TC08.06 Comments on 2013 Building Efficiency Standards – 45 day language

To: California Energy Commission

Please find attached ASHRAE TC08.06 Standards Subcommittee's comments to the 2013 Building Efficiency Standards – 45 day language. Comments to 2013 Building Energy Efficiency Standards – 45 day language are shown in green on the following pages to distinguish TC08.06 comments from the CEC's revisions to the current draft of the standard. ~~Strikethroughs~~ are used for suggested deletions and <u>underline</u> is used for suggested additions to the text.

Submitted to CEC Docket No. 12-BSTD-1 on March 14, 2012

Frank T. Morrison

Frank Morrison

Chair, TC08.06 Subcommittee on Industry Standards

<u>Subcommittee Members</u>

Paul Lindahl – SPX Cooling Technologies

Daryn Kline - Evapco

Steve Kline – Baltimore Aircoil Company

Dick LeClaire – SPX Cooling Technologies

Ron Wood - GSA

Frank Morrison – Baltimore Aircoil Company

<u>Attachments</u>:

Evapco Letter dated March 8, 2012

Addendum "af" to ASHRAE Standard 90.1

ASHRAE TC08.06 Cooling Towers and Evaporative Condensers

Comments to: *2013 Building Energy Efficiency Standards*

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CLOSED-CIRCUIT COOLING TOWER is a ~~closed-circuit~~ cooling tower that utilizes indirect contact between a heated fluid, typically water or glycol, and the cooling atmosphere to transfer the source heat load through sensible and latent heat and mass transfer indirectly to the air, essentially combining a heat exchanger and cooling tower into ~~one~~ an integrated and relatively compact device.

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CTI ATC-105S(~~96~~11) is the Cooling Technology Institute document entitled "Acceptance Test Code for Closed-Circuit Cooling Towers," ~~1996~~ 2011(CTI ATC-105-~~96~~11).

CTI STD-201 is the Cooling Technology Institute document entitled "Standard for ~~the Certification of Water-Cooling Tower~~ Thermal Performance Certification of Evaporative Heat Rejection Equipment," 20~~0411~~~~09~~ 11(CTI STD-201-~~0411~~~~09~~11).

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FLUID COOLER is a fan-powered heat rejection device that includes a water or glycol circuit connected by a closed circulation loop to a ~~water~~liquid-cooled refrigerant condenser, and may be either evaporative-cooled or air-cooled or a combination of the two (also see closed circuit cooling tower).

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OPEN CIRCUIT COOLING TOWER is an open, or direct contact, cooling tower which exposes water directly to the cooling atmosphere, thereby transferring the source heat load from the water directly to the air by a combination of heat and mass transfer.

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PART-LOAD OPERATION occurs when a ~~loaded air compressor~~system or device is operating below its maximum rated capacity.

***Justification*: All of the above comments are to clarify the definitions listed to industry standard terms and update the revision/review dates for the CTI certification standard (2011) and closed circuit cooling tower test code (2011).**

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WATER BALANCE IN EVAPORATIVE COOLING TOWERS The water balance in cooling towers is:
M = E + B ~~+ D~~, where:

- M = makeup water (from the mains water supply)
- E = losses due to evaporation
- B = losses due to blowdown
- ~~D = drift losses~~

***Justification*: Drift is actually a form of blowdown and as such any drift loss reduces the blowdown from a cooling tower equipped with a conductivity controlled blowdown system. However, efficient drift eliminators reduce emissions from the tower, which helps to minimize issues such as carryover on parking lots and the risk of biological contamination, so it is prudent to install efficient drift eliminators as proposed in Title 24.**

Pages 74 / 75 (underline from original text removed for clarity)

(e) **~~Evaporative or~~ Open and Closed Circuit Cooling Towers.** All ~~evaporative or~~ open and closed circuit cooling tower~~s~~ installations shall comply with the following:

