or District Chilled Water Systems
15	≥ 960,000 Btu/h (280 kW)	≥ 1,250,000 Btu/h (365 kW)
1,2,3,4,5,6,7,8,9,10,11,12,13,14	≥ 720,000 Btu/h (210 kW)	≥ 940,000 Btu/h (275 kW)
16	≥ 1,320,000 Btu/h (385 kW)	≥ 1,720,000 Btu/h (505 kW)

Proposed Code Language

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(e) Economizers.

7. Systems that include a water economizer to meet Section 140.4(e)2 shall include the following:

   A. Maximum Pressure Drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer system shall either have a water-side pressure drop of less than 15 ft. of water, or a secondary loop shall be installed so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling (non-economizer) mode.

   B. Heat Rejection Fan Energy Impact. Heat rejection for water economizers shall be configured such that:

      i. no added heat-rejection fan energy is used when the water economizer is not in operation, or

      ii. air-cooled chillers with water economizer heat rejection coils in series with the refrigerant condenser coils meet the efficiency ratings listed in Table 110.2-D.

   C. Economizer systems shall be integrated with the mechanical cooling system so that they are capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Controls shall not false load the mechanical cooling system by limiting or disabling the economizer or by any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

Questions?

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Comments Due by July 7th
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