Approved by GBCI for 1 CE Hour
Course Approval Number is 0090009535

Key Impacts of ASHRAE Standards on Waterside Design

James M. Pleasants Company

www.jmpco.com

A Few **Key Impacts of ASHRAE** Standards on Building Code Waterside Design

(**Standards 90.1 and 189.1**)

I. History of ASHRAE 90.1
II. 90.1 Comparisons Energy
III. 90.1 - 2010 Current and DOE Requirements
IV. 189.1 (Army Corp Engineer) LEED Green
V. 90.1 - 2013 Future (Economics)
VI. Summary

2

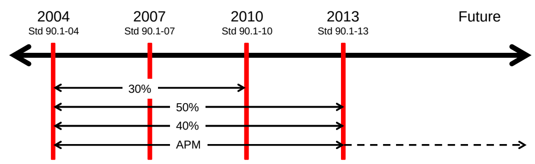
History of Standard 90.1

Standard 90.1 originated in 1975 in response to the energy crisis of the early 1970s. It was revised in 1980, but became more prominent in building designs with the co-sponsorship of the Illuminating Engineering Society of North America (IESNA) in the 1989 edition and as a result of its adoption within the building codes of many regions of the country.

In 1999, ASHRAE placed the standard on continuous maintenance in conjunction with the American National Standards Institute (ANSI). **The U.S. Department of Energy (DOE) also reviewed the 1999 edition and determined that it was in the country's best interests to require all states to implement a state energy code requirement that met or exceeded Standard 90.1-1999 by July 2004.**

3

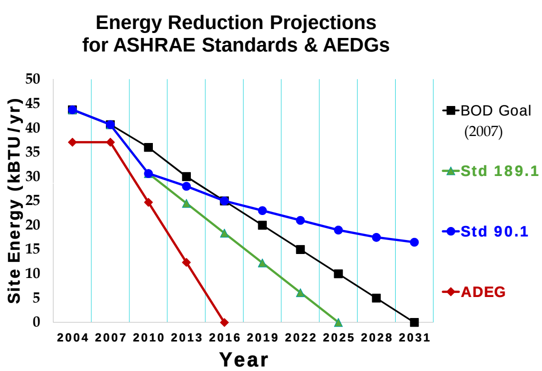
ASHRAE Standard 90.1-2013



- 90.1-10 Work Plan - 30%
- 90.1-13 Work Plan - 50%
  on regulated end use loads
- 90.1-13 Work Plan - 40%
  whole building (all end uses)
- 90.1-13 Work Plan - EUI
- 90.1-13 Work Plan - Alternate
  Performance Methodology (APM)

Milestones

4



5

What is **NZEB**?

Net Zero Energy Building

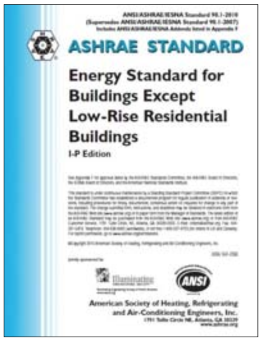
- Net **Zero Site Energy** - A building that produces at least as much renewable energy as it uses
- Net **Zero Source Energy** - A building that produces or purchases at least as much renewable energy as it uses

- Solar
- Wind Turbines
- Water Turbines
- Biomass
- Geothermal

6

ASHRAE STANDARD

ASHRAE is dedicated to improve its Standards to facilitate the move to **NZEBs**



ANSI/ASHRAE/IESNA/Standard 90.1-2010 (I-P Edition)

7

States to Use 90.1-2010 by Oct. 18, 2013

WASHINGTON—ASHRAE's Washington office is reporting that the U.S. Department of Energy (DOE) has determined that ANSI/ASHRAE/IES Standard 90.1-2010, *Energy Standard for Buildings Except Low-Rise Residential Buildings,* saves more energy than Standard 90.1-2007. Specifically, DOE found national source energy savings of approximately 18.2%, and site energy savings of approximately 18.5%, when comparing the 2010 and 2007 versions of Standard 90.1. As a result of this week's **DOE final determination, states are required to certify by Oct. 18, 2013 that have reviewed the provisions of their commercial building code regarding energy efficiency and updated their code to meet or exceed Standard 90.1-2010.**

http://www.iccsafe.org/gr/documents/stateadoptions.pdf

8

CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 6.4
Mandatory Provisions

6.4.1.4 Verification of Equipment Efficiencies. Equipment *efficiency* information supplied by *manufacturers* shall be verified as follows: …

f. Requirements for plate type liquid-to-liquid heat exchangers are listed in Table 6.8.1H

TABLE 6.8.1H Heat Transfer Equipment

Equipment Type	Subcategory	Minimum Efficiency[a]	Test Procedure[b]
Liquid-to-Liquid heat exchangers	Plate type	NR	**AHRI 400 - 2008**

[a] NR = No requirement
[b] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

9

Plate Heat Exchangers
LEEDS, ASHRAE Std.90.1 and AHRI Std.400

Date January 2011

Energy Efficient Solutions
Go Green • Live Better

10

CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 6.4
Mandatory Provisions

6.4.2 Calculations.

6.4.2.1 Load Calculations. Heating and cooling system design loads for the purpose of sizing systems and equipment shall be determined in accordance with ANSI/ASHRAE/ACCA Standard 183-2007, Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings.

6.4.2.2 Pump Head. Pump differential pressure (head) for the purpose of sizing pumps shall be determined in accordance with generally accepted engineering standards and handbooks acceptable to the *adopting authority.* **The pressure drop through each device and pipe segment in the critical circuit at design conditions shall be calculated.**

11

Calculator

iPad & iPhone Versions

- Available free from iTunes App Store
- All the calculators from the plastic wheel PLUS
  - Greater range of pipe sizes
  - Addition of PVC Pipe
  - Includes English & Metric Units
  - Handles fluids other than water
  - Incorporates Circuit Setter wheel

12

Calculator for Windows

Version 4

- Spanish Language
- Multiple units of measure
- PVC Pipe addition
- Additional fluid proprieties
- New advanced features
- **ASHRAE 90.1 support**

13

Calculator

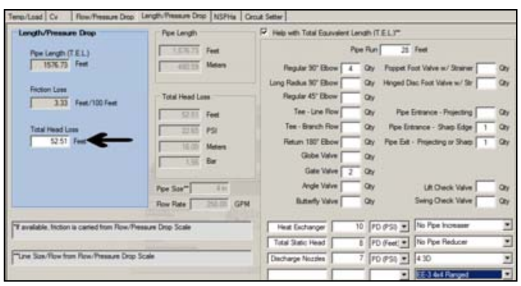
Length/Pressure Drop

- Help determining system pressure drop
- **ASHRAE 90.1 requirement for computer calculation**
- Library of Fittings, Reducers, Suction Diffusers, TDV's
- Enter components using K, Cv, PSI Drop…

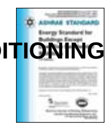
14

Go to the Length/Pressure Drop Scale and check the "Help with TEL" box. The pipe info, pressure drop and velocity will be carried over. Enter fittings, components and static head.