1. Be equipped with Conductivity or Flow-based Controls that maximize cycles of concentration based on local water quality conditions. Controls shall automate system bleed and water treatment program based on conductivity, or in proportion to metered makeup volume, metered bleed volume, recirculating pump run time or bleed time. Conductivity controllers shall be installed in accordance with manufacturer's specifications in order to maximize accuracy
2. Documentation of Maximum Achievable Cycles of Concentration. Building owner shall document the maximum cycles of concentration based on local water supply as reported annually by the local water supplier, and a water treatment plan developed by a qualified water treatment specialist. The calculator is intended to determine maximum cycles based on a Langelier Saturation Index (LSI) of 2.~~5~~8 or less. Building owner shall document maximum cycles of concentration on Compliance Form MECH 5C, which shall be reviewed and signed by the Professional Engineer (P.E.) of Record.
3. Be equipped with a Flow Meter with data logging capability on the makeup water line.
4. Be equipped with an Overflow Alarm to prevent overflow of the sump in case of makeup water valve failure. Overflow alarm shall send an audible signal or provide an alert via the Energy Management Control System to the tower operator in case of sump overflow.
5. Be equipped with Drift Eliminators that achieve drift reduction to 0.002% of the circulated water volume for counter-flow towers and 0.005% for cross-flow towers.

EXCEPTION to Section 110.2(e): Towers with rated capacity ~~<~~≤ ~~150~~300 tons.

***Justification*: The increase to an LSI of 2.8 provides more leeway for water treatment providers to keep the tower within the proper water quality range. Increasing the exception to 300 tons corresponds to the current limitation on air cooled chillers and helps to level the first cost for small water cooled systems that must compete with air cooled systems.**

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TABLE 110.2-G PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT [d]

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 Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75 °F entering air wb	> ~~38.2~~ 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 air wb	> 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 air wb	> 14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal fan closed-circuit cooling towers	All	95°F entering water 85°F leaving water 75 °F entering air wb	> 7.0 gpm/hp	CTI ATC-105S and CTI STD-201
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	ARI 460

a For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the given rated 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 rated conditions divided by the sum of the fan motor nameplate rated 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% 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 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.

***Justification*: During the January 2012 ASHRAE meeting held in Chicago, TC08.06, the ASHRAE technical committee for Cooling Tower and Evaporative Condensers, voted to support an increase in the minimum efficiency of axial fan, open circuit cooling towers from 38.2 to 42.1 gpm/hp at the base rating condition of 95°/85°/75°. This is an increase of over 10%, which is justified based on the current limitation on air cooled chillers as proposed for the 2013 version of Title 24 which will help to prevent market shifts to less energy efficient systems for first cost reasons.**

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Reference Table 120.6-B – Reduce the minimum efficiency requirements for evaporative condensers.

TC08.06 Standards Subcommittee supports values for the minimum efficiency requirements similar to those found in:

"**Docket No. 12-BSTD-1EVAPCOPublicCommentRefrigeratedWarehouses.pdf**"

These comments were submitted by Daryn Cline of Evapco on March 8, 2012. The TC also encourages other manufacturers and interested parties to comment on the minimum efficiency levels listed in the 45-day draft.

***Justification*: The values in the table for evaporative condensers should be reduced to a more reasonable value, along the lines suggested in the Evapco letter referred to above, to avoid restricting the range of evaporative condensers available to the marketplace, which are inherently much more efficient than air cooled alternatives and can produce lower condensing temperatures at a lower energy input. The higher efficiency levels in the current 45-day draft will increase first cost, require greater plan area, and larger and more costly support steel, which will likely lead to a market shift to other, less energy efficient technologies.**

Compressors consume the largest amount of energy in a typical refrigeration system while the power draw by the evaporative condenser is a relatively small portion of the overall system energy consumption. Lower condensing temperatures significantly reduce the power consumption by the compressor and thus the overall system. Evaporative condensers, which are highly efficient and cool towards the wet bulb of the air as opposed to the dry bulb, enable these lower condenser temperatures, providing significant energy savings to the system. Besides the lower condensing temperature, the power draw for a given unit of heat rejection is significantly lower for evaporative condensers than air cooled alternatives.

Note that the TC Subcommittee supports the adoption of minimum efficiency requirements for evaporative condensers in Title 24. As mentioned above, the Subcommittee believes that the levels are too restrictive for this first adoption. Setting the levels at a more reasonable level will allow time for the industry to adapt to the new requirement and will also encourage innovation in the industry, leading to higher efficiency levels in the future.

TC08.06 Comments on 2013 Building Efficiency Standards – 45 day language

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(h) **Heat Rejection Systems.**

1. **General.** Subsection ~~144~~140.4(h) applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers, and evaporative condensers.
2. **Fan Speed Control.** 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/pressure of the heat rejection device.

