Codes, Standards, and Rating Systems

Overview

Numerous codes, standards, and rating systems from various organizations govern and surround the building industry, intertwining and sometimes cross referencing themselves. This section defines and differentiates between the primary ones while highlighting the organizations that create, reference, or enforce them.

First, it is important to differentiate between a code, a standard, and a rating system.

A building code establishes the minimum requirements for buildings within a given area/jurisdiction and is enforceable by local authorities. Adoption and implementation can vary. Some states adopt statewide codes, while others leave code adoption up to local agencies, councils, or boards.

A standard is a "how-to" guideline of suggested best practices and minimum requirements that is supplied by an industry or professional organization. Standards are often referenced within codes, but by themselves, standards are not enforced.

A rating system is a voluntary program that goes beyond the industry minimums set forth in the standards and codes. Qualified buildings attain certification at different levels after they are evaluated by inspectors representing the rating system.

ASHRAE Standards

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) is an international organization that works towards advancing the fields of heating, ventilation, air conditioning, and refrigeration. Founded in 1894, ASHRAE has spent over 100 years serving and promoting a sustainable world through research, standards writing, publishing, and continuing education. ASHRAE encourages interaction from its constituents through membership in ASHRAE Technical Committees, Task Groups, and Technical Resource Groups. These groups are responsible for preparing the applicative text for the annual ASHRAE Handbook, presenting at ASHRAE meetings, reviewing technical papers, evaluating the need for standards, and advising the general membership on all aspects of the technology in which it specializes.

ASHRAE guides the industry with written standards. These standards are created to establish consensus for test methods and performance criteria within the heating, ventilation, air conditioning, and refrigeration industries. Consensus standards are developed and published to define minimum values of acceptable performance. Within the HVAC industry, two of ASHRAE's most referenced standards are Standard 90.1 and Standard 189.1.

STANDARD 90.1- 2013

ASHRAE Standard 90.1, entitled *Energy Standard for Buildings Except Low-Rise Residential Buildings*, provides minimum requirements for energy efficient designs for buildings, including both new construction and renovation projects. Standard 90.1 is continually maintained and updated due to rapid changes in technology and energy prices with the most recent version published in 2013. Federal law requires that all states adopt Standard 90.1 as a base energy code or have an energy code that is at least as stringent as Standard 90.1. **Table 1** shows the USGPM/HP ratings for cooling towers and closed circuit cooling towers and btu/h·hp for condensers according to Standard 90.1.

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition[h]	Performance Required [a,b,c,d,f,g]	Test Procedure[e]
Propeller or Axial Fan Open Circuit Cooling Towers	All	95°F entering water 85°F leaving water 75°F entering wet-bulb	≥40.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Fan Open Circuit Cooling Towers	All	95°F entering water 85°F leaving water 75°F entering wet-bulb	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or Axial Fan Closed Circuit Cooling Towers	All	102°F entering water 90°F leaving water 75°F entering wet-bulb	≥14.0 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Closed Circuit Cooling Towers	All	102°F entering water 90°F leaving water 75°F entering wet-bulb	≥7.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or Axial Fan Evaporative Condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wet-bulb	≥157,000 Btu/h·hp	CTI ATC-106
Propeller or Axial Fan Evaporative Condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wet-bulb	≥134,000 Btu/h·hp	CTI ATC-106
Centrifugal Fan Evaporative Condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wet-bulb	≥135,000 Btu/h·hp	CTI ATC-106
Centrifugal Fan Evaporative Condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wet-bulb	≥110,000 Btu/h·hp	CTI ATC-106
Air-Cooled Condensers	All	125°F condensing temperature 190°F entering gas temperature 15°F sub-cooling 95°F entering dry-bulb	≥176,000 Btu/h·hp	AHRI 460

Table 1. ASHRAE Standard 90.1 Table 6.8.1-7: Performance Requirements for Heat Rejection

NOTES: For **Table 1** notes, see **page J24**.