ANSWER: 53 Feet



15



CHAPTER 6

HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 6.5

Prescriptive Path

6.5 Prescriptive Path

6.5.1 Economizers. Each cooling system that has a fan shall include either an **air or water economizer** meeting the requirements of Sections 6.5.1.1 through 6.5.1.4.

Exceptions: Economizers are not required for the systems listed below.

TABLE 6.5.1A Minimum Fan-Cooling Unit Size for Which an Economizer is Required for Comfort Cooling

Climate Zones	Cooling Capacity for Which an Economizer if Required
1a, 1b	**No economizer requirement**
2a, 2b, 3a, **4a, 5a,** 6a 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	≥54,000 Btu/h

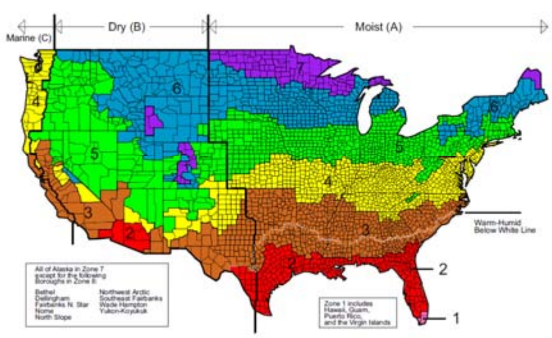
TABLE 6.5.1B Minimum Fan-Cooling Unit Size for Which an Economizer is Required for Computer Rooms

Climate Zones	Cooling Capacity for Which an Economizer if Required
1a, 1b, 2a, 3a, 4a	No economizer requirement
2b, 5a, 6a, 7, 8	≥135,000 Btu/h
3b, 3c, 4b, 4c, 5b, 5c, 6b	≥65,000 Btu/h

The Southeast is mostly 3a and 4a

16

Map of DOE's Proposed Climate Zones



March 24, 2003 17

CHAPTER 6

HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 6.5
Prescriptive Path

6.5.1.2 Water Economizers

6.5.1.2.1 Design Capacity. Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to **100% of the expected system cooling load at *outdoor air* temperatures of 50ºF dry bulb/45ºF wet bulb and below.**

Exceptions:

a. Systems primarily serving *computer rooms* in which 100% of the expected system cooling load at 40ºF dry bulb / 35ºF wet bulb is met with evaporative water economizers.

b. Systems primarily serving *computer rooms* with dry cooler water economizers which satisfy 100% of the expected system cooling load at 35ºF dry bulb.

c. Systems where dehumidification requirements cannot be met using outdoor air temperatures of 50ºF dry bulb/45ºF wet bulb and where 100% of the expected system cooling load at 45ºF dry bulb/40ºF wet bulb is met with evaporative water economizers.

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

6.5.1.3 Integrated Economizer Control. Economizer systems shall be integrated with the mechanical cooling system and be **capable of providing partial cooling even when additional mechanical cooling is required** to meet the remainder of the cooling load.

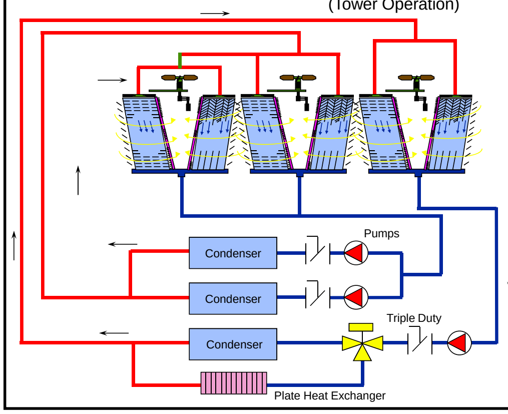
18

Cooling Tower Piping

- May require **two different cooling tower cold water supply temperatures** (Economizers need **cold** water)
- Two supply and return connections to towers maybe required because of **chiller head pressure control**. What is minimum allowable condensing temperature for your chillers?

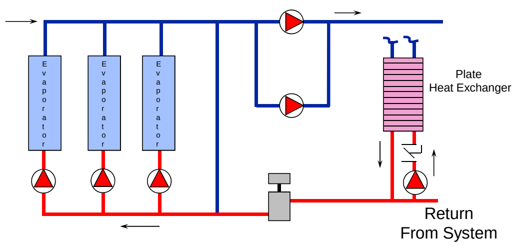
19

Water Side Economizers Condenser Water Flow
(Tower Operation)



20

Chilled Water Piping



Economizer Heat Exchanger in Series with Chillers
(more operating hours)

21

Economizer Heat Exchanger in **Series** with Chillers

- Provides **more operating hours** and a faster payback by running in series with mechanical cooling (the Economizer **reduces return water temperature** to the chiller plant)
- Will operate at higher wet bulb temperature than economizers piped in parallel with chiller plant
- May require **two different cooling tower cold water supply temperatures** (Economizers need **cold** water)
- Will gradually reduce load on chillers as the wet bulb temperature goes down and can cause **short cycling** of chillers if controls are not set up properly
- If you **elevate the chilled water supply temperature**, make sure you can **still control humidity**.

