

# Facility Dynamics

## *ENGINEERING*

## Controlling the Mixed Air Section

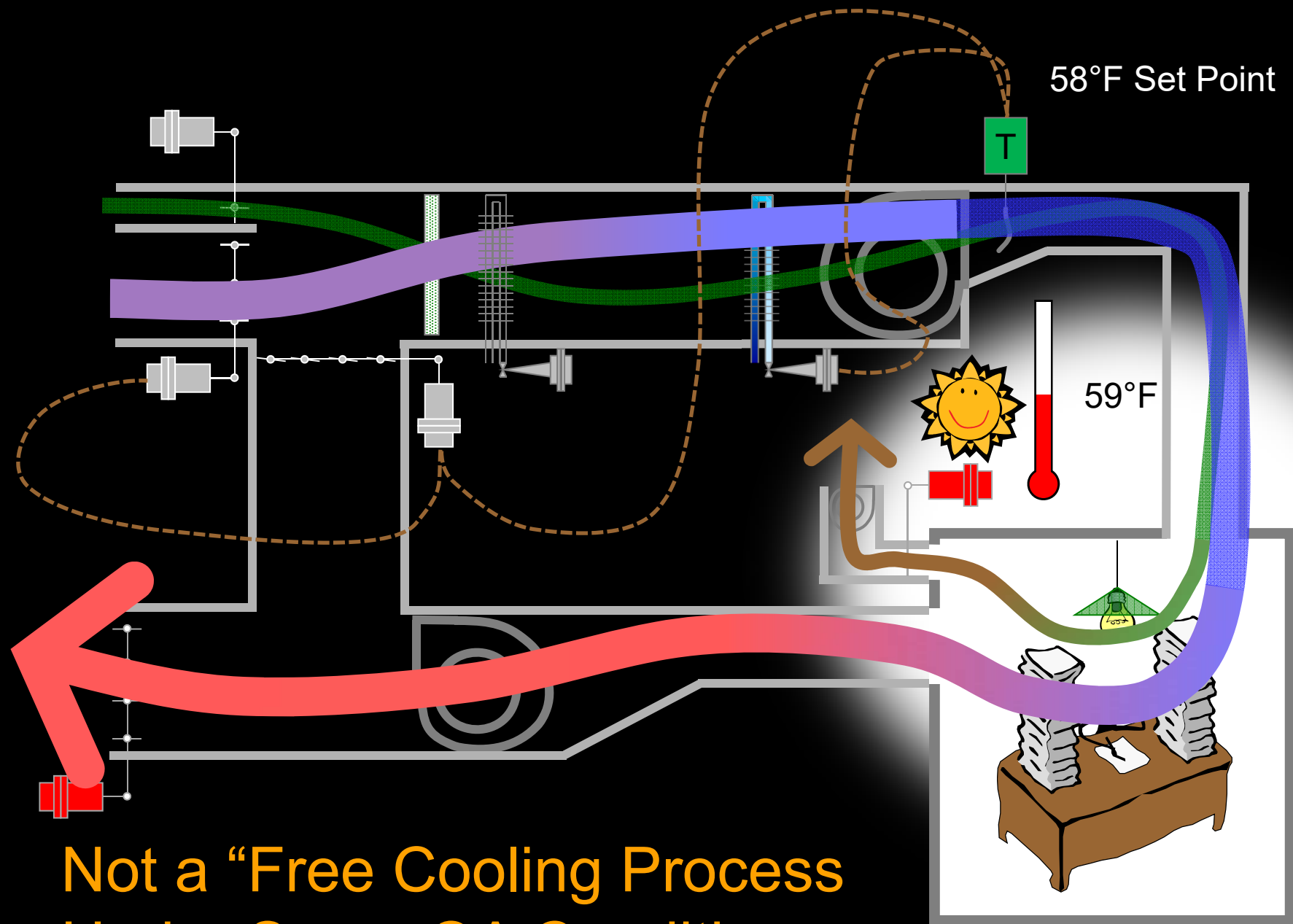
Limiting Economizer Operation Based on Enthalpy vs. Dry Bulb Temperature (Supplemental)

**Presented By:**

David Sellers; Facility Dynamics Engineering

Senior Engineer

NAVFAC, San Diego



Not a “Free Cooling Process  
Under Some OA Conditions

TAB 14-3 - ENTHALPY VS. OA DRYBULB ECONOMIZER LIMITS

# Enthalpy and Sensor Accuracy

Assumptions				
1.	Given Condition -	72.0 °F		
2.	-	40% RH		
3.	Pressure -	14.7 psi		
Enthalpy with perfect measurements				
	Enthalpy =	24.55 Btu/lb		
Enthalpy based on a perfect humidity sensor and a temperature sensor that is accurate to +/- 1°F				
	Error band -	1.0 °F, +/-		
	Maximum possible temperature -	73.0 °F		
	Minimum possible temperature -	71.0 °F		
	Maximum possible enthalpy -	25.0 Btu/lb		
	Minimum possible enthalpy -	24.1 Btu/lb		
Enthalpy based on a perfect temperature sensor and a humidity sensor that is accurate to +/- 3%				
	Error band -	3% +/-		
	Maximum possible humidity -	43%		
	Minimum possible humidity -	37%		
	Maximum possible enthalpy -	25.1 Btu/lb		
	Minimum possible enthalpy -	24.0 Btu/lb		
Enthalpy based on a temperature sensor that is accurate to +/- 1°F and a humidity sensor that is accurate to +/- 3%				
	RH sensor error band -	3% +/-		
	Maximum possible humidity -	43%		
	Minimum possible humidity -	37%		
	Temperature sensor error band -	1.0 °F, +/-		
	Maximum possible temperature -	73.0 °F		
	Minimum possible temperature -	71.0 °F		
	Maximum possible enthalpy -	25.6 Btu/lb		
	Minimum possible enthalpy -	23.5 Btu/lb		