   EXCEPTION 1 to Section ~~144~~140.4(h)2: Heat rejection devices included as an integral part of the equipment listed in TABLE 110.2-A through TABLE 110.2-E.
   EXCEPTION 2 to Section ~~144~~140.4(h)2: Condenser fans serving multiple refrigerant circuits.
   EXCEPTION 3 to Section ~~144~~140.4(h)2: Condenser fans serving flooded condensers.
   ~~**EXCEPTION 4 to Section 144140.4(h)2:** Up to 1/3 of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement.~~

3. Multiple cell heat rejection equipment with variable speed fan drives shall:

   a. Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and

   b. Control all fans to the same fan speed required for the instantaneous cooling duty as opposed to staged (on/off) operation. Minimum fan speed shall comply with the minimum allowable speed of the fan drive system per the manufacturer's recommendations.

***Justification**: As virtually all heat rejection equipment utilize VSDs on fans 7.5 HP and above, a requirement to operate the maximum number of fans in a multi-fan installation to minimize energy for a given duty is justified. All fans should be operated in tandem at the same fan speed as this control sequence for multi-fan installations is more energy efficient than on/off or sequenced fan operation. A note that the minimum fan speed must comply with the minimum allowable speed of the fan drive system per the heat rejection device manufacturer's recommendations was also added.*

Two other changes were also made:

- ***Paragraph (h) 1 was revised to include dry coolers as an example since they are common devices used for heat rejection and to clarify the two types of cooling towers referenced in this section (open-circuit and closed-circuit).***
- ***Exception (4) to Paragraph (h) 2 needs to be eliminated as most heat transfer devices utilize VSDs due to the many benefits and declining costs of VSDs. This exception would also conflict with the fan speed requirement proposed in (h) 3 for multi-cell heat rejection devices.***

Note that this change to the Standard is supported by the Standards Subcommittee of TC08.06, the ASHRAE technical committee for Cooling Tower and Evaporative Condensers. A similar change has been proposed for ASHRAE Standard 90.1, which should be out for public review in the very near future.

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3. **Tower Flow Turndown.** Open circuit cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:
A. The flow that's produced by the smallest pump; or
B. ~~33~~ 50 percent of the design flow for the cell.

4. **Limitation on Centrifugal Fan Open Circuit Cooling Towers.** Open circuit 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.

EXCEPTION 1 to Section ~~144~~140.4(h)4: Open circuit c~~C~~ooling towers that are ducted (inlet or discharge) or have an external sound trap that requires external static pressure capability.
EXCEPTION 2 to Section ~~144~~140.4(h)4: Open circuit c~~C~~ooling towers that meet the energy efficiency requirement for propeller fan open circuit towers in Section 110.2, TABLE 110.2-G.

***Justification*: Clarifies that this section applies to open circuit cooling towers only as opposed to closed circuit cooling towers.**

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(j) **Limitation of Air-Cooled Chillers**

1. Chilled water plants ~~with more than 300 tons total capacity~~ shall not have more than ~~100~~300 tons provided by aircooled chillers.

~~**EXCEPTION 1 to Section 144140.4(jj):** Where the designer demonstrates that the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled equipment.~~

EXCEPTION ~~2~~ to Section ~~144~~140.4(j~~i~~): ~~Plants that employ a cooling~~Chillers that are used to charge thermal energy storage system with a design temperature of less than 40 degrees F (4 degrees C).

~~**EXCEPTION 3 to Section 144140.4(jj):** Air cooled chillers with minimum efficiencies approved by the Commission pursuant to Section 10-109(d).~~

***Justification*: Exception 1 allows a designer to arbitrarily dismiss water cooled systems in lieu of air cooled. Tower manufacturers today offer a wide range of materials of construction that can handle most, if not all, water qualities that may be encountered, including the use of recycled and grey water as make-up. This negates the need for the first exception. Exception 3 negates the intent of the air cooled chiller limitation while providing no visibility to what "high efficiency" air cooled chillers have been approved by the Commission. Delete this exception to strengthen the requirement.**

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COOLING TECHNOLOGY INSTITUTE

CTI ATC-105-00	Acceptance Test Code for Water Cooling Towers (2000)
CTI ATC-105S-11	Acceptance Test Code for Closed Circuit Cooling Towers (2011)
CTI STD-201-~~04~~ 11	Standard for the Certification of Water-Cooling Tower Thermal Performance (20~~04~~11)
Available from:	Cooling Technology Institute 2611 FM 1960 West, Suite A-101 Houston, Texas 77068-3730 PO Box 73383 Houston, Texas 77273-3383 (281) 583-4087