Codes, Standards, and Rating Systems

NOTES FOR TABLE 1 (PAGE J23):

a. For purposes of this table, open circuit cooling tower performance is defined by ASHRAE as the water flow rating of the tower at the thermal rating condition listed in Table 6.8.1-7 of ASHRAE Standard 90.1 divided by the fan motor nameplate power.
b. For purposes of this table, closed circuit cooling tower performance is defined by ASHRAE as the process water flow rating of the tower at the thermal rating condition listed in Table 6.8.1-7 of ASHRAE Standard 90.1 divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
c. For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
d. Section 12 [of ASHRAE Standard 90.1] contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
e. The efficiencies and test procedures for both open and closed circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections.
f. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.
g. For the purposes of this table, evaporative condenser performance is defined as the heat rejected at the specific rating condition in the table, divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
h. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed above with R-507A as the test fluid.

An important point to note in Standard 90.1 pertaining to cooling towers is that centrifugal fan open circuit cooling towers with a combined rated capacity of 1,100 USGPM or greater at 95°F (35°C) condenser water return, 85°F (29.4°C) condenser water supply, and 75°F (23.9°C) entering wet-bulb temperature shall meet the energy efficiency requirement for axial fan open circuit cooling towers listed in ASHRAE table 6.8.1G (**Table 1**). The exception to this rule is when the centrifugal open circuit cooling towers are ducted with inlet or discharge ducting or require external sound attenuation.

Standard 90.1 also makes a specific exception for applications with cooling towers or closed circuit cooling towers that work with hydronic heat pumps. When hydronic heat pumps are connected to a common heat pump water loop, which has central devices for heat rejection and heat addition (e.g. cooling tower and boiler), the following applies according to Standard 90.1 section 6.5.2.2.3 part b:

> "For climate zones 3 through 8, if a closed-circuit tower (fluid cooler) is used, either an automatic valve shall be installed to bypass all but a minimal flow of water around the tower (for freeze protection) or low-leakage positive closure dampers shall be provided. If an open circuit tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the tower. If an open-circuit tower is used in conjunction with a separate heat exchanger to isolate the tower from the heat pump loop, then heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop."

For zoning information please see Standard 90.1, Table 3.1.

STANDARD 189.1

Introduced in 2009, Standard 189.1, *Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings*, was the first code intended for commercial green building standard in the United States. It provides a total building sustainability package for those who strive to design, build, and operate green buildings. From site location, to energy use to recycling, this standard sets the foundation for green buildings by addressing site sustainability, water use efficiency, energy efficiency, indoor environmental quality, and the building's impact on the atmosphere, materials, and resources. Standard 189.1 applies to new construction, additions, and renovations.

Standard 189.1 provides a minimum requirement for sustainability, while LEED® (for more about LEED, see **page J34**), which it is sometimes compared to, provides an increased voluntary effort at sustainability measures. When a government or group accepts Standard 189.1, there are mandatory minimums that must be met, while LEED, as a rating system, continues to be optional. Of particular note, the US Army issued their new sustainable design and development initiatives in December 2010 and incorporated Standard 189.1.

Compared to ASHRAE Standard 90.1, which only addresses energy efficiency, Standard 189.1 also provides minimum requirements for the siting, design, and construction of high performance, green buildings. **Table 2** lists the energy efficiency performance requirements for cooling towers and closed circuit cooling towers according to Standard 189.1.

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Rating Condition	Performance Required [a,b]	Rating Standard
Open Loop Propeller or Axial Fan Cooling Towers[a]	All	95°F entering water, 85°F leaving water 75°F entering wet-bulb	≥40.2 gpm/hp	CTI ATC-105 and CTI STD-201
Open Loop Centrifugal Fan Cooling Towers[a]	All	95°F entering water, 85°F leaving water 75°F entering wet-bulb	≥22.0 gpm/hp	CTI ATC-105 and CTI STD-201
Closed Loop Propeller or Axial Fan Cooling Towers[b]	All	102°F entering water, 90°F leaving water 75°F entering wet-bulb	≥15.0 gpm/hp	CTI ATC-105 and CTI STD-201
Closed Loop Centrifugal Fan Cooling Towers[b]	All	102°F entering water, 90°F leaving water 75°F entering wet-bulb	≥8.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or Axial Fan Evaporative Condensers	All	R-507A test fluid, 165°F entering gas temperature 105°F condensing temperature, 75°F entering wet-bulb	≥157,000 Btu/h·hp	CTI ATC-106
Propeller or Axial Fan Evaporative Condensers	All	Ammonia test fluid, 140°F entering gas temperature 96.3°F condensing temperature, 75°F entering wet-bulb	≥134,000 Btu/h·hp	CTI ATC-106
Centrifugal Fan Evaporative Condensers	All	R-507A test fluid, 165°F entering gas temperature 105°F condensing temperature, 75°F entering wet-bulb	≥135,000 Btu/h·hp	CTI ATC-106
Centrifugal Fan Evaporative Condensers	All	Ammonia test fluid, 140°F entering gas temperature 96.3°F condensing temperature,75°F entering wet-bulb	≥110,000 Btu/h·hp	CTI ATC-106