22

Waterside Economizers

6.5.1.2.1 Design capacity
50ºF drybulb/45ºF wet bulb and below

Calculate Required cooling load
Series or Parallel application
Cooling Tower piping
Dedicated Cell?
Required CW supply temperature
Calculate the approach
Select Heat Exchanger size & type
Control Sequence

23

ASHRAE 90.1 – 2010

Waterside Economizers Selection

- **Calculate design capacity cooling load at 50ºF dry bulb and 45ºF wet bulb.**
  (Required design capacity of your heat exchanger.)
- Determine the supply chilled water temperature required to maintain humidity control at above conditions. Run cooling coil program at part load to determine GPM, supply and return chilled water temperature.
- Review two-way valve selection and system balance at part load operation. (The higher the return chilled water, the more hours of operation.)
- **Decide if heat exchanger will be piped in series with chillers.**
  (6.5.13 integrated economizer control) or parallel with chillers.
- What cooling tower cells will be used for economizer and at what approach can it provide the required design cooling capacity? What is the lowest constant supply condenser water to chillers? (For same load, a lower wet bulb increases the cooling tower approach.)
- What type of heat exchanger will you use? Use plate type on clean systems. Use straight tube High K type on dirty systems. (What good is a fouled plate heat exchanger?)
- Establish heat exchanger selection temperatures using 3º temperature water approach on plates and 4º temperature approach on High K straight tube. Nominal cooling tower ton is 15,000 btu, 3 GPM at 10º range. Nominal chilled water ton is 12,000 btu, 2.4 GPM at 10º Delta T.
- Write control sequence allowing the economizer to maximized operating hours. **(At what wet bulb can we turn the economizer on?)**
- **Use cooling load profile,** local weather data and equipment selected to calculate hours of operation and **energy savings.**

24

060711CE

Raleigh-Durham, N C

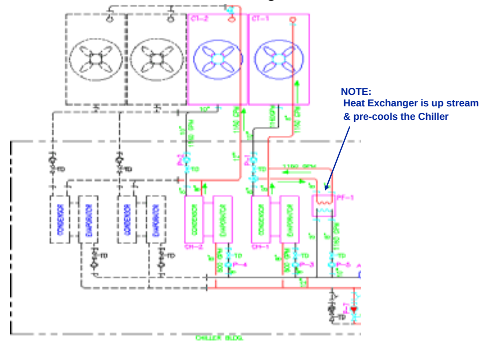
Temp Bin	Time Group 1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24	Annual Total
Wet-Bulb Temp:			Hours of Occurrence				
80 / 81	0	0	2	0	1	0	3
78 / 79	0	0	12	18	13	1	44
76 / 77	0	0	55	79	43	6	183
74 / 75	8	16	93	107	81	23	328
72 / 73	49	60	105	76	101	87	478
70 / 71	101	98	55	75	78	117	524
68 / 69	93	83	64	87	77	77	481
66 / 67	78	58	70	64	81	77	428
64 / 65	68	74	87	80	89	62	460
62 / 63	66	85	73	91	62	79	456
60 / 61	75	60	62	67	54	73	391
58 / 59	81	79	58	59	63	51	391
56 / 57	52	55	53	35	47	70	312
54 / 55	42	48	43	57	52	35	277
52 / 53	67	50	50	32	29	49	277
50 / 51	54	53	32	35	33	33	240
48 / 49	29	46	35	70	52	55	287
46 / 47	53	41	51	49	53	40	287
44 / 45	41	38	43	50	56	57	285
42 / 43	37	19	57	49	64	57	283
40 / 41	41	39	53	40	54	62	289
38 / 39	48	42	49	48	33	43	263
36 / 37	59	41	42	45	46	66	299
34 / 35	61	63	40	33	35	28	260
32 / 33	37	54	35	27	35	22	210
31 & Below							1,024

Total Hrs 3,487

25

Water Economizer / Free Cooling / Evaporative Chilling

Chiller and Heat Exchanger in Series



26

Chiller and Heat Exchanger in Series

Control Sequence

Cooling Tower:

The tower is basically divided as two towers. Cell 1 acts independently and serves Chiller 1 and the Plate Frame Economizer. Cells 2 & 3 are on a common piping system and serve Chillers 2 & 3.

If Chiller 2 or 3 is started, open the valve to the respective cell. Once the tower leaving water rises to its set point, open the valve to the second cell and allow flow through both Cells 2 & 3. Monitor the tower leaving water temperature and stage the fans, first on low speed and then to high speed. Stage both fans to low speed before either moves to high speed. No additional action is required when the remaining chiller starts since both cells will already be operating.

If Chiller 1 or the Plate Frame Economizer is enabled, monitor the tower leaving water temperature and stage the fan to maintain set point.

Tower Leaving Water Set Point:

Tower leaving water set point shall be adjusted in relation to outside wet bulb temperature. The set point shall be 85 degrees when outside wet bulb is 80 degrees. Modulate the set point to 65 degrees leaving water as outside wet bulb approaches 58 degrees.

Cell 1 operates with the water side economizer cycle and has an alternate setting when the Plate Frame is Enabled. Provide a safety to prevent the set point range from being changed to this lower setting if Chiller 1 is operating. When the economizer cycle is enabled as described elsewhere, the set point for the tower leaving water temperature shall be 60 degrees when outside wet bulb is 55 degrees, Modulate the set point to 45 degrees as wet bulb approaches 38 degrees.

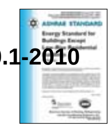
Plate Frame Economizer (Water Side Economizer):

Monitor the building chilled water return temperature and outside wet bulb temperature. **When the outside wet bulb temperatures falls 5 degrees below the building chilled water return temperature**, move the tower water selection valve to direct water flow the Plate Frame, start the tower water pump for Cell 1 and enable the economizer tower water set point as described above.

Monitor the water temperature of the water leaving the tower and entering the Plate Frame. When the temperature falls 1.5 degrees below the building chilled water return temperature, start the Plate Frame chilled water pump, P9. When tower leaving water is within 1/2 degree below the building chilled water return temperature, disable the Plate Frame chilled water pump.

27

Proposed Addendum of to Standard 90.1-2010



*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.*

28

CHAPTER 6

HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 6.5
Prescriptive Path

6.5.4 Hydronic System Design and Control.

6.5.4.1 Hydronic Variable Flow Systems. HVAC pumping systems having a total pump system power exceeding 10 hp that include control valves designed to modulate or step open and close as a function of load shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to 50% or less of the design flow rate. **Individual chilled water pumps** serving variable flow systems having motors **exceeding 5 hp** shall have controls and/or devices (**such as variable speed control**) that will result in pump motor demand of no more than 30% of design wattage at 50% of design water flow. The controls or devices **shall be controlled** as a **function of desired flow or** to maintain a **minimum required differential pressure**. Differential pressure shall be measured at or near the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure. The **differential pressure setpoint** shall be **no more than 110% of** that required to achieve **design flow through the heat exchanger**. Where differential pressure control is used to comply with this section and DDC controls are used the setpoint shall be **reset downward based on valve positions until one valve is nearly wide open**.