***Justification*: CTI ATC-105S has been referenced in the 2013 edition of Title 24. STD-201 was also revised in 2011 so the latest revision date is shown. Note that there were no changes in this latest revision that would affect its use in Title 24.**

ASHRAE TC08.06 Cooling Towers and Evaporative Condensers

Comments to: *Appendix JA1– Glossary*

CLOSED-CIRCUIT COOLING TOWER

is a ~~closed-circuit~~ cooling tower that utilizes indirect contact between a heated fluid, typically water or glycol, and the cooling atmosphere to transfer the source heat load through sensible and latent heat and mass transfer indirectly to the air, essentially combining a heat exchanger and cooling tower into ~~one~~ an integrated and relatively compact device.

CTI

is the Cooling Technology Institute.

CTI ATC-105

is the Cooling Technology Institute document entitled "Acceptance Test Code for Water Cooling Towers," 2000 (CTI ATC-105-00).

CTI ATC-105S(~~96~~11)

is the Cooling Technology Institute document entitled "Acceptance Test Code for Closed-Circuit Cooling Towers," 1996 (CTI ATC-105-~~96~~11).

CTI STD-201

is the Cooling Technology Institute document entitled "Standard for the Certification of Water-Cooling Tower Thermal Performance," ~~2004~~2011 (CTI STD-201-~~04~~11).

FLUID COOLER

is a fan-powered heat rejection device that includes a water or glycol circuit connected by a closed circulation loop to a ~~water~~liquid-cooled refrigerant condenser, and may be either evaporative-cooled or air-cooled or a combination of the two (also see *closed circuit cooling tower*).

OPEN CIRCUIT COOLING TOWER

is an open, or direct contact cooling tower which exposes water directly to the cooling atmosphere, thereby transferring the source heat load from the water directly to the air by a combination of heat and mass transfer.

PART-LOAD OPERATION

occurs when a ~~loaded air compressor~~system or device is operating below its maximum rated capacity.

***Justification*: All of the above comments are to clarify the definitions listed to industry standard terms.**

Attachments

Evapco Letter dated March 08 2012

Addendum "af" to ASHRAE Standard 90.1-2010 (soon to be out for public review)

EVAPCO, INC.
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Westminster, Maryland 21158
Telephone: 410-756-2600
Facsimile: 410-756-6450

March 8, 2012

California Energy Commission

Attention: Docket No. 12-BSTD-1
Dockets Office
1516 Ninth Street, MS-4
Sacramento, CA 95814

Subject: EVAPCO's response to the Revisions to the California Building Energy Efficiency Standards, California Code of Regulations, Title 24, Part 1 and Part 6
2013 Building Energy Efficiency Standards

To the Energy Commissioner:

EVAPCO recognizes and appreciates the efforts to increase energy and water efficiency for the commercial building and refrigeration industry with the proposed 2013 California Title 24. However, we have concerns regarding several new sections of the code. The sections are posted below along with our comments, suggested code modifications and justification.

First and foremost, setting the efficiency levels for evaporative condensers at 350 btuh/Watt for outdoor (axial fan) evaporative condensers and 160 btuh/Watt for indoor (centrifugal) condensers, as presented in the CASE Study for Refrigerated Warehouses dated October 31, 2011 and in the new 2013 code are unreasonably inflated efficiency values for a starting point in a new code. CEC's CASE report dated February 2007 for Refrigerated Warehouses quotes a survey of contractors on "Evaporative Condenser Fan and Pump Power" that Refrigerated Warehouse condensers operate in the **200 btuh/Watt efficiency level.**

These proposed values will have an immediate negative impact on our industry and will restrict the use of 30-50% of the evaporative condenser product lines available in the market place. EVAPCO suggests lowering the efficiency values to a more realistic starting level. We respectfully propose the following specific efficiency for Outdoor/Indoor Evaporative Cooled Condensers:

Description	Specific Efficiency[1]
Vane-Axial/Outdoor	225 Btuh/Watt
Centrifugal/Indoor	150 Btuh/Watt

[1]The specific efficiency above is based on 100°F condensing temperature at 70°F entering air wet bulb design condition.

