



AHRI 920 & ASHRAE 90.1

Optimizing Solutions through Superior Dehumidification Technology SM

1

About the Presenter – Paul Stewart

Education: BSGE – University of Illinois

Work History:

- Johnson Controls Inc. 1985-2009
 - OEM & Distributor Channel Sales
 - OEM Sales Manager
 - Six Sigma Black Belt
 - North American Parts & Repair Center Manager
- Desert Aire Corp 2009- present
 - Director Sales & Marketing

ASHRAE Member: Louisville KY Chapter

2

Agenda

AHRI 920 Standard for DX-DOAS

- Discuss Why Dehumidification is needed
- Define the terms of the new standard
- Show how the calculations were derived

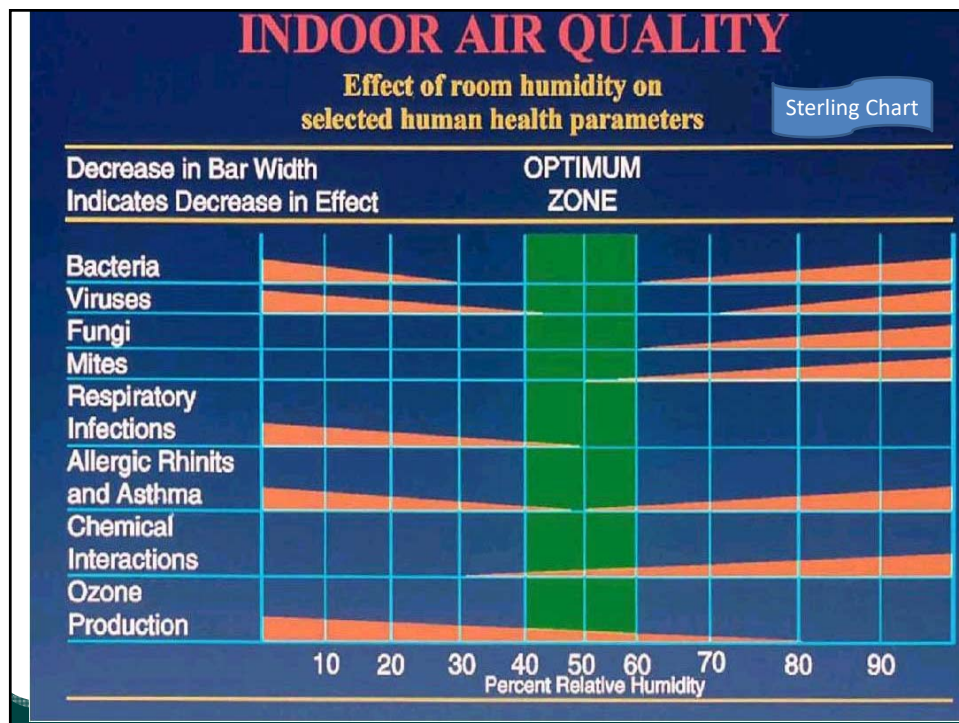
3

Why do we need
Dehumidification?



Reasons for Dehumidification

- Protect the Building Structure
 - Prevent Condensation
 - Prevent building decay
- Provide Proper Indoor Air Quality
 - Prevent Mold, Virus & Fungus Growth
 - Preserve Artifacts or Products
 - Reduce Spoilage
 - Reduce Manufacturing Hours





Occupant Health and Comfort

Thermal Comfort and Humidity Requirements

The HVAC system must be designed to maintain the thermal and humidity parameters shown in Table 5-1.

Ventilation

Provide ventilation as required by ASHRAE Standard 62.1-2010: Ventilation for Acceptable Indoor Air Quality.

The HVAC system must have Dedicated Outdoor Air Ventilation Systems (DOAVS) sized to meet the latent or total heat exchange. The DOAVS must deliver temperature and humidity conditioned outside air to the occupied spaces at the required ventilation air flow rates. The DOAVS are used to maintain positive pressure in the perimeter zones with respect to outdoor air pressure,

and to keep the space dew-point temperature less than 12.8°C (55°F) at all times in conjunction with other HVAC systems.

The DOAVS must be capable of operating independent of any other air distribution system. The DOAVS can be coupled with building exhaust air heat recovery to precondition the outdoor air.

During unoccupied hours, run the DOAVS at reduced capacity to maintain positive pressure in the perimeter zones with thermally conditioned air that provides a space dew-point temperature less than 12.8°C (55°F).