Exceptions:

a. Systems where the minimum flow is less than the minimum flow required by the equipment *manufacturer* for the proper operation of equipment served by the system, such as chillers, and where total pump system power is 75 hp or less.

b. Systems that include no more than three control valves.

29

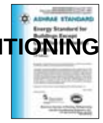
Required Addition to all Variable Speed Pump Logic Control Master Specifications

The pump logic controller shall be capable of resetting the differential pressure set point to no more than 110% of that required to achieve design flow at the critical heat exchanger. Logic controller shall be capable of **reset based on valve position or logic based on flow to vary differential set point** to achieve design flow until one valve is nearly wide open.

"It's The Law"

30

CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING



SECTION 6.5
Prescriptive Path

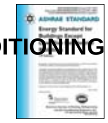
6.5.4 Hydronic System Design and Control.

6.5.4.2 Pump Isolation. When a chilled-water plant includes **more than one chiller**, provisions shall be made so that the flow in the **chiller plant can be automatically reduced**, correspondingly, when a **chiller is shut down**. Chillers referred to in this section, piped in series for the purpose of increased temperature differential, shall be considered as one chiller.

When a *boiler* plant includes **more than one *boiler***, provisions shall be made so that the flow in the *boiler* plant can be **automatically reduced**, correspondingly, when a ***boiler* is shut down.**

31

CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING



SECTION 6.5
Prescriptive Path

6.5.4.4 Hydronic (Water Loop) Heat Pumps and Water-Cooled Unitary Air-Conditioners.

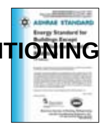
6.5.4.4.1 Each hydronic heat pump and water-cooled unitary air-conditioner shall have a **two-position *automatic* valve interlocked to shut off water flow when the compressor is off.**

Exception: Units employing water economizers.

6.5.4.4.2 Hydronic heat pumps and water-cooled unitary air-conditioners having **a total pump system power exceeding 5 hp** shall have controls and/or devices (**such as variable speed control**) that will result in pump motor demand of no more than 30% of design wattage at 50% of design water flow.

32

CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING



SECTION 6.5
Prescriptive Path

6.5.4.4 Hydronic (Water Loop) Heat Pumps and Water-Cooled Unitary Air-Conditioners.

6.5.4.5 Pipe Sizing. All chilled-water and condenser-water piping shall be designed such that the design flow rate in each pipe segment shall not exceed the values listed in Table 6.5.4.5 for the appropriate total annual hours of operation. Pipe size selections for systems that operate under variable flow conditions (e.g., modulating two-way control valves at coils) and that contain variable-speed pump motors are allowed to be made from **the "Variable Flow/Variable Speed" columns. All others shall be made from the "Other" columns.**

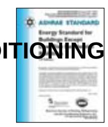
Exceptions:

a. Design flow rates exceeding the values in Table 6.5.4.5 are allowed in specific sections of pipe if the pipe in question is not in the critical circuit at design conditions and is not predicted to be in the critical circuit during more than 30% of operating hours.

b. Piping systems that have equivalent or lower total pressure drop than the same system constructed with standard weight steel pipe with piping and fittings sized per Table 6.5.4.5.

33

CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING



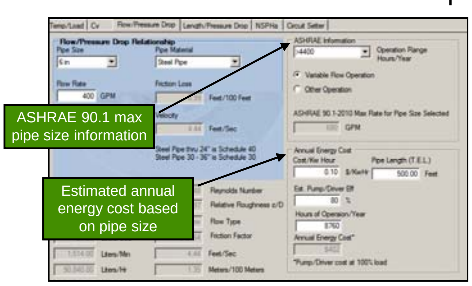
SECTION 6.5
Prescriptive Path

TABLE 6.5.4.5 Piping System Design Maximum Flow Rate in GPM

Operating Hours/Year	**≤2000 Hours/Year**		**<2000 and ≤4400 Hours/Year**		**>4400 Hours/Year**	
Nominal Pipe Size, in.	**Other**	**Variable Flow/ Variable Speed**	**Other**	**Variable Flow/ Variable Speed**	**Other**	**Variable Flow/ Variable Speed**
2½	120	180	85	130	68	110
3	180	270	140	210	110	170
4	350	530	260	400	210	320
5	410	620	310	470	250	370
6	740	1100	570	860	440	680
8	1200	1800	900	1400	700	1100
10	1800	2700	1300	2000	1000	1600
12	2500	3800	1900	2900	1500	2300
Maximum Velocity for Pipes over 12 in. Size	8.5 fps	13.0 fps	6.5 fps	9.5 fps	5.0 fps	7.5 fps

34

Calculator – Flow/Pressure Drop



Note that cost is based on a constant load – it is independent of the info in ASHRAE frame

35

CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 6.5
Prescriptive Path

6.5.6.2 Heat Recovery for Service Water Heating

6.5.6.2.1 Condenser heat recovery systems shall be installed for **heating or preheating of service hot water** provided all of the following are true:

a. The facility operates 24 hours a day.

b. The total installed heat rejection capacity of the water-cooled systems exceeds 6,000,000 Btu/h of heat rejection.

c. The design service water heating load exceeds 1,000,000 Btu/h.

6.5.6.2.2 The required heat recovery system shall have the capacity to provide the smaller of:

a. 60% of the peak heat rejection load at design conditions,
or

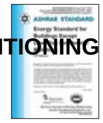
b. Preheat of the peak service hot water draw to 85°F.

Exceptions:

a. Facilities that employ condenser heat recovery for space heating with a heat recovery design exceeding 30% of the peak water-cooled condenser load at design conditions.

b. Facilities that provide 60% of their service water heating from *site-solar* or *site-recovered energy* or from other sources.

36



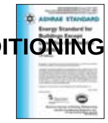
CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING
SECTION 6.7
Submittals

6.7.2.3 System Balancing

6.7.2.3.1 General. *Construction documents* **shall require that all *HVAC systems* be balanced** in accordance with *generally accepted engineering standards* (see Informative Appendix E). *Construction documents* shall **require that a written balance report be provided to the building owner** or the designated representative of the building owner for HVAC *systems* serving *zones* with a total conditioned **area exceeding 5000 ft²**.