Table 2. ASHRAE Standard 189.1 Table C-8: Performance Requirements for Heat Rejection Equipment (Supersedes Table 1: 6.8.1G in AHSRAE Standard 90.1)

NOTES: For **Table 2** notes, see **page J26**.

Codes, Standards, and Rating Systems

NOTES FOR TABLE 2 (PAGE J25):

a. For purposes of this table, open circuit cooling tower performance is defined by ASHRAE as the water flow rating of the tower at the thermal rating condition listed in C-15 of ASHRAE Standard 189.1 divided by the fan motor nameplate power.

b. For purposes of this table, closed circuit cooling tower performance is defined by AHSRAE as the process water flow rating of the tower at the thermal rating condition listed in C-15 ASHRAE Standard 189.1 divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

As Standard 189.1 addresses issues beyond just energy consumption, there are water restrictions that may impact the HVAC industry. Measurement devices with remote capabilities should be provided to collect water use data of each water supply source for the building project if the measurement total is to exceed the threshold listed in **Table 3** below**.**

Water Source	Main Measurement Threshold
Potable water	1,000 gal/day (3,800 L/day)
Municipally reclaimed water	1,000 gal/day (3,800 L/day)
Alternate sources of water	500 gal/day (1,900 L/day)

Table 3. ASHRAE Standard 189.1 Table 6.3.3-1 – Water Supply Source Measurement Thresholds

Sub-metering remote communication measurement systems must then also be provided to collect water use data for each of the following building subsystems, if the subsystems have been sized above the threshold levels listed in **Table 4.**

Subsystem	Sub-Metering Threshold
Cooling towers (meter on make-up water and blowdown)	Cooling tower flow through tower > 500 gpm (30 L/s)
Evaporative coolers	Makeup water > 0.6 gpm (0.04 L/s)
Steam and hot-water boilers	> 500,000 BTU/h (50 kW) input
Total irrigated landscape area with controllers	> 25,000 ft^2 (2,500m^2)
Separate campus or project buildings	Consumption > 1,000 gal/day (3,800 L/day)
Separately leased or rental space	Consumption > 1,000 gal/day (3,800 L/day)
Any large water using process	Consumption > 1,000 gal/day (3,800 L/day)

Table 4. ASHRAE Standard 189.1 Table 6.3.3-2 Subsystem Measurement Thresholds

Standard 189.1 goes on to address cycles of concentration requirements for cooling towers. For more information on cycles of concentration and how to address the standard, contact your local water quality expert.

Also involving water in the tower, Standard 189.1 requires that cooling towers be equipped with efficient drift eliminators, reducing drift rates to 0.005% in a crossflow tower and 0.002% in a counterflow tower.

BAC and ASHRAE Standards

BAC's products meet or exceed Standard 90.1 energy efficiency requirements. BAC also continues to move forward with research and development of new products that continue to be more energy efficient. BAC is active on the committee of Standard 90.1, and continues to support the committee efforts for both ASHRAE Standards 90.1 and 189.1. BAC's Extreme Efficiency (XE) Models are at least 2 times more efficient than the minimum requirements established in ASHRAE Standard 90.1 - 2013. BAC's CXVT Evaporative Condenser XE Models are at least 3 times more efficient than the minimum requirements.

ASME B31.5 and U Designator

The American Society of Mechanical Engineers (ASME) publishes two important codes that apply to the industrial and refrigeration industries: ASME B31.5 and ASME Pressure Vessel Code.

ASME B31.5

ASME B31 sets standards for pressure piping, and ASME B31.5 specifically applies to refrigerant heat transfer components and secondary coolant piping for temperatures down to -320°F (-195.6°C).