Use one of these three installation methods:

1. The DOAVS ducted directly to the occupied spaces
2. The DOAVS ducted directly to terminal units serving occupied spaces or zones

3. The DOAVS ducted through air flow control devices (airflow measuring station and airflow control damper) to the return side of the floor-by-floor air-handling units.

In this case, the DOAVS must be provided with a means of bypassing the air-handling units and directing airflow to the supply ducts during unoccupied hours. Do not use return air plenums to provide airflow pathways for pressurization during unoccupied hours.

Provide ventilation as required by ASHRAE Standard 62.1-2010: Ventilation for Acceptable Indoor Air Quality.

The HVAC system must have Dedicated Outdoor Air Ventilation Systems (DOAVS) sized to meet the latent or total heat exchange. The DOAVS must deliver temperature and humidity conditioned outside air to the occupied spaces at the required ventilation air flow rates. The DOAVS are used to maintain positive pressure in the perimeter zones with respect to outdoor air pressure.

Do not provide for one means and connect to one point occupants, design the ventilation system using all Ventilation Rate Procedure (Section 6.2) or the In Air Quality Procedure (Section 6.3) specified in ASHRAE Standard 62.1-2010.

Filtration
Air filtration must be provided in every air-handling unit including the DOAVS. Air-handling units must have filter and a final filter, each located upstream of it.

Requirements

Chapter 5 Mechanical Engineering

5.1 Goals and Objectives	121
5.2 Codes, Standards, and Guidelines	122
5.3 HVAC Performance Characteristics	123
5.4 Design Criteria	126
5.5 HVAC System	131
5.6 Special Area HVAC Systems	135
5.7 Mechanical and Service Space Requirements	138
5.8 HVAC Components	141
5.9 Air Distribution	149
5.10 Humidification	152
5.11 Water Treatment	153
5.12 Primary Heating Systems	154
5.13 Primary Cooling Systems	155
5.14 Piping Systems	156
5.15 Thermal Insulation	158
5.16 Vibration Isolation, Acoustical Isolation, and Seismic Design	160
5.17 Meters, Gages, and Flow Measuring Devices	162
5.18 Building Automation Systems (BAS)	163
5.19 Testing and Balancing	166
5.20 Plumbing Systems	167
5.21 Alterations to Existing Buildings and Historic Structures	176

- Ventilation Air based on ASHRAE 62.1
- Positive Pressure to perimeter zones.
- Deliver air $\leq 55^{\circ}\text{F}$ Dewpoint
- Use the 0.4 percent weather data
- Supply Air $\geq 52^{\circ}\text{F}$ DB

Table 5-1				
Indoor Design Conditions				
Type of Area	Summer DB 13	By E3.4	Winter DB 13	By E3.4
General office ¹³	24 (75)		22 (72)	
ADP, computer, and information technology equipment rooms ⁹	20 (68)	45	22 (72)	50
Corridor ¹³				
Building lobbies				
Toilets ¹³				
Locker rooms				
Electrical closets				
Mechanical room				
Electrical switch				
Elevator machine room ¹¹	20 (68)		18 (65)	
Emergency generator room	40 (104) ⁸		18 (65)	
Transformer vaults	40 (104) ⁸			
Stairwells	(none)		18 (65)	
Communications/telecommunications frame room ⁷	24 (75)	45	22 (72)	30 ¹²
Storage room	30 (85)		18 (65)	
Conference room ^{13,14}	24 (75)		22 (72)	
Auditorium ^{13,15}	24 (75)		22 (72)	
Kitchen ¹⁶	24 (75)		22 (72)	
Dining ^{13,15}	24 (75)		22 (72)	
Cafeteria ^{13,15}	24 (75)		22 (72)	
Courtsroom ¹³	24 (75)	45	22 (72)	30 ¹²

⁸May require humidification in the winter. See Program Requirements.

Table 5-1 Notes

1. Dry bulb (DB) temperatures are degrees Celsius (Fahrenheit), to be maintained at $\pm 1^{\circ}\text{C}$ ($\pm 2^{\circ}\text{F}$) of setpoint.
2. Unless specifically noted, minimum permissible relative humidity in conditioned areas is 30 percent and maximum permissible relative humidity is 60 percent.
3. Dry bulb and relative humidity are to be maintained at 150 mm (6 in.) to 1,800 mm (6 ft.) above the floor.
4. System must be designed for process cooling. Cooling system must be a dedicated independent system.
5. Provide independent temperature control.
6. Minimum relative humidity requirements may be omitted in moderate southern climate zones, upon the approval of local ASHRAE representatives.
7. The values shown are for dry bulb temperatures in occupied spaces, when the air speed is less than 0.2 m/s (40 fpm) and when the net thermal radiant exchange between the occupants and surrounding surfaces is negligible. Otherwise, the values shown are for operative temperatures as defined in ASHRAE Standard 55.

