Codes, Standards, and Rating Systems

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 law. Adoption and implementation can vary. Some states adopt statewide codes, while others leave code adoption up to local agencies, councils, or boards.

A standard provides the enforceable practices and minimum requirements that are supplied by a Standards Development Organization (SDO) such as ASHRAE and ASME. Standards are written in code-ready language and can be adopted by local jurisdiction. Many standards function as the “standard of care” in their area of focus.

A building 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. Examples include LEED, Green Globes, etc.

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 instructs 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.

For more information on all ASHRAE Standards, visit https://www.ashrae.org/technical-resources/standards-and-guidelines.

Standard 90.1

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 2022. 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** on the next page shows the USGPM/HP ratings for cooling towers and closed circuit cooling towers and btu/h·hp for condensers according to Standard 90.1. The latest version includes dry cooler minimum efficiency requirements which will help to level the playing field between air cooled and evaporatively cooled systems. Certification coverage for dry coolers will likely be included in the 2025 version though BAC Representatives should promote the CTI certification program as soon as it is officially announced so Customers can choose between fully rated dry and evaporative heat rejection alternatives, which will give a decided advantage to evaporative heat rejection equipment.

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.

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

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 RS
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 RS
Propeller or Axial Fan Closed Circuit Cooling Towers	All	102°F entering water 90°F leaving water 75°F entering wet-bulb	≥16.1 gpm/hp	CTI ATC-105S and CTI STD-201 RS
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-105S and CTI STD-201 RS
Propeller or Axial Fan Dry Coolers (Air-Cooled Fluid Coolers)	All	115°F entering water 105°F leaving water 95°F entering dry bulb	≥4.5 gpm/hp	CTI ATC-105 DS
Propeller or Axial Fan Evaporative Condensers	All	R-448A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wet-bulb	≥160,000 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-448A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wet-bulb	≥137,000 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

NOTES:

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, dry-cooler performance is defined as the process water flow rating of the unit at the thermal rating listed in Table 6.8 1-7 of ASHRAE Standard 90.1 divided by the total fan motor nameplate power of the unit, and air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the total fan motor nameplate power of the unit.

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. The certification requirements do not apply to field-erected cooling towers.

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-448A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-448A must meet the minimum efficiency requirements listed above with R-448A as the test fluid. For R-448A, which is a zeotropic refrigerant, the condensing temperature is defined as the arithmetic average of the dew point and the bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance.

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. Axial fan open circuit cooling towers should be used whenever possible for the lowest fan energy consumption (fan energy savings of approximately 50% versus centrifugal units). However, centrifugal fan open circuit cooling towers continue to be useful when very low sound ratings are required, indoor ducted locations are required for either security reasons or operation in very cold climates, or to meet other unique Customer needs.

Standard 90.1 also includes requirements for water source heat pump applications with cooling towers or closed circuit cooling towers. 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."

The reasoning behind this requirement is to minimize the loss of heat from the loop when in heating mode (waste of boiler energy). Please refer to ASHRAE 90.1 for climate zone information.

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 J25**), 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.

Note that 189.1 minimum efficiencies are slightly higher (approximately 5%) than those in Standard 90.1, reflecting the "high performance" nature of this code.

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)

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

NOTES:

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.

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

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)

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.**

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

Water Source	Sub-Metering Threshold
Cooling Towers (Meter on make-up water and blowdown)	Cooling tower flow through tower >500 gpm (30 L/s)
Evaporative Coolers	Make-up water >0.6gpm (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)

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. All BAC cooling towers, and evaporative condensers meet or exceed these requirements.

Standard 188

ASHRAE Standard 188 establishes the minimum legionellosis risk management requirements for buildings' water systems. Legionella is a bacteria found naturally in fresh water which can multiply and contaminate a water system causing a serious form of pneumonia. This standard is intended for human-occupied buildings to minimize the health risks associated with these bacteria. It was developed for owners and managers of human-occupied buildings, excluding single-family residential buildings as well as those involved in the design, construction, installation, commissioning, operation, maintenance, and service of centralized building water systems and components. For more information refer to the Alliance to Prevent Legionnaires' Disease, https://preventlegionnaires.org/risk-management/.