The code applies to:

- Refrigerant and secondary cooling piping for temperatures as low as -320°F (-195.6°C)
- Factory assembled and field erected piping
- Heat transfer components

The code does not apply to:

- Self-contained equipment subject to the requirements of nationally recognized laboratories
- Water piping
- Internal or external low pressure piping (less than 15 psig)
- Pumps, pressure vessels and compressors, but does apply to primary and secondary refrigerant piping connected after the first joint adjacent to the equipment

BAC and ASME B31.5

BAC designs coils that comply with ASME B31.5 for all condensers and closed circuit cooling towers. Compliance with ASME B31.5 assures the highest quality coil design, materials, and manufacturing processes, providing the customer a safe and superior product. Coils for condensers and closed circuit cooling towers are rated at 300 psig maximum allowable working pressure, and they are pneumatically tested at 375 psig.

BAC and the ASME U Designator

BAC offers coils that are certified in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division I. These coils bear the U designator and are available for evaporative condensers and closed circuit cooling towers. ASME U designated coils are available for projects requiring ASME certified pressure vessels and involve 3rd party inspection and certification. ASME U designated coils are rated at 340 psig maximum allowable working pressure, and they are pneumatically tested at 375 psig The ASME code only governs the coil and does not affect the design of the coil casing, cold water basin, or any other closed circuit cooling tower or evaporative condenser component.

Codes, Standards, and Rating Systems

IBC and ASCE 7

The International Building Code® (IBC) is a model code developed by the International Code Council® (ICC) and available for adoption by jurisdictions internationally. The IBC was first issued in 2000 and is updated triennially. The latest edition is 2015.

Up to six editions of the IBC (2000, 2003, 2006, 2009, 2012, and 2015) have been adopted and are effective at the local or state level in all 50 states and the District of Columbia. Once adopted, the IBC provisions become enforceable regulations governing the design of buildings and structures.

The IBC defines design requirements for buildings, structures, and parts thereof. Contained within the structural design provisions of the IBC are requirements for cooling towers that may be subjected to various types of environmental factors, such as wind loads and seismic loads. For the seismic load design requirements, the IBC refers extensively to and incorporates many provisions of ASCE/SEI 7, the consensus standard published by the American Society of Civil Engineers (ASCE).

BAC, IBC, and ASCE 7

BAC supports both IBC and ASCE. When it comes to seismic certification, the most reliable form of testing is shake table testing. BAC goes beyond calculations by shake table testing its products for certification, proving functionality after a seismic event. To see the shake table ratings for BAC's products, please see each product's introduction section.

NOTE: For more information on seismic certification please refer to "Seismic Design and Qualification Methods" on **page J38**.

California's Title 24 and OSHPD

Title 24 is the California Building Standards Code and is part of the larger California Code of Regulations. It applies to all occupancies that submit for a building permit in California, and the most recent edition is dated 2013. Title 24 has twelve parts, each outlining a specific section of the building standards code, and includes regulations for energy efficiency and specific building requirements. Of particular interest to the evaporative cooling industry are the seismic regulations included in Title 24, Part 2: The California Building Code.

The California Building Code is based on IBC 2012 and ASCE 7-10 (see **page J38** for "Seismic Design and Qualification Methods"). It is important to note how California interprets these two standards. For critical facilities, including essential care, hospitals, and mission critical entities, California requires shake table testing to prove mechanical operation following a seismic event. Calculations are not accepted. While most states have the same requirements, very few enforce it. For its most critical of facilities, heath facilities, California designates this enforcement to its Office of Statewide Health Planning and Development (OSHPD). In addition to enforcement, OSHPD also has the authority to amend Title 24 when necessary. To help make the building and submittal process easier for contractors, OSHPD provides a pre-approved list of mechanical and electrical components available for use on hospitals. If outside components are selected for use on a facility, those individual components must be shake table tested.

BAC and State Building Codes

BAC takes seismic certification, wind load certification, and energy efficiency very seriously and is committed to having the best product line in the market. BAC's PT2 was the first cooling tower to qualify for the OSHPD pre-approved list, and it, along with BAC's Series 3000 and Series 1500 are still on the list, continuing to be frequently used on healthcare facilities in California. As states continue to make changes to and upgrade their building and energy codes, BAC will also continue to update product lines to meet all applicable codes.