Reference Data


75F @ 60%RH = 60.2F Dewpoint
68F @ 30%RH = 35.5F Dewpoint

2011 ASHRAE Handbook HVAC Applications

Table 2 Typical Recommended Indoor Temperature and Humidity in Office Buildings

Area	Indoor Design Conditions		Comments
	Temperature, °F/ Relative Humidity, %		
	Winter	Summer	
Offices, conference rooms, common areas	70.0 to 74.0 20 to 30% ^a	74.0 to 78.0 50 to 60% ^a	
Cafeteria	70.0 to 73.5 20 to 30% ^a	78.5 50% ^a	
Kitchen	70.0 to 73.5	84.0 to 88.0	No humidity control
Toilets	72.0		Usually not conditioned
Storage	64.0		No humidity control
Mechanical rooms	61.0		Usually not conditioned






ANSI/ASHRAE Standard 55-2004
(Supersedes ANSI/ASHRAE Standard 55-1992)

ASHRAE STANDARD

**Thermal
Environmental
Conditions for
Human Occupancy**

5.2.2 Humidity Limits. Systems designed to control humidity shall be able to maintain a humidity ratio at or below 0.012, which corresponds to a water vapor pressure of 1.910 kPa (0.277 psi) at standard pressure or a dew-point temperature of 16.8°C (62.2°F).

category/rh31-02
<http://www.ashrae.org/template/TechnologyLinkLanding/>
category/1686



**AMERICAN SOCIETY OF HEATING,
REFRIGERATING AND
AIR-CONDITIONING ENGINEERS, INC.**
1791 Tullie Circle, NE • Atlanta, GA 30329

Why a New Standard?

- Provides a method for comparison



- ASHRAE 90.1 sub-committee request



13

Why a New Standard?

- Other Equipment Ratings
 - 550 Chillers
 - 320 WSHP
 - 310 PTACS
- DOAS is unique application

ANSI/AHRI Standard 920 (I-P)

2015 Standard for
Performance Rating of DX-
Dedicated Outdoor Air System
Units



14

Other Ratings

- Air Conditioning/VRF
 - EER/SEER/IEER
- Chillers
 - IPLV
- DOAS
 - ISMRE/ISCOP

Let's start the conversation about DOAS ratings!

15

AHRI Standard 920

ANSI/AHRI Standard 920 (I-P)

2015 Standard for
Performance Rating of DX-
Dedicated Outdoor Air System
Units

Approved
Jan 2016



16

AHRI 920 - New Terms

- Moisture Removal Efficiency (MRE)
 - Lb/hr per kW_{input}
- Coefficient of Performance (COP)
 - kW_{output} / kW_{input}
- Integrated Values
 - **ISMRE** (Integrated Seasonal Moisture Removal Efficiency)
 - **ISCOP** (Integrated Seasonal Coefficient of Performance)

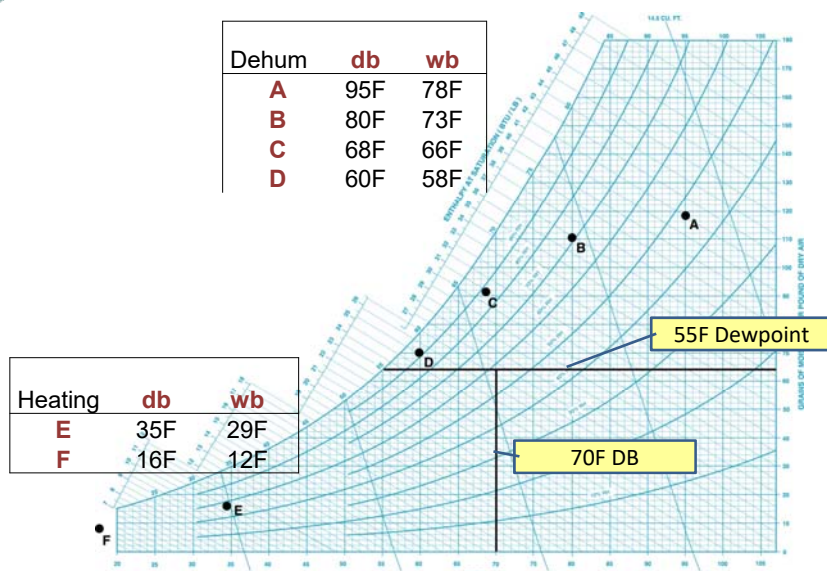
17

AHRI 920 Defined

- OA conditioned \leq 55F Dewpoint
- Reheat Supply Air to 70F
- Ratings based on Type of Equipment
 - Air Cooled
 - Water Cooled
 - WSHP
 - With & W/o Energy Recovery of Exhaust