Standard 62.1

This ASHRAE standard is intended to provide the minimum ventilation rates and other measures to ensure proper indoor air quality (IAQ) is present for human beings. The overall goal is to reduce negative health effects to occupants. Per table 5-1 of standard 62.1, the minimum distance between the cooling tower exhaust and the building air intake is 25 feet. In addition, the cooling tower basin must be a minimum of 15 feet from the building air inlet.

Standard 90.4

Standard 90.4 is a performance-based design standard that offers numerous design components for mechanical load (MLC) and electrical loss (ELC). After determining the calculations of both the MLC and ELC, these calculations are compared to the maximum allowable values based on climate zones. Compliance with Standard 90.4 is achieved when the calculated values do not exceed the values contained in the standard. An alternative compliance path is provided to allow tradeoffs between the MLC and ELC.

The absence of PUE in 90.4 allows the primary focus to be on energy consumption, rather than efficiency.

PUE, as a simpler metric, represents efficiency. It allows data center operators to measure the effectiveness of the power and cooling systems over time. However, PUE is quite limited, as it measures only the relative difference between power consumed on IT equipment, and the energy consumed on IT and infrastructure combined. PUE isn't a useful tool for determining whether the overall energy consumption was increased at the facility level.

ASHRAE 90.4 intends to tackle and regulate lower performers, while being mindful of geographic areas. The new standard aims to impact power utilization throughout a data center facility, highlighting the impact of raising the temperature into the white space on overall energy consumption.

Another key part of this standard is containment. Containment looks closely at the homogeneity of a given air volume across a data center, therefore limiting the power loads necessary to overcome hotspots.

BAC and Energy Efficiency

BAC monitors all energy efficiency standards and is an active participant in many committees including ASHRAE. As a result, we offer products that meet or exceed minimum energy efficiency requirements found in any local code. Our products are innovative, and their inception is based on research and development towards sustainable solutions.

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 refrigerant 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 ensures the highest quality coil design, materials, and manufacturing processes, providing the customer with a safe and superior product. B31.5 specifies the materials that can be used, weld techniques, weld joint design, the use of certified welders. 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. The specific coil is registered with ASME and can be tracked throughout its lifetime. This number is on a plate permanently attached to the coil. ASME U designated coils are rated at 340 psig maximum allowable working pressure, and they are pneumatically tested at 375 psig. Higher pressures are available as a special design. 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.

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 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 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 available for select galvanized and stainless steel coil configurations.

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 2021.

Up to eight editions of the IBC (2000, 2003, 2006, 2009, 2012, 2015, 2018, and 2021) have been adopted and are effective at the local or state level in all 50 states and the District of Columbia. Once an edition is 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.

Make sure all bidders are quoting the same level of seismic rating as some levels require extensive changes to the unit, lower thermal ratings, and add cost to the design.

Note: For more information on seismic certification please refer to "Seismic Design" on **page J27.**

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 2022, which becomes effective on January 1, 2023. 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 2019 California Building Code is based on IBC 2018 and ASCE 7-16 (see **page J27** for "Seismic Design"). 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) which became the Department of Health Care Access and Information (HCAI) in Aug 2021. In addition to enforcement, OSHPD or HCAI also has the authority to amend Title 24 when necessary. To help make the building and submittal process easier for contractors, OSHPD or HCAI 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.

Make sure all bidders are quoting the same level of seismic rating.

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.

In 2019, Title 24 was changed to require cooling towers used on water cooled chiller systems over approximately 300 tons to have a minimum of 60 GPM/HP. Two exceptions apply as follows:

- **Exception 1** to Section 140.4(h)5:
  Replacement of existing cooling towers that are inside an existing building or on an existing roof.
- **Exception 2** to Section 140.4(h)5:
  Cooling towers serving buildings in Climate Zone 1 or 16