California Title 24 Code - Building Energy Efficiency Standards

California Title 24, created by the California Energy Commission, has an energy efficiency standard for both residential and nonresidential buildings. The standard covers all aspects of building energy use in order to: reduce energy use and create more efficient operation, increase electricity reliability and reduce demand, increase comfort of building inhabitants, and promote environmental conservation.

For applications with open and closed circuit cooling towers greater than 150 tons, California Title 24 has requirements for both energy and water efficiency.

The energy efficiency requirements are applicable for all products are stated in **Table 5** and **Table 6**.

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required [a,b,c,d]	Test Procedure
Propeller or Axial Fan Open Circuit Cooling Towers	All	95°F entering water, 85°F leaving water 75°F entering wet-bulb	= 42.1 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Fan Open Circuit Cooling Towers	All	95°F entering water, 85°F leaving water 75°F entering wet-bulb	= 20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or Axial Fan Closed Circuit Cooling Towers	All	102°F entering water, 90°F leaving water 75°F entering wet-bulb	= 14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal Fan Closed Circuit Cooling Towers	All	102°F entering water, 90°F leaving water 75°F entering wet-bulb	= 7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Air-Cooled Condensers	All	125°F condensing temperature, R-22 test fluid 190°F entering gas temperature, 15°F sub-cooling 95°F entering dry-bulb	= 176,000 Btu/h·hp	ANSI/AHRI 460

Table 5. California Title 24 Building Energy Efficiency Standards Table 110.2-G: Performance Requirements for Heat Rejection Equipment

NOTES: For Table 5 notes, see **page J30**.

Codes, Standards, and Rating Systems

NOTES FOR TABLE 5 (PAGE J29):

a. For purposes of this table, open circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating conditions divided by the fan motor nameplate power.

b. For purposes of this table, closed circuit cooling tower performance is defined as the process water flow rating of the tower at the thermal rating condition divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

c. For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.

d. Open cooling towers shall be tested using the test procedures in CTI ATC-105. Performance of factory assembled open cooling towers shall be either certified as base models as specified in CTI STD-201 or verified by testing in the field by a CTI approved testing agency. Open factory assembled cooling towers with custom options added to a CTI certified base model for the purpose of safe maintenance or to reduce environmental or noise impact shall be rated at 90 percent of the CTI certified performance of the associated base model or at the manufacturer's stated performance, whichever is less. Base models of open factory assembled cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201.

e. Applicable test procedure and reference year are provided under the definitions.

For Industrial Refrigeration Applications, California Title 24 applies to:

Refrigerated spaces greater than or equal to 3,000 ft^2 and are served by the same refrigeration compressor(s) and condenser(s). Exempt are systems for which more than 20% of the total design refrigeration load is for quick chilling or freezing or process refrigeration cooling for other than a refrigerated space.

Code Required Design Criteria:

- Design saturated condensing temperatures (SCT) for evaporative-cooled condensers and water-cooled condensers served by fluid coolers or cooling towers shall be less than or equal to:
  - Wet Bulb ≤76°F ; SCT ≤20°F + Design WBT
  - 78°F ≤ Wet Bulb ≤ 76°F ; SCT≤ 19°F + Design WBT
  - 78°F ≥ Wet Bulb; SCT≤ 18°F + Design WBT
- All condenser fans for evaporative-cooled condensers or fans on cooling towers or fluid coolers shall be continuously variable speed, and the condensing temperature control system shall control the speed of all fans serving a common condenser high side in unison.
- The minimum condensing temperature set point shall be less than or equal to 70°F.

DID YOU KNOW?

- Title 24 standards took effect **July 1, 2014** increasing the minimum energy efficiency requirements on all air-cooled and water-cooled products.
- BAC's XE Models have an efficiency of at least 2 times the minimum requirements.
- For additional information on commercial refrigeration applications, see **page J32**.