18

AHRI 920 Rating Conditions



Integrated Seasonal Weighting

MRE		COP	
Rating Point	Weight %	Rating Point	Rating Point
A	12%	E	77%
B	28%	F	23%
C	36%		
D	24%		

- Created by composite of bin hour data from multiple cities
- Weighting puts emphasis on Part Load values

Integrated Seasonal Moisture Removal Efficiency (ISMRE).

- Dehumidification MRE values
 - Expressed in lb of moisture/kWh

$$\text{ISMRE} = (\text{MRE}_A \cdot 0.12) + (\text{MRE}_B \cdot 0.28) + (\text{MRE}_C \cdot 0.36) + (\text{MRE}_D \cdot 0.24)$$

Terms:

- MRE_A = Standard Rating Condition A (95 Fdb/78 Fwb)
- MRE_B = Standard Rating Condition B (80 Fdb/73 Fwb)
- MRE_C = Standard Rating Condition C (68 Fdb/66 Fwb)
- MRE_D = Standard Rating Condition D (60 Fdb/58 Fwb)

21

Integrated Seasonal Coefficient of Performance (ISCOP).

- Heating COP values
 - Expressed in watt / watt

$$\text{ISCOP} = (\text{COP}_E \cdot 0.77) + (\text{COP}_F \cdot 0.23)$$

Coefficient of Performance at

- COP_E = Standard Rating Condition E (35 Fdb)
- COP_F = Standard Rating Condition F (16 Fdb)

22

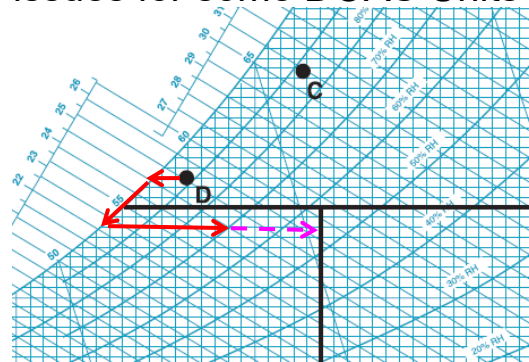
70°F LAT Requirement

- Must meet 70F LAT in Dehum & Heat Pump Modes
 - Lower ISMRE values
 - Lower IS COP values
- The ISMRE & IS COP ratings will identify inefficient designs

23

MRE Comments

- Standard requires reheat to achieve 70F LAT
- Rating Condition C (68°Fdb) and/or D (60°Fdb) may cause some issues for some DOAS Units