These unrealistically high specific efficiencies are further magnified when compared to air cooled condenser specific efficiencies that are in the range of 65-75 Btuh/Watt. If the true goal of the California Investor Owned Utilities and California Energy Commission is to achieve significant energy savings in refrigerated warehouses then disparate specific efficiencies appear to be contradictory.

It will take an air cooled condenser 4.66 times the amount of energy to reject the heat load compared to an evaporative-cooled condenser based on the recommended specific efficiencies [(350 btuh/W) / (75 btuh/W)]. Furthermore, the higher condensing temperature specified for the air-cooled condenser specific efficiency significantly increases the compressor's power consumption therefore increasing the overall energy consumption of the system, the opposite goal of the IOU's and CEC's energy savings strategy.

In addition, the evaporative condenser design conditions are based on lower condensing temperatures than the 105°F condensing temperature used to evaluate air cooled condensers. Therefore, an evaporative cooled refrigeration system will be inherently more efficient due to the lower condensing temperature and the resulting lower horsepower consumption of the compressor.

EVAPCO is not trying to eliminate the use of air-cooled condensers as a viable means of condensing but would like to understand why evaporative-cooled products are being held to such a high energy efficiency requirement. Should air-cooled condensing systems and evaporative-cooled condensing systems be lumped into the same program? The concern we have is that the specific efficiency requirements proposed for evaporative-cooled condensers will restrict the number of models provided by manufacturers of evaporative cooled condensers and the code is more flexible for air-cooled condensers. Note, even the least efficient evaporative-cooled condenser is significantly more efficient than the specified air cooled condenser specific efficiency of 75 Btuh/Watt. Why limit design engineers from using an evaporative-cooled condenser that is still more energy efficient than an air-cooled condenser?

The CEC's proposed efficiency will require manufacturers to obsolete existing models resulting in the inability to effectively optimize selections, address project specific layout issues and offer the most cost effective solutions. Placing restrictions on evaporative cooled equipment will potentially drive the market to more inefficient technologies. This is not in the best interest of the California Energy Commission.

We believe Evapco's proposed specific efficiencies shown above offer a reasonable baseline for this section of the code at this time. Future code revisions will likely include thermal performance certification and higher minimum specific efficiencies. This will be a challenge for all manufacturers of both evaporative and air cooled condensers.

We encourage further evaluation of the overall energy impact associated with operating the refrigeration system at lower condensing temperatures. It is well recognized within the industrial refrigeration industry that the optimum system operating condition is based on lowering the condensing temperature to reduce the horsepower consumption of the compressor.

EVAPCO's suggested efficiency levels are provided in Table 120.6 below:

TABLE 120.6-B FAN-POWERED CONDENSERS – MINIMUM EFFICIENCY REQUIREMENTS

Condenser Type	Refrigerant Type	Minimum Efficiency	Rating Condition
Outdoor Evaporative-Cooled with THR Capacity > 8,000 MBH	All	~~350~~ 225 Btuh/Watt	100°F Saturated Condensing Temperature (SCT), 70°F Outdoor Wet bulb Temperature
Outdoor Evaporative-Cooled with THR Capacity < 8,000 MBH and Indoor Evaporative-Cooled	All	~~160~~ 150 Btuh/Watt	
Outdoor Air-Cooled	Ammonia	75 Btuh/Watt	105°F Saturated Condensing Temperature (SCT), 95°F Outdoor Drybulb Temperature
	Halocarbon	65 Btuh/Watt	
Indoor Air-Cooled	All	Exempt	

Other items we find problematic in the documents are:

1) In the CASE study on the energy use of Refrigerated Warehouses dated October 31, 2011 a chart is published in Section 2, page 8 and 9 for different climate zones. The chart suggests energy savings for each type of condenser and presents data on the energy savings benefits of *air cooled condensers* compared to indoor evaporative cooled condensers.

For example, in Fresno, CA, it is shown that there is a **7680 kWh** annual energy savings with an air cooled condenser versus **344 kWh** for an indoor evaporative cooled condenser. This appears illogical. Knowing air cooled condenser efficiencies at 75 btuh/watt and centrifugal indoor evaporative condenser efficiencies of 160 btuh/watt, how is this savings figure achieved?