Condenser Type	Refrigerant Type	Minimum Efficiency	Rating Condition
Outdoor Evaporative-Cooled with THR Capacity > 8,000 MBH	All	350 Btuh/Watt	100°F Saturated Condensing Temperature (SCT), 70°F Outdoor Wetbulb Temperature
Outdoor Evaporative-Cooled with THR Capacity < 8,000 MBH and Indoor Evaporative-Cooled	All	160 Btuh/Watt	
Outdoor Air-Cooled	Ammonia	75 Btuh/Watt	105°F Saturated Condensing Temperature (SCT), 95°F Outdoor Drybulb Temperature
	Halocarbon	65 Btuh/Watt	

Table 6. Reference 2013 Title 24 - Table 120.6-B: Fan-Powered Condensers – Minimum Efficiency Requirements

In addition to meeting the minimum the efficiency, Title 24 requires fan speed control, tower flow turndown, fan operating recommendations and limitations on centrifugal fan cooling towers.

Fan Speed Controls: Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at 2/3 of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature or pressure of the heat rejection device.

Tower Flow Turndown: Open cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:

- The flow that is produced by the smallest pump; or
- 50 percent of the design flow for the cell.

Operating Recommendations: Multiple cell heat rejection equipment with variable speed fan drives shall:

- Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components, and
- Control all operating fans to the same speed. Minimum fan speed shall comply with the minimum allowable speed of the fan drive per the manufactures recommendation. Staging of fans is allowed once the fans are at their minimum operating speed.

Limitation on Centrifugal Fan Cooling Towers: Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor wetbulb temperature, shall use propeller fans and shall not use centrifugal fans. The exception to this if the cooling towers are ducted, or have sound attenuation requiring external static pressure.

California Title 24 includes water efficiency requirements including:

1. **Conductivity or Flow-based Controls** that maximize cycles of concentration based on local water quality conditions.
2. **Documentation of Maximum Achievable Cycles of Concentration** based on local water supply as reported annually by the local water supplier, and using the calculator approved by the Energy Commission.
3. **Flow Meter** with an analog output on the makeup water line.
4. **Overflow Alarm** to prevent overflow of the sump in case of makeup water valve failure.
5. **Efficient Drift Eliminators** that achieve drift reduction to 0.002 percent of the circulated water volume for counter-flow towers and 0.005 percent for crossflow towers.

Codes, Standards, and Rating Systems

California Title 24 Code - Building Energy Efficiency Standards - Commercial Refrigeration

The following table summarizes some of the code requirements, how the code effects the refrigeration system, and how the TrilliumSeries™ Condenser can be an ideal solution for commercial refrigeration applications..

Title 24 Code Requirements (§120.6(b))	Effects to the Commercial Refrigeration System	The Solution
Title 24 applies to retail food stores that have: • Air-cooled or evaporatively-cooled condensers • > 8,000 ft^2 of conditioned space • Condensers with THR capacity > 150,000 Btu/h at 100°F CT / 70°F WBT • New condensers replacing existing units, if the system THR is increased and > 25% of attached compressors and display cases are new	Higher installed cost due to larger and higher first cost of equipment.	TrilliumSeries™ Condenser is exempt from Btu/h/W requirements, but is designed to maximize energy efficiency and meets all of the requirements from Title 24.
All condenser fans must be continuously variable speed.	Staged fans are no longer acceptable.	The TrilliumSeries™ Condenser has high efficiency variable speed electronically commutated (VSEC) motors as standard.
The refrigeration system controls must reset the condensing temperature based on the ambient dry bulb temperature for air-cooled condensers and on the ambient wet bulb temperature for evaporative condensers. The minimum condensing setpoint shall be ≤ 70°F.	Maintaining the constant design condensing temperature, irrespective of the outside temperature, is not acceptable. Lowering the condensing temperature allows the compressors and the overall refrigeration system, to run more efficiently and save energy.	Each TrilliumSeries™ Condenser is offered with custom controls logic which can reduce the condensing temperature on non-design days to maximize system energy savings.
Air-cooled condensers must have a fin density ≤ 10 fins per inch. Microchannel coils are exempt.	Some air cooled manufacturers provide selections using 12+ fpi to reduce footprint.	The TrilliumSeries™ Condenser is supplied with a microchannel coil for high heat transfer efficiency.
Air-cooled condensers must have efficiency ≥ 65 Btu/h/W at 105°F CT / 95°F DBT. Evaporative condensers must have efficiency ≥ 160 Btu/h/W at 100°F CT / 70°F.	Failure to meet the threshold may mean that the city inspector will refuse to provide a passing inspection.	The minimum efficiency of the product line is 205 Btu/h/W at 105°F CT / 95°F DBT / 70°F WBT.