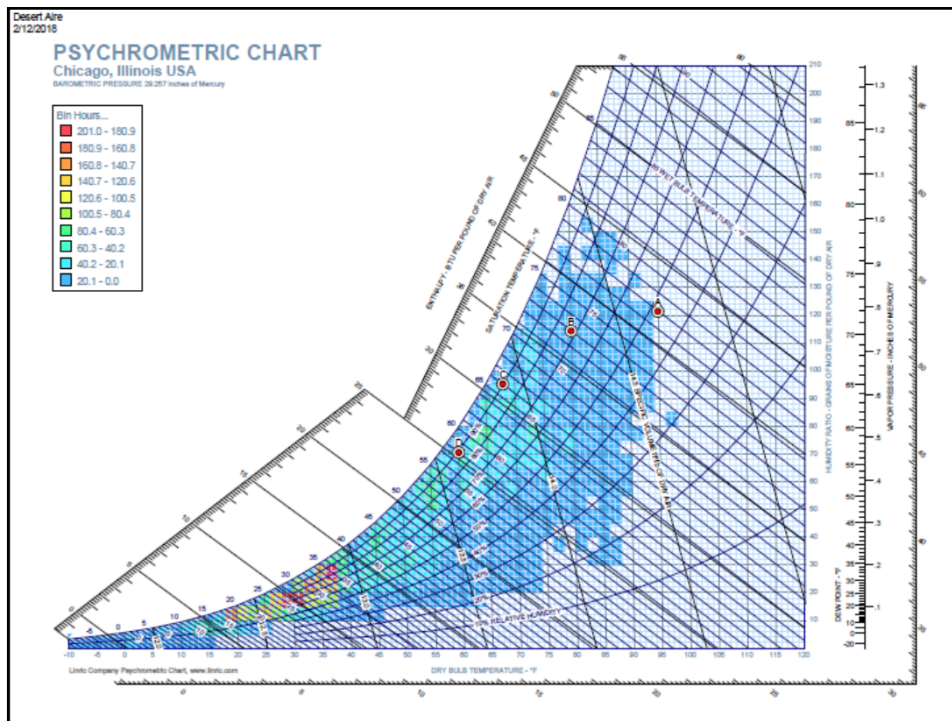
24

MRE Comments

- Why will system not achieve 70F?
 - Hot Gas Bypass to prevent coil freezing
 - Partial Hot Gas Reheat Coils
- Options
 - Add electric heater to reach 70F
 - Select unit with larger compressor

Acceptable but
must account
for NEW
Energy!

25



Operating Conditions Air & Water Cooled

Rating	OSA Temp		E/A Temp		Inlet Fluid Temp		Ambient Air
	Fdb	Fwb	Fdb	Fwb	Clg Tower	Chilled Water	Fdb
Dehumidification							
A	95	78	75	62.5	85	45	95
B	80	73	75	62.5	80	45	80
C	68	66	75	62.5	68	45	68
D	60	58	75	59.6	55	45	60
Heating	For Air to Air Heat Pumps						
E	35	29	70	58.5	N/A	N/A	35
F	16	12	70	58.5	N/A	N/A	16

All Temperatures are listed in °F

27

Operating Conditions Water Source Heat Pumps

Rating	OSA Temp		E/A Temp		Inlet Fluid Temperatures		
	Fdb	Fwb	Fdb	Fwb	Closed-loop	Ground-water	Water Source
Dehumidification							
A	95	78	75	62.5	85	70	85
B	80	73	75	62.5	80	70	85
C	68	66	75	62.5	70	50	75
D	60	58	75	59.6	70	50	75
Heating							
E	35	29	70	58.5	41	70	75
F	16	12	70	58.5	32	50	70

All Temperatures are listed in °F

28

COP Comments

- Standard requires heat pump mode to achieve 70F SAT

Manufacturers must include all energy to achieve 70F SAT in their ISCOP rating

- This may include:
 - Auxiliary Heaters
 - Larger compressors

29

ASHRAE 90.1 – 2013 Addendum for DX-DOAS Minimum Efficiency

Approved at
ASHRAE
St. Louis
June 25-29, 2016



BSR/ASHRAE/IES Addendum cd
to ANSI/ASHRAE/IES Standard 90.1-2013

Public Review Draft

Proposed Addendum cd to Standard 90.1-2013, *Energy Standard for Buildings Except Low-Rise Residential Buildings*

First Public Review (September 2015)
(Draft shows Proposed Changes to Current Standard)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research-technology/public-review-drafts, and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ASHRAE. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-846-6400 or 1-800-727-4772 (for orders in the U.S. or Canada).

This standard is under continuous maintenance. To propose a change to the current standard, use the change submittal form available on the ASHRAE website: www.ashrae.org

The appearance of any technical data or editorial material in this public review document does not constitute endorsement, warranty, or guaranty by ASHRAE of any product, service, process, procedure, or design, and ASHRAE expressly disclaims such.

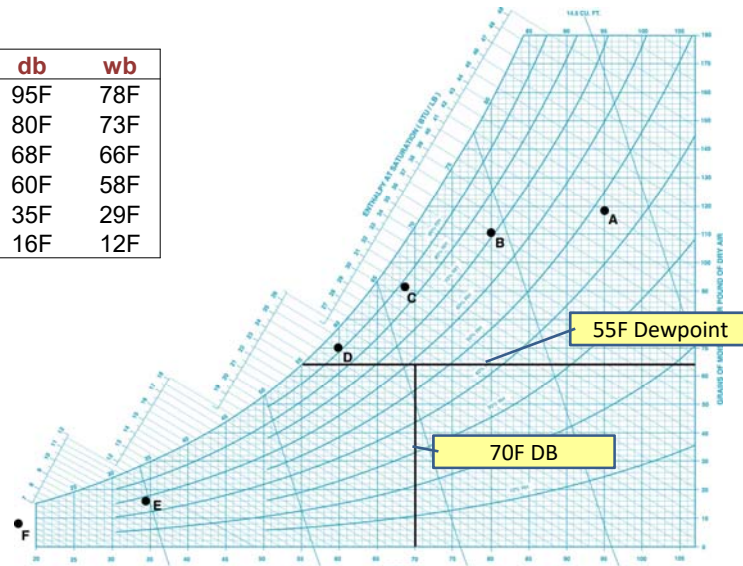
© 2012 ASHRAE. This draft is covered under ASHRAE copyright. Permission to reproduce or redistribute all or any part of this document must be obtained from the ASHRAE Manager of Standards, 1791 Tullie Circle, NE, Atlanta, GA 30329. Phone: 404-846-6400, Ext. 1125. Fax: 404-521-5475. E-mail: standards.ashrae@ashrae.org