6.7.2.3.2 Air System Balancing. Air *systems* shall be balanced in a manner to first minimize throttling losses. Then, for *fan system power* greater than 1 hp, fan speed shall be adjusted to meet design flow conditions.

37



CHAPTER 6
HEATING, VENTILATING, AND AIR CONDITIONING
SECTION 6.7
Submittals

6.7.2.3 System Balancing

6.7.2.3.3 Hydronic System Balancing. Hydronic *systems* **shall be proportionately balanced** in a manner to first minimize throttling losses; then the pump impeller shall be trimmed or **pump speed shall be adjusted** to meet design flow conditions.

Exceptions: Impellers need not be trimmed nor pump speed adjusted

a. for pumps with pump motors of 10 hp or less, or

b. when throttling results in no greater than 5% of the *nameplate horsepower* draw, or 3 hp, whichever is greater, above that required if the impeller was trimmed.

38

CHAPTER 6
HVAC Systems
6.7 Submittals
6.7.2.3 System Balancing

Example 6-QQQ. Balancing Requirements, Balancing Valves
Corresponding section: System Balancing (6.7.2.3)

Q What types of balancing valves does the Standard require?

A The Standard requires only that the system be specified to be balanced, which implies that it must be capable of being balanced. But it does not require that any particular balancing device be used. Common examples of balancing designs at coils and heat exchangers include:

- **Calibrated balancing valves**;
- Automatic system-powered flow control (**flow limiting**) valves;
- Standard ball or butterfly valves along with pressure gauges or test plugs that will allow pressure drop across the coil or heat exchanger flow to be measured and flow deduced from manufacturer's performance data;
- **Pressure-independent control valves**; and
- Automatic control valves (see further discussion in Example 6-RRR).

39

Calibrated balancing valves

Automatic system-powered flow control (flow limiting) valves

Pressure-independent control valves

40

Performance Measurement

- **ASHRAE** and **NEBB** believe that building performance is evolving as a new standard by which our industry will be measured in the future.
- **ASHRAE** and **NEBB** believe that combining their strengths would produce an approach to building performance that would be far superior to any that could be produced by their individual efforts.
- **Talks continue between the two organizations to consolidate**.

41

CHAPTER 7
SERVICE WATER HEATING
SECTION 7.4
Mandatory Provisions

7.4.4 Service Water Heating System Controls

7.4.4.2 Temperature Maintenance Controls. *Systems* designed to maintain usage temperatures in hot-water pipes, such as recirculating hot-water *systems* or *heat trace*, shall be equipped with ***automatic* time switches or other *controls*** that can be set to switch off the usage temperature maintenance *system* during extended periods when hot water is not required.

7.4.4.3 Outlet Temperature Controls. Temperature controlling means shall be provided to **limit the maximum temperature** of water delivered from lavatory faucets in *public facility restrooms* to **110ºF**.

7.4.4.4 Circulating Pump Controls. When used to maintain storage tank water temperature, recirculating pumps shall be equipped with *controls* limiting operation to a period from the start of the heating cycle to **a maximum of five minutes after the end of the heating cycle**.

42

Following is from section III, Chapter 7 of OSHA's technical manual.
(http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_7.html#5)

C. DOMESTIC HOT-WATER SYSTEMS.

1. **Background.** Domestic hot-water systems are frequently **linked to Legionnaires' outbreaks.**

Water heaters that are **maintained below 60°C (140°F) and contain scale and sediment tend to harbor the bacteria** and provide essential nutrients for commensal micro-organisms that foster growth of *L. pneumophila.*

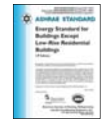
2. **Design.** Water systems **designed to recirculate water** and minimize dead legs will **reduce stagnation.**

3. **Maintenance.**

a. To **minimize the growth of Legionella** *in the system, domestic* hot water should be **stored at a minimum of 60°C (140°F)**

c. Domestic hot-water **recirculation pumps should run continuously.** They should be excluded from energy conservation measures.

43



CHAPTER 10
OTHER EQUIPMENT

SECTION 10.4
Mandatory Provisions

10.4.2 Service Water Pressure Booster Systems. Service water pressure booster systems shall be designed such that:

a. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensor(s) shall either be located near the **critical fixture(s)** that determine the pressure required, **or logic** shall be employed that adjusts the setpoint to **simulate operation of remote sensor(s).**

b. **No device(s)** shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, **except for safety devices.**

c. **No booster** system pumps shall operate when there is **no service water flow.**

44

Constant Speed Pressure Boosters using
Pressure Reducing Valves are obsolete
October 18th, 2013

(Constant Speed Dead)

All pressure boosters **will become variable speed** with no across the line constant speed bypass. A constant speed bypass may lead to discharge pressure being to high.

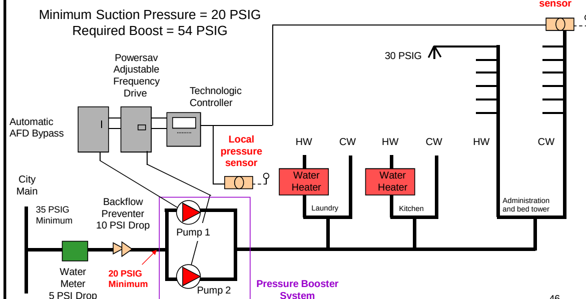
"It's The Law"

45

Domestic water pressure boosting system with adjustable frequency pump drives.

Maximum Design System Flow = 400 GPM
Required Discharge Pressure = 74 PSIG
30 psig residual pressure
24 psig static pressure
20 psig friction head loss

Minimum Suction Pressure = 20 PSIG
Required Boost = 54 PSIG



46

Effects of Sensor Location on Example System

	Local Sensor	Remote Sensor
Set Point	74 psig	30 psig
Control curve	Little change with flow	Significant head reduction at lower flows
Speed reduction achievable	**10 percent**	**26 percent**

47

AOC Review

Two **constant speed** pumps, $6,792/yr.
50/50 percent split

Two variable speed pumps,
local sensor,
50/50 percent split $3,566/yr.