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

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

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[a,b,c,d]	Test Procedure[e]
Propeller or Axial Fan Cooling Towers[a]	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 RS
Centrifugal Fan Cooling Towers[a]	All	95°F entering water 85°F leaving water 75°F entering wet-bulb	≥20.0 gpm/hp	
Propeller or Axial Fan Closed Circuit Cooling Towers[b]	All	102°F entering water 90°F leaving water 75°F entering wet-bulb	≥16.1 gpm/hp	
Centrifugal Fan Closed Circuit Cooling Towers[b]	All	102°F entering water 90°F leaving water 75°F entering wet-bulb	≥7.0 gpm/hp	
Propeller or Axial Fan Evaporative Condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature	≥157,000 Btu/h·hp	CTI ATC-106
	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wet-bulb	≥134,000 Btu/h·hp	
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	
	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wet-bulb	≥110,000 Btu/h·hp	
Air Cooled Condensers	All	125°F condensing temperature R22 test fluid 190°F entering gas temperature 15°F subcooling 95°F entering drybulb	≥176,000 Btu/h·hp	ANSI/AHRI 460

NOTES:

a. For purposes of this table, open circuit cooling tower performance is defined as the water flow rating of the tower at the given 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 given 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 are open cooling towers cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201. There are no certification requirements for field erected cooling towers.

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

f. Requires more efficient cooling towers for water cooled chiller plants over about 300 tons – can get around this through the exceptions listed or by doing a whole building energy model to demonstrate that the proposed building is as or more efficient than the base line building.

For Industrial Refrigeration Applications, California Title 24 applies to:

Refrigerated spaces greater than or equal to 3,000 ft2 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 cooling 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:

- 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.

Table 6. Table 120.6-B: Fan-Powered Condensers—Minimum Efficiency Requirements—2019 Title 24

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 Wetbulb Temperature
	Halocarbon	65 Btuh/Watt	
Adiabatic Dry Mode	Halocarbon	45 Btuh/Watt	105°F Saturated Condensing Temperature (SCT), 95°F Outdoor Drybulb Temperature
Indoor Air-Cooled	All	Exempt	

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

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.

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 wet-bulb 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.

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. The minimum fan speed shall comply with the minimum allowable speed of the fan drive per the manufacture's recommendation. Staging of fans is allowed once the fans are at their minimum operating speed.

California Title 24 includes water efficiency requirements including:

Conductivity or Flow-based Controls that maximize cycles of concentration based on local water quality conditions.

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.

Flow Meter with an analog output on the makeup water line.

Overflow Alarm to prevent overflow of the sump in case of makeup water valve failure.

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.

Consult your sales representative to find the best solution for your Title 24 needs.

DID YOU KNOW?

The current Title 24 standards took effect July 1, 2021, requiring the minimum energy efficiency requirements on all air-cooled and water-cooled products.

In December 2021, Title 24 – 2022 was approved by the California Building Standards Commission for inclusion into the California Building Standards Code. The 2022 Energy Code encourages efficient electric heat pumps, establishes electric-ready requirements for new homes, expands solar photovoltaic and battery storage standards, strengthens ventilation standards, and adds minimum energy efficiency requirements and the CTI Test Code for dry coolers. Buildings whose permit applications are applied for on or after January 1, 2023, must comply with the 2022 Energy Code.

BAC's XE Base Models have an efficiency of at least 2 times the minimum requirements. Note that on actual projects, the efficiency of the units must include the impact of any accessories or options that may impact the thermal performance, such as sound attenuation or Whisper Quiet Fans.

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-201RS

The Cooling Technology Institute (CTI) has been certifying cooling tower thermal performance for over forty years. CTI Standard STD-201RS 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-201RS as the required rating 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 reduce the 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.

Also promotes true innovation in the Industry thanks to a level playing field.

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.

BAC and CTI

BAC is committed to providing independent thermal performance verification for all its applicable 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. BAC's heat rejection systems help customers earn LEED points due to their energy savings.

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, CO2 emissions reduction, indoor environmental air quality, and resource utilization. Administered by the Green Building Certification Institute (GBCI), LEED is currently on V4.1 which allows projects to earn more LEED points through building performance monitoring. However, some jurisdictions mandate that all buildings over a certain size must achieve a specific level of LEED Certification.

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
- Cities and Communities

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 nine categories:

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

LEED for Neighborhood development has the following additional credit categories:

- Smart Location and Linkage
- Neighborhood Pattern and Design
- Green Infrastructure 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 110,000 projects are participating in LEED across 167+ countries and territories, comprising over 24 billion square feet. More and more state and local governments across the country have adopted green building policies, and 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" has become the voluntary norm worldwide as the price of energy increases and our natural resources are increasingly challenged.

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 credentialed 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 F1.**

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.