ASHRAE, 1791 Tullie Circle, NE, Atlanta GA 30329-2265

30

AHRI 920 Rating Conditions

	db	wb
A	95F	78F
B	80F	73F
C	68F	66F
D	60F	58F
E	35F	29F
F	16F	12F



ASHRAE 90.1 Dehumidification Minimum

Equipment Type	without Energy Recovery	with Energy Recovery
	ISMRE	ISMRE
Air Cooled	4.0	5.2
Cooling Tower	4.9	5.3
Chilled Water	6.0	6.6
Water - Ground source - closed loop	4.8	5.2
Water - Ground water source	5.0	5.8
Water source	4.0	4.8

ISMRE values rated at lb of moisture/kWh

Energy Wheel Systems



High quality energy recovery impacts
ISMRE & IS COP

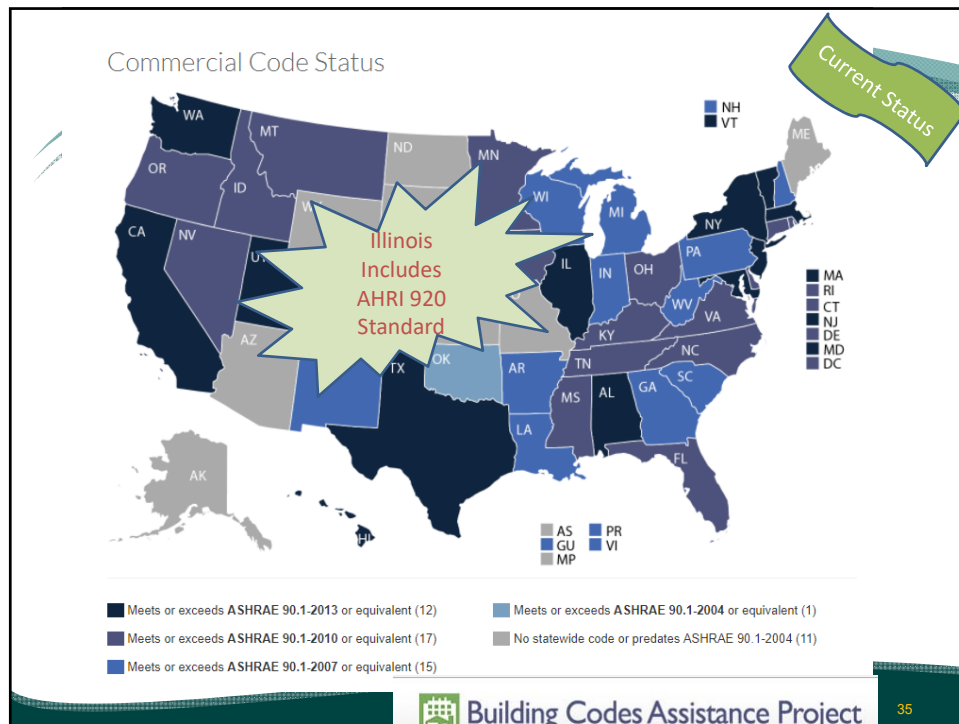
33

ASHRAE 90.1 Heating Minimum

Equipment Type	without Energy Recovery	with Energy Recovery
	ISCOP	ISCOP
Air Cooled	2.7	3.3
Water - Ground source - closed loop	2.0	3.8
Water - Ground water source	3.2	4.0
Water source	3.5	4.8

ISCOP values rated at W/W

34



Without AHRI 920

- Difficult for engineers
- No Part Load operating values
 - When do they not work?
- No method to rate equipment
 - Performance or energy usage issues?
- No apples to apples comparison
- Fossil fuels being used for reheat!