Two variable speed pumps.
remote sensor,
50/50 percent split $2,537/yr.

48

Required Addition to all Pressure Booster Master Specifications

To meet ASHRAE 90.1-2010 standard and DOE building code requirement by October 18th, 2013 the variable speed pressure booster shall control to a **remote sensor at the critical fixture or logic to vary the local discharge pressure setpoint based on demand** to simulate the operation of a **remote sensor.**

"It's The Law"

49

Why 189.1 Is Important

The more important question is why do we need such a standard? The environmental impact of the building design, construction and operations industry is enormous. **Buildings in the United States are responsible for 39% of CO_2 emissions, 40% of energy consumption, 13% of water consumption and 15% of GDP per year**, making green building a source of significant environmental opportunity. ASHRAE, together with our partners, the **U.S. Green Building Council** and the **Illuminating Engineering Society**, see this standard as a way to begin to reduce the environmental impact of the building environment.

50

189.1-2009 Adopted By Army

ASHRAE Insights

February 2011 • Volume 26 • Number 1

ASHRAE recently met with U.S. Army officials regarding a new sustainable design and development policy that incorporates requirements of the green building standard developed by the Society, USGBC and IES.

The U.S. Army has made it a matter of policy to promote sustainability and improve green building standards for its facilities.

On Oct. 27, 2010, Katherine Hammack, assistant secretary of the Army for installations, energy and the environment (IE&E), issued a policy memorandum that incorporates ASHRAE/USGBC/IES Standard 189.1-2009, *Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings*.

The Army's policy sets a new approach to the design and construction of efficient military construction projects and major renovations by using Standard 189.1 as the baseline. The policy requires that facility construction projects follow specified requirements and guidance in the standard. These requirements address siting, energy efficiency, cool roofs, metering, storm water management and water consumption.

"After nearly four years of peer review and collaboration with various members of industry, we are extremely pleased that the Army has taken up the initiative to incorporate the standard into its day-to-day practices," said Lynn G. Bellenger, ASHRAE president. "The Army is clearly committed to taking the lead within the military to incorporate innovative practices proven by the private sector. Their willingness to adopt this standard speaks volumes about its value and efficacy."

The net effect of the Army's sustainable design initiative is likely to be immense. The policy applies to all construction and renovation of new buildings and structures in the U.S. territories, permanent overseas active army installations, Army Reserve centers, Army National Guard facilities and Armed Forces Reserve centers. The footprint of the existing Army buildings and structures worldwide covers more than 954 million ft².

"We are committed to sustainable design and development but our commitment extends far beyond construction and renovation savings," said Hammack. "We are on a path to integrating energy and sustainability considerations into our fundamental way of thinking as we progress toward net-zero energy, water and waste in buildings and installations."

ASHRAE leadership and Army officials discussed how the Society could continue development and stringency of Standard 189.1 to provide guidance toward net-zero buildings. The parties also discussed how ASHRAE can help fulfill the Army's training needs regarding the standard and how 189.1 fits into the Army's long-term plans to make their facilities more sustainable.

2012 Papers, From Page 1

on tracks, contacts and submittal requirements, visit www.ashrae.org/chicago.

Full-length technical papers or conference paper abstracts (400 words or less) should be submitted by April 18.

More information about the two types of papers and how to submit a full-length technical paper or conference paper abstract is also available at www.ashrae.org/chicago.

For accepted conference paper abstracts, the completed conference papers will be due July 8, 2011.

The conference is expected to attract some 3,000 attendees from 60 countries. The technical program takes place Sunday, Jan. 22–Wednesday, Jan. 25, and includes paper presentations as well as non-paper presentations. Approved papers are published in ASHRAE Transactions.

The ASHRAE-cosponsored AHR Expo will be held in conjunction with the ASHRAE conference, Jan. 23–25.

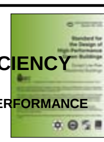
51

CHAPTER 7
ENERGY EFFICIENCY
7.3 Mandatory Provisions
7.3.3 Energy Consumption Management

7.3.3.1 Consumption Management. Measurement devices with remote communication capability shall be provided to **collect energy consumption data** for each energy supply source to the building, including gas, electricity, and district energy, that exceeds the thresholds listed in Table 7.3.3.1A.

52

NORMATIVE APPENDIX D
PERFORMANCE OPTION FOR ENERGY EFFICIENCY



D3. CALCULATION OF THE PROPOSED AND BASELINE BUILDING PERFORMANCE

D3.1.3.5 Hot-Water Pumps. The baseline building design **hot-water pump power shall be 19 W/gpm** (300 kW/1000 L/s). The Pumping system shall be modeled as primary-only with continuous variable flow. Hot-water systems serving 120,000 ft² (12,000 m²) or more shall be modeled with variable-speed drives, and systems serving less than 120,000 ft² (12,000 m²) shall be modeled as riding the pump curve.

Exception: The pump power for systems using purchased heat shall be 14 W/gpm (0.9 W/lps).

D3.1.3.10 Chilled-Water Pumps. The baseline building design **pump power shall be 22 W/gpm** (350 kW/1000 L/s). Chilled-water systems with a cooling capacity of 300 tons (1050 kW) or more shall be modeled as primary/secondary systems with variable-speed drives on the secondary pumping loop. Chilled water pumps in systems serving less than 300 tons (1050 kW) cooling capacity shall be modeled as primary/secondary systems with secondary pump riding the pump curve.

Exception: The pump power for systems using chilled water shall be 16 W/gpm.

53

CHAPTER 6
WATER USE EFFICIENCY
6.4 Prescriptive Option
6.4.2 Building Water Use Reduction

6.4.2.1 Cooling Towers. The water being discharged from cooling towers for air conditioning systems such as chilled-water systems shall be limited in accordance with method (a) or (b):

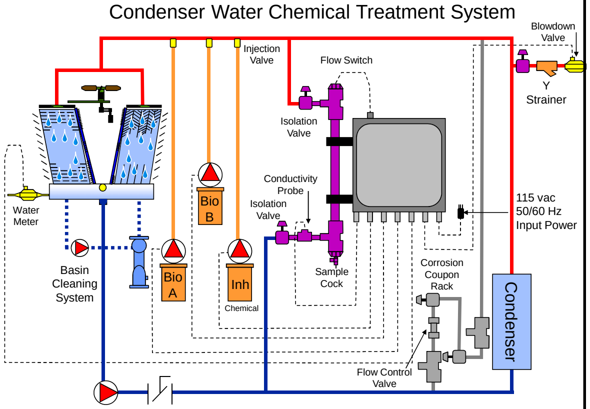
a. For makeup waters **having less than 200 ppm (200 mg/L)** of total hardness expressed as calcium carbonate, by achieving a minimum of **five *cycles of concentration***.

b. For makeup waters with **more than 200 ppm (200 mg/L)** of total hardness expressed as calcium carbonate, by achieving a minimum of **3.5 *cycles of concentration***.