Table 7. The TrilliumSeries™ Condenser Provides a Peace of Mind Solution when Meeting Title 24 Condenser Requirements

For questions on how BAC can best meet your condenser needs, including payback and total cost of ownership analyses, contact Baltimore Aircoil Company. For the full Title 24 text, go to www.energy.ca.gov/Title24.

CTI STD-201

The Cooling Technology Institute (CTI) has been certifying cooling tower thermal performance for over sixty years. CTI Standard STD-201 provides independent assurance, prior to shipment and installation, that a specific cooling tower will perform in accordance with the manufacturer's published thermal performance data. Having CTI certification eliminates the need for costly onsite field tests and ensures system performance will meet design objectives. ASHRAE Standards 90.1 and 189.1 both cite CTI's STD-201 as the required test methods when evaluating cooling towers.

CTI certification is important to many different groups involved in the cooling tower life cycle:

Equipment Owners and Operators: Independent certification of cooling tower thermal performance assures owners and operators that they will receive full value from their investment. It eliminates the potential for years of excessive operating costs due to deficient equipment and provides this benefit at no additional cost to the project. In fact, performance certification can actually reduce first cost by eliminating the need for "safety factors" when sizing the equipment and the cost of a field acceptance test to verify performance.

Design Engineers: By specifying CTI Certification of thermal performance, a design engineer can protect the owner and ensure that the client receives the specified performance. CTI performance certification provides a responsible basis for design and complements codes and standards used to control other systems and products. Many industry organizations are working to include certification in their codes and standards.

Installing Contractors: Independent certification of cooling tower thermal performance assures the installing contractor that all certified cooling tower proposals are based on the same level of thermal performance. This not only eliminates the potential for costly callbacks due to deficient thermal performance, but also maintains a responsible basis of design for design/build, design/assist, or value-engineered projects.

The Cost of Cooling Tower Deficiency

While sometimes hard to detect, a deficient cooling tower forces other system components to work harder to make up for its shortcomings. In an air conditioning application, this burden is imposed upon the chiller. If the cooling tower cannot reject the required load at the lowest possible temperatures, the chiller is forced to operate against a condensing pressure higher than necessary, thereby consuming considerably more energy. This may not affect building comfort levels except at peak conditions, but it will increase operating costs year-round. A tower that is 20% underrated will cost the owner three to four times the original price of the tower in added system energy costs.

Codes, Standards, and Rating Systems

BAC and CTI

BAC is committed to providing independent thermal performance verification for all its products. Every BAC cooling tower has been certified, starting with the FXT Cooling Tower line in 1981. Since then, every factory-assembled BAC cooling tower line has been CTI Certified.

In 1998, CTI Standard STD-201 was expanded to include closed circuit cooling towers, and BAC again led the industry, being the first to achieve certification, with the FXV Closed Circuit Cooling Tower line. Since 1998 all BAC closed circuit cooling towers have been certified, and most notably in 2003 the Dual Air Inlet FXV Closed Circuit Cooling Tower was certified with the largest capacity of any factory-assembled closed circuit cooling tower cell in the industry. In 2009, BAC was the first company to offer certification with water, and ethylene or propylene glycol as the process fluid.

As the certification landscape continues to change, BAC remains committed to providing independent thermal performance, and it is important that contractors and engineers require the same. The equipment sections of this handbook include suggested specifications for each product. When adding verbiage to an existing specification, suggested wording is as follows:

> "The thermal performance shall be certified by the Cooling Technology Institute in accordance with CTI Standard STD-201 or, lacking such certification, a field acceptance test shall be conducted within the warranty period in accordance with CTI Acceptance Test Code ATC-105, by the Cooling Technology Institute, or other qualified independent third-party testing agency, licensed by CTI. Tests performed by the manufacturer's personnel are not acceptable."

USGBC and LEED®

The US Green Building Council (USGBC) is a non-government organization comprised of leaders from the building industry, brought together to promote buildings that are environmentally responsible, profitable, and healthy places to live and work. Members of the USGBC represent all segments of the building industry including: manufacturers, municipalities, architects, interior designers, builders, and several branches of the military. USGBC conceived and now administers the development and ongoing improvement of the Leadership and Energy and Environmental Design (LEED) Green Building Rating Systems.