2) In this same study, EVAPCO agrees with **Section 4.4 Allow Air-Cooled Ammonia Condensers** by allowing air-cooled condensers for ammonia applications for greater energy savings versus halocarbons. However, the analysis performed in Appendix G to show the attractiveness of air cooled condensers in cool climates contains an overstated water consumption value for evaporative condensers.

EVAPCO performed its own evaluation of water usage for an evaporative condenser using the data for the Prototype Warehouse #1 from "Appendix A: Load Calculations for Fresno" Calculating the total load of this warehouse:

i) The 35°F cooler space of 1,277,384 btuh
ii) The -10°F freezer space of 1,385,001btuh
iii) The 40°F dock space of 1,107, 846 btuh

Total load is 3,770,231 btuh for this 92,000 sf. warehouse.

Using typical design conditions of 96°F condensing and a 73°F wet bulb (not sure why 70°F SCT was utilized in Appendix G), a selection was made utilizing EVAPCO's custom software program which utilizes up to date global climactic data, a typical load profile for refrigerated warehouses provided by Cascade Energy and an increased value of 5 cycles of concentration which is the California average based on the Cooling Tower Water Savings CASE study of October 2011. Note: 2.4 cycles was used in the Refrigerated Warehouse Appendix G study.

The EVAPCO ATC-305E-1g evaporative condenser is acceptable for this application and only uses **2,400,000** gallons of water annually. The example illustrated an annual water savings of **4,016,431 gallons** of *water* as shown in Appendix G using air cooled condensers.

By the ratio of the specific efficiencies, the air cooled condenser system could consume up to 4.66 times the power of the evaporative system. The additional water consumption required by the power plant to produce this additional power needs to be considered in the evaluation of true water saved.

The energy savings realized in cooler climates for air cooled is also confusing, the energy efficiency of evaporative cooled equipment, especially in cooler climates will still exceed air cooled.

Simply stated, the energy and water saving values in Appendix G are inflated, and give the reader the impression that using air cooled condensers can save both water and energy.

3) In Appendix F of the October 31, 2011 Refrigerated Warehouse CASE study, the "Savings by Design" efficiency tables shown in **Figure 71: Axial Fan evaporative cooled ammonia condenser baseline** do not provide a set of design conditions that were used to establish the efficiency levels listed. In addition, the simple average of the values as shown in the table is actually 305 btuh/watt, not 350 as shown and used through the entire study.

EVAPCO, an environmentally focused company, looks forward to participating in the development of the next version of Title 24 Refrigerated Warehouses.

Best regards,

Daryn S. Cline

Daryn S. Cline
Director, Environmental Technologies
EVAPCO, Inc.

cc:\\Mr. Joe Mandato	Senior Vice President, Industrial Refrigeration, EVAPCO, Inc.
Mr. Tom Bugler	Chief Technical Officer and Senior Vice President, EVAPCO, Inc.
Mr. Trevor Hegg	Director, Product Development Industrial Refrigeration, EVAPCO, Inc.
Mr. Don Hamilton	Product Development Manager, Evaporative Condensers, EVAPCO, Inc.

BSR/ASHRAE/IES Addendum af
to ANSI/ASHRAE/IES Standard 90.1-2010

Public Review Draft

Proposed Addendum af to Standard 90.1-2010, *Energy Standard for Buildings Except Low-Rise Residential Buildings*

First Public Review (February 2012)
(Draft shows Proposed Changes to Current Standard)

ASHRAE, 1791 Tullie Circle, NE, Atlanta GA 30329-2305

(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

This Addendum covers two changes to Chapter 6 of the Standard incorporating open circuit cooling tower flow turndown and fan control for multi-fan heat rejection installations as follows:

- *The addition of a flow turndown requirement to the Standard will require the use of cooling towers capable of handling modulation of condenser water flow as a means to save energy. Manufacturers would need to design and supply spray water distribution systems, either gravity flow or pressurized, that will function properly at a reduced flow over the tower. The 50% flow turndown ratio was established to minimize the potential for scaling of the heat transfer surface in the tower, which can reduce the capacity of the tower and consequently lead to higher energy use. The 50% turndown ratio also corresponds with the latest proposal for a similar flow turndown requirement in California Title 24.*

- *As virtually all heat rejection equipment utilize VSDs on the 7.5 HP fans and above, a requirement to operate the maximum number of fans in a multi-fan installation to minimize energy for a given duty has been added as 6.5.5.2.2. All fans should be operated in tandem at the same fan speed as this control sequence for multi-fan installations is more energy efficient than on/off or sequenced fan operation. A note that the minimum fan speed must comply with the minimum allowable speed of the fan drive system per the heat rejection device manufacturer's recommendations was also added.*