Exception: Where the total dissolved solids concentration of the discharge water exceeds 1500 mg (1500 ppm/L), or the silica exceeds 150 ppm (150 mg/L) measured as silicon dioxide before the above cycles of concentration are reached.

54

Condenser Water Chemical Treatment System



55

CHAPTER 6
WATER USE EFFICIENCY
6.3 Mandatory Provisions
6.3.2.2 Appliances

TABLE 6.3.2.1 Plumbing Fixtures and Fittings Requirements

Plumbing Fixture	Maximum
Water closets (toilets) - flushometer valve type	Single flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - flushometer valve type	Effective dual flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - tank-type	Single flush volume of 1.28 gal (4.8 L)
Water closets (toilets) - tank-type	Effective dual flush volume of 1.28 gal (4.8 L)
Urinals	Flush volume of 0.5 gal (1.9 L)
Public lavatory faucets	Flow rate - 0.5 gpm (1.9 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
Residential bathroom lavatory sink faucets	Flow rate - 1.5 gpm (5.7 L/min)
Residential kitchen faucets	Flow rate - 2.2 gpm (8.3 L/min)
Residential showerheads	Flow rate - 2.0 gpm (7.6 L/min)
Residential shower compartment (stall) in dwelling units and guest rooms	Flow rate from all shower outlets total of - 2.0 gpm (7.6 L/min)

56

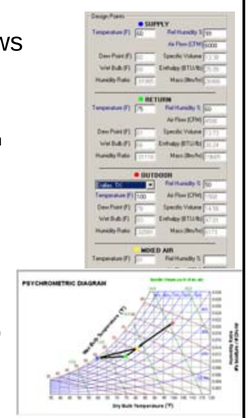
CHAPTER 6
WATER USE EFFICIENCY
6.3 Mandatory Provisions
6.3.2.3 HVAC Systems and Equipment

a. *Once-through cooling with potable water* is prohibited.
b. **Cooling towers** and evaporative coolers shall be equipped with makeup and **blowdown meters, conductivity controllers**, and **overflow alarms** in accordance with the thresholds listed in Table 6.3.3B. Cooling towers shall be equipped with efficient drift eliminators that achieve drift reduction to a maximum of 0.002% of the recirculated water volume for counterflow towers and 0.005% of the recirculated water flow for cross-flow towers.
c. **Condensate from air-conditioning units** with a **capacity greater that 65,000 Btu/h** (19 kW) and from all steam systems shall be **recovered for re-use**.

57

Calculator for Windows Psychrometry

- Helpful design tool for coils
- Animated cooling process is graphed on top of chart
- Calculates multiple psychrometric characteristics based on two inputs
- Calculates mass flow and cooling load
- Fresh air mix values are re-calculated automatically
- Built-in design day temperatures for 100 U.S. Cities



58

CHAPTER 7
ENERGY EFFICIENCY
7.3 Mandatory Provisions

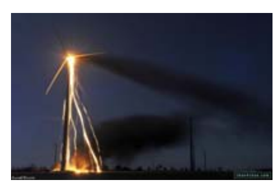
7.3.1 General. *Building projects* shall be designed to comply with Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 of ANSI/ASHRAE/IESNA Standard 90.1.

7.3.2 On-site Renewable Energy Systems. *Building projects* shall provide for the **future installation of *on-site renewable energy systems* with a minimum rating of 3.7 W/ft² or 13 Btu/h·ft² (40 W/m²)** multiplied by the **total *roof* area in ft²** (m²). *Building projects* design shall show allocated space and pathways for installation of *on-site renewable energy systems* and associated infrastructure.

59

Renewable or Waste Energy

- Solar
  - Solar panels for DC power
  - Solar collectors for heating water
  - Evacuated tube collectors for producing steam
- Wind turbines
- Biomass
- Water turbines
- Geothermal



60

Federal Incentives

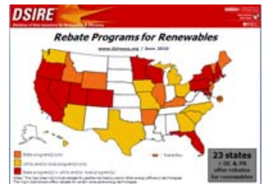
The Energy Policy Act of 2005 included a new tax incentive, to improve the energy efficiency of commercial buildings. The **"Commercial Building Tax Deduction"** establishes a tax deduction for expenses incurred for energy efficient building expenditures made by a building owner. The deduction is limited to $1.80 per square foot of the property, with allowances for partial deductions for improvements in interior lighting, HVAC and hot water systems, and building envelope systems.
The Emergency Economic Stabilization Act of 2008 (HR-1424), approved and signed on October 3, 2008, extends the benefits of the Energy Policy Act of 2005 through December 31, 2013.

***Federal Tax Credits for Consumer Energy Efficiency* – 30% Tax credit with no limit (expires 12/31/2016)**

61

Local Incentives

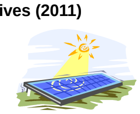
Starting in May 2010, ***California*** has a program subsidizing the purchase and installation of solar water heating equipment. The program sets aside $358 million for direct economic subsidies and market development support. The program will continue through 2017, or until funding is used completely.



http://www.dsireusa.org/solar/incentives/incentive.cfm?Incentive_Code=TN61F&re=1&ee=1