LEED

LEED rating systems are voluntary, internationally recognized, certification systems that provide third party verification that a building or community was designed, constructed, and will be operated using strategies intended to improve energy efficiency, water savings, CO_2 emissions reduction, indoor environmental air quality, and resource utilization. In its third iteration, LEED is now administered by the Green Building Certification Institute (GBCI).

LEED® standards are available or under development for:

- Building Design and Construction (BD+C)
- Interior Design and Construction (ID+C)
- Building Operations and Maintenance (O+M)
- Neighborhood Development (LEED-ND)
- Homes

LEED was created to define the "green building" by establishing a common standard of measurement, all while raising consumer awareness of green building benefits. A voluntary system, LEED promotes whole-building design practices as it recognizes environmental leadership in the building industry. Points are given for various sustainable features in eight categories:

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Location and Transportation
- Innovation
- Regional Priority Credits

LEED for Neighborhood development has the following additional credit categories:

- Smart Location and Linkage
- Neighborhood Pattern and Design
- Green Infastructure and Buildings

A project must satisfy all prerequisites and earn a minimum number of points to be certified.

Depending on the number of points, the project can be classified at the following levels:

Certified: 40–49 points

Silver: 50–59 points

Gold: 60–79 points

Platinum: 80 points and above

More than 60,000 projects are participating in LEED across 150+ countries and territories, comprising over 11 billion square feet. Over 450 state and local governments across the country have adopted green building policies, and fourteen federal agencies have adopted department-wide LEED initiatives, including the Department of Defense, the Department of Energy, and the Department of State. LEED buildings and the concept of building "green" will become the voluntary norm worldwide as the price of energy increases and our natural resources decline.

Codes, Standards, and Rating Systems

BAC, USGBC, and LEED®

BAC is a member of USGBC and is active in both local chapters and on a national basis. BAC is an active participant at GREENBUILD, USGBC's Annual Conference, and additionally, BAC has a number of LEED certified employees who have become leaders in providing green products.

BAC is a leader in Ice Thermal Storage Systems that currently qualify for LEED credits under the Energy and Atmosphere category, saving 20-40% on cooling energy costs. For more information on BAC's Ice Thermal Storage Systems, please see **page G1**.

CRN

The Canadian Registration Number (CRN) is a number issued by each Canadian province or territory to certify the design of a boiler, pressure vessel, or fitting. The CRN identifies that the design has been accepted and registered for use in that particular province or territory. Canadian provinces and territories are each individually represented by numeric digits following the decimal point within the CRN. For a CRN that is registered across the Canada, "C" follows the designation of the province of first registration (e.g., M 4156.5C shows the design as first registered in Ontario, then across Canada). For more information and individual province listings please visit http://www.tssa.org.

BAC and CRN

BAC is committed to developing products that can be utilized in Canada. Currently, BAC has a CRN in all Canadian provinces for closed circuit cooling towers, evaporative condensers, and ice thermal storage units with standard galvanized, dual row coil design, with a maximum allowable working pressure of up to 300 psig at 350°F (176.7°C). BAC also has a CRN in all Canadian provinces for units with TriCoil galvanized coils, a three-row design, with a maximum allowable working pressure of 300 psig at 350°F (176.7°C).

FM Approval

Factory Mutual Approvals (FM) is not a code, standard, or rating system. It is a recommendation from an independent insurance company, FM Global, to their clients. FM Global specializes in loss protection for large corporations in the Highly Protected Risk insurance sector. They have created guidelines for building materials and products in order "to develop cost-effective insurance and risk financing solutions that protect the value created by [their] clients' businesses" (www.fmglobal.com). Meaning, FM Approved products are used by FM Global and their customers to manage risk.

When specifying or purchasing a new unit, it is best to verify the need for an FM Approved product. Since most facility owners are not FM Global customers, most facilities do not require FM Approved products.

For FM Global customers, it is possible to use products that are not FM Approved. Your local FM insurance underwriter can grant job specific approval for non-listed products.

BAC and FM

BAC offers two factory assembled product lines that comply with FM Approval in multi-cell installations: the 3000C and the PT2. BAC is committed to working with FM Global in the development of equipment and product specifications that support the needs of our mutual customers. If you have questions about product recommendations or specifications, please contact your local BAC Representative.

Series 3000 Cooling Tower

PT2 Cooling Tower