Two other changes were also made:

- *6.5.5.1 was revised to include dry coolers as an example since they are common devices used for heat rejection and to clarify the two types of cooling towers referenced in this section (open-circuit and closed-circuit).*
- *6.5.5.2.1 was revised to eliminate exception d. as most heat transfer devices utilize VSDs due to the many benefits and declining costs of VSDs. This exception would also conflict*

with the fan speed requirement proposed in 6.5.5.2.2 for multi-cell heat rejection devices.

Note that this change to the Standard is supported by the Standards Subcommittee of TC08.06, the ASHRAE technical committee for Cooling Tower and Evaporative Condensers.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and strikethrough (for deletions) unless the instructions specifically mention some other means of indicating the changes. Only these changes are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed substantive changes.

Addendum af to 90.1-2010

Revise the Standard as follows (I-P units)

6.5.5 Heat Rejection Equipment

6.5.5.1 General. Section 6.5.5 applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers, and evaporative condensers.

Exception: Heat rejection devices whose energy usage is included in the equipment efficiency ratings listed in Tables 6.8.1A through 6.8.1D.

6.5.5.2 Fan Speed Control.

6.5.5.2.1 Each fan powered by a motor of 7.5 hp or larger shall have the capability to operate that fan at two-thirds of full speed or less and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

Exceptions:
a. Condenser fans serving multiple refrigerant circuits.
b. Condenser fans serving flooded condensers.
c. Installations located in climate zones 1 and 2.
d. Up to one-third of the fans on a condenser or tower with multiple fans, where the lead fans comply with the speed control requirement.

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

a. Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and
b. Control all fans to the same fan speed required for the instantaneous cooling duty as opposed to staged (on/off) operation. Minimum fan speed shall comply with the minimum allowable speed of the fan drive system per the manufacturer's recommendations.

6.5.5.3 Limitation on Centrifugal Fan Open-Circuit Cooling Towers. Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1100 gpm or greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table 6.8.1G.

Exception: Centrifugal open-circuit cooling towers that are ducted (inlet or discharge) or require external sound attenuation.

6.5.5.4 Tower Flow Turndown. Open circuit cooling towers used on water cooled chiller systems that are configured with multiple or variable speed condenser water pumps shall be designed so that all open circuit cooling tower cells can be run in parallel with the larger of:

A. The flow that is produced by the smallest pump at its minimum expected flow rate, or
B. 50 percent of the design flow for each the cell.

Revise the Standard as follows (S-I units)

6.5.5 Heat Rejection Equipment

6.5.5.1 General. Section 6.5.5 applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers, and evaporative condensers.

Exception: Heat rejection devices whose energy usage is included in the equipment efficiency ratings listed in Tables 6.8.1A through 6.8.1D.

6.5.5.2 Fan Speed Control.

6.5.5.2.1 Each fan powered by a motor of 5.6 kW or larger shall have the capability to operate that fan at two-thirds of full speed or less and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

Exceptions:
a. Condenser fans serving multiple refrigerant circuits.
b. Condenser fans serving flooded condensers.
c. Installations located in climate zones 1 and 2.
d. Up to one-third of the fans on a condenser or tower with multiple fans, where the lead fans comply with the speed control requirement.

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

a. Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and
b. Control all fans to the same fan speed required for the instantaneous cooling duty as opposed to staged (on/off) operation.
1. Minimum fan speed shall comply with the minimum allowable speed of the fan drive system per the manufacturer's recommendations.

6.5.5.3 Limitation on Centrifugal Fan Open-Circuit Cooling Towers. Centrifugal fan open-circuit cooling towers with a combined rated capacity of 69 L/s or greater at 35°C condenser water return, 29°C condenser water supply, and 24°C outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table 6.8.1G.

Exception: Centrifugal open-circuit cooling towers that are ducted (inlet or discharge) or require external sound attenuation.

6.5.5.4 Tower Flow Turndown. Open circuit cooling towers used on water cooled chiller systems that are configured with multiple condenser water pumps shall be designed so that all open circuit cooling tower cells can be run in parallel with the larger of:

A. The flow that is produced by the smallest pump, or
B. 50 percent of the design flow for the cell.