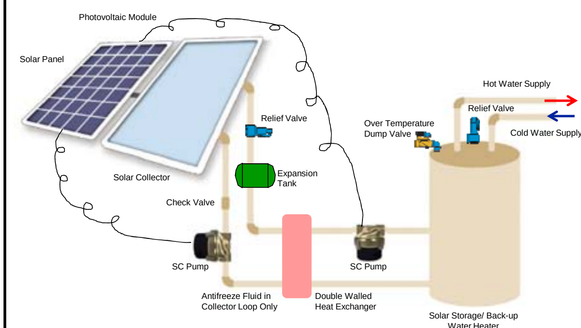
62

Efficiency and Renewable Energy Incentives (2011)
North Carolina



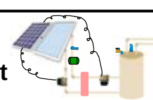
1. Renewable Energy Tax Credit (Corporate):
   http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC19F&re=1&ee=1
   - NC offers tax credit equal to 35% of the cost of renewable energy products
   - Includes solar and geothermal products
   - Up to $2.5 million available
2. Active Solar Heating and Cooling Systems Exemption:
   http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC09F&re=1&ee=1
   - Active solar heating and cooling systems cannot be assessed at more than the value of a conventional system for property tax purposes
   - This includes all pumps, tanks, controls, and heat exchangers
3. Progress Energy Carolinas - SunSense Commercial Solar Water Heating Incentive Program:
   https://www.progress-energy.com/shared/segment-selectors/sunsense.page
   - Progress Energy will pay $20 for each renewable energy credit generated by the solar water heating system for 10 years
   - One REC is equivalent to 1 MWh (1,000 kWh = 3,412,000 BTU's)
   - Duke Power will pay $30 for 2011
4. North Carolina Green Business Fund:
   http://www.ncscienceandtechnology.com/gbf/index.htm
   - Grants are available for sustainable building practices such as renewable energy technology
   - Up to $500,000 available depending on the award
5. Energy Improvement Loan Program:
   http://www.nccommerce.com/energy
   - Program provides loans with a 1% interest rate for renewable energy products
   - Loans with an interest rate of 3% are available for energy efficient products
   - Includes boilers, VFD's, and solar water heaters
   - Up to $500,000 available

63



64

Solar How Water System Equipment



1 - Solar Collector 130ft²	$	4365
1 – 119 Gallon Jacket Storage Tank	$	1050
1 - Double-Wall Brazed Exchanger	$	450
2 - SC Pumps	$	340
2 - Photovoltaic Modules	$	260
1 - Inline Temperature Control	$	60
1 - Solar Expansion Tank	$	60
1 - Solar Glycol 5- gallons	$	90
2 - ASME Tank125 psi Relief Valves	$	50
Basic Equipment Cost	$	6725
Estimated Labor to Install	$	2075
	$	8800

65

Typical Sun Shine Day

- Solar Collector System can recover 130,000 Btu
- 130,000 Btu will heat 260 gallons water 60ºF
- Based on a demand of 20 gallons/person 13 people
- Based on 65% sunshine - recover 30,842,000 Btu Annual
- Annual energy saved 9,070 KWH
- Annual CO_2 offset 4,626 lbs

66

Estimated Total Cost

Location: Greensboro, North Carolina

Equipment, Piping and Labor		$ 8800
Potential Credits		
Federal Tax Credit of 30%	(-)	$ 2640
North Carolina Tax Credit of 35%	(-)	$ 3080
Duke Power REC Credit of $30	(-)	$ 270
Total Cost		$ 2810

Operating Cost Savings

9070 KWH saved at .08/KW = $ 725 Annual

*Estimate 3.9 Year Pay Back

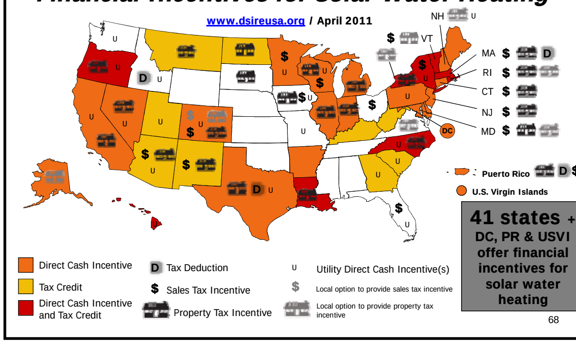
(Based on $2810 cost divided by $725 savings)

030112CE

67

DSIRE — Database of State Incentives for Renewables & Efficiency

Financial Incentives for Solar Water Heating



68

USA Today - Thurs. June 21, 2011

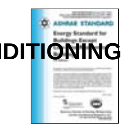
"Boom in Solar Power Shines for Consumers"

- First QTR 2011 Photovoltaic up 66%
- United States poised to lead the world
- A dramatic decrease in panel cost
- Solar City, SunRun and Sungevity
- No up front cost and lower electric bills
- **Solar Thermal panels also reduce electric demand**

69

CHAPTER 6

HEATING, VENTILATING, AND AIR CONDITIONING



SECTION 6.5
Prescriptive Path

6.5.5 Heat Rejection Equipment

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 95ºF condenser water return, 85ºF condenser water supply, and 75ºF *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.

70

CHAPTER 6

HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 6.8
Minimum Equipment Efficiency Tables

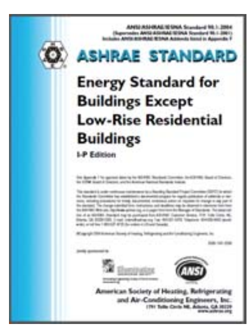
TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment

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 open-circuit cooling towers	All	95ºF entering water 85ºF leaving water 75ºF entering wb	≥38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal fan open-circuit cooling towers	All	95ºF entering water 85ºF leaving water 75ºF entering wb	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed-circuit cooling towers	All	102ºF entering water 90ºF leaving water 75ºF entering wb	≥14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal closed-circuit cooling towers	All	102ºF entering water 90ºF leaving water 75ºF entering wb	≥7.0 gpm/hp	CTI ATC-105S and CTI STD-201

[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 condition listed in Table 6.8.1G divided by the fan motor nameplate power. **90.1-2013 40.2 GPM PER HP**

71

ASHRAE Standard 90.1-2013



Aiming at **50% Energy Savings for 90.1-2013**

ENERGY CODES 2011
Department of Energy
July 28, 2011

72

Summary

- The drive to **NZEBs (Net Zero Energy Buildings)** is a trend, not a fad! **Executive order 13514 by 2020 NZEB**
- Future ASHRAE Standards 90.1 and 189.1 along with DOE will continue to **push us to NZEBs**.
- The opportunities for **efficient water side system** design and **efficient equipment are immense!**
- The age old compliance with “Contract Documents” standard will disappear and “Building Performance” will be the New Standard. (**The least first cost will not rule**)
- There will be a **fundamental shift in the way we design**, construct, maintain and operate a building

73