ALTITUDE: 6 FEET  
 BAROMETRIC PRESSURE: 29.915 in. HG  
 ATMOSPHERIC PRESSURE: 14.693 psia

# Enthalpy and Sensor Accuracy

## San Francisco, California

Weather Data Location:  
 SAN\_FRANCISCO\_INTL\_AP, CALIFORNIA, USA

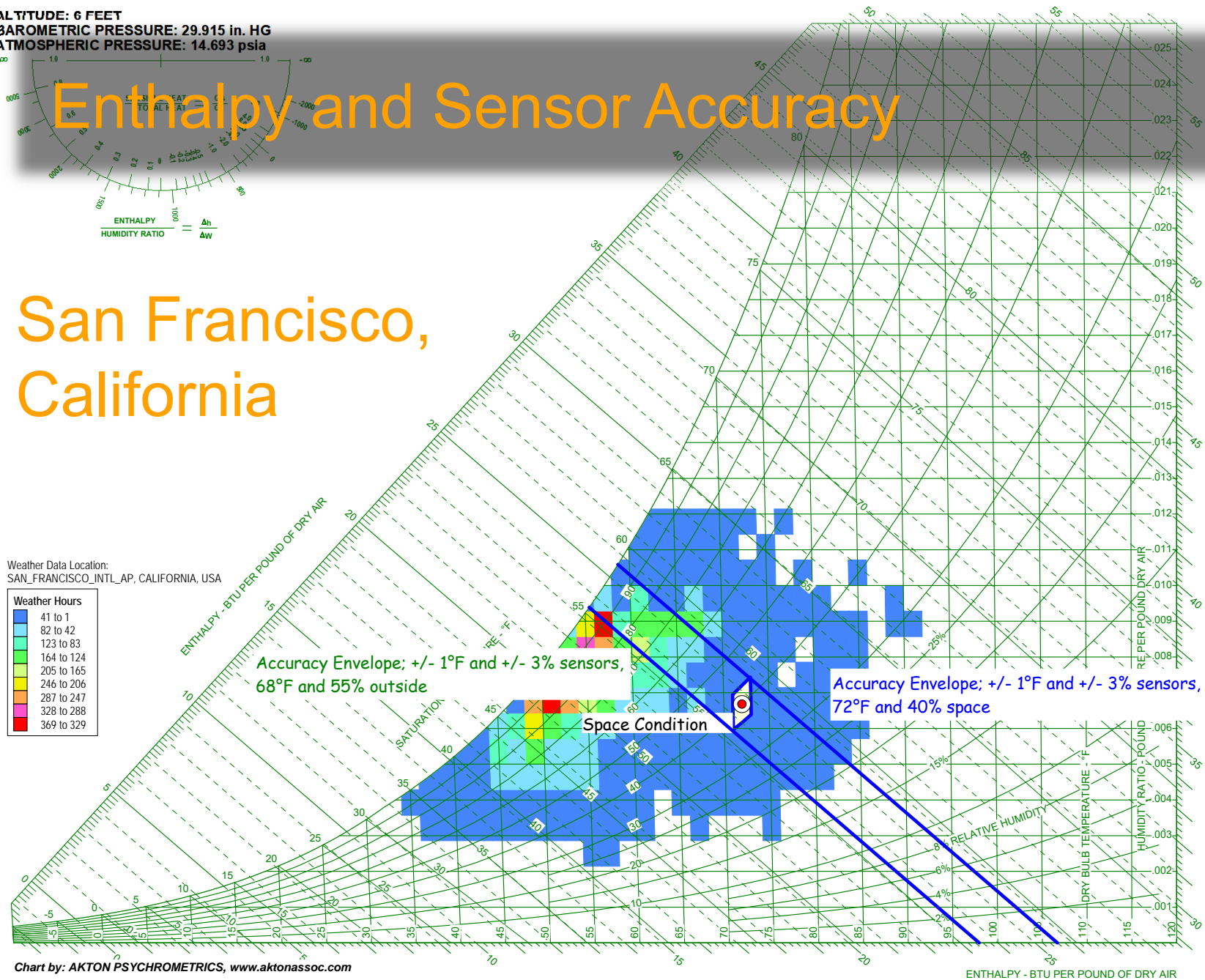
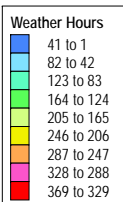
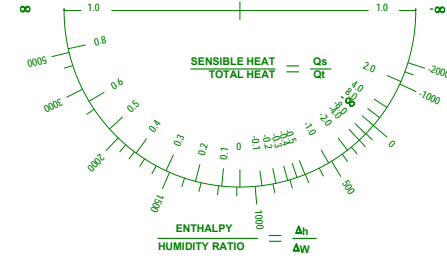


Chart by: AKTON PSYCHROMETRICS, [www.aktonassoc.com](http://www.aktonassoc.com)

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# San Francisco, California

Weather Data Location:  
 SAN\_FRANCISCO\_INTL\_AP, CALIFORNIA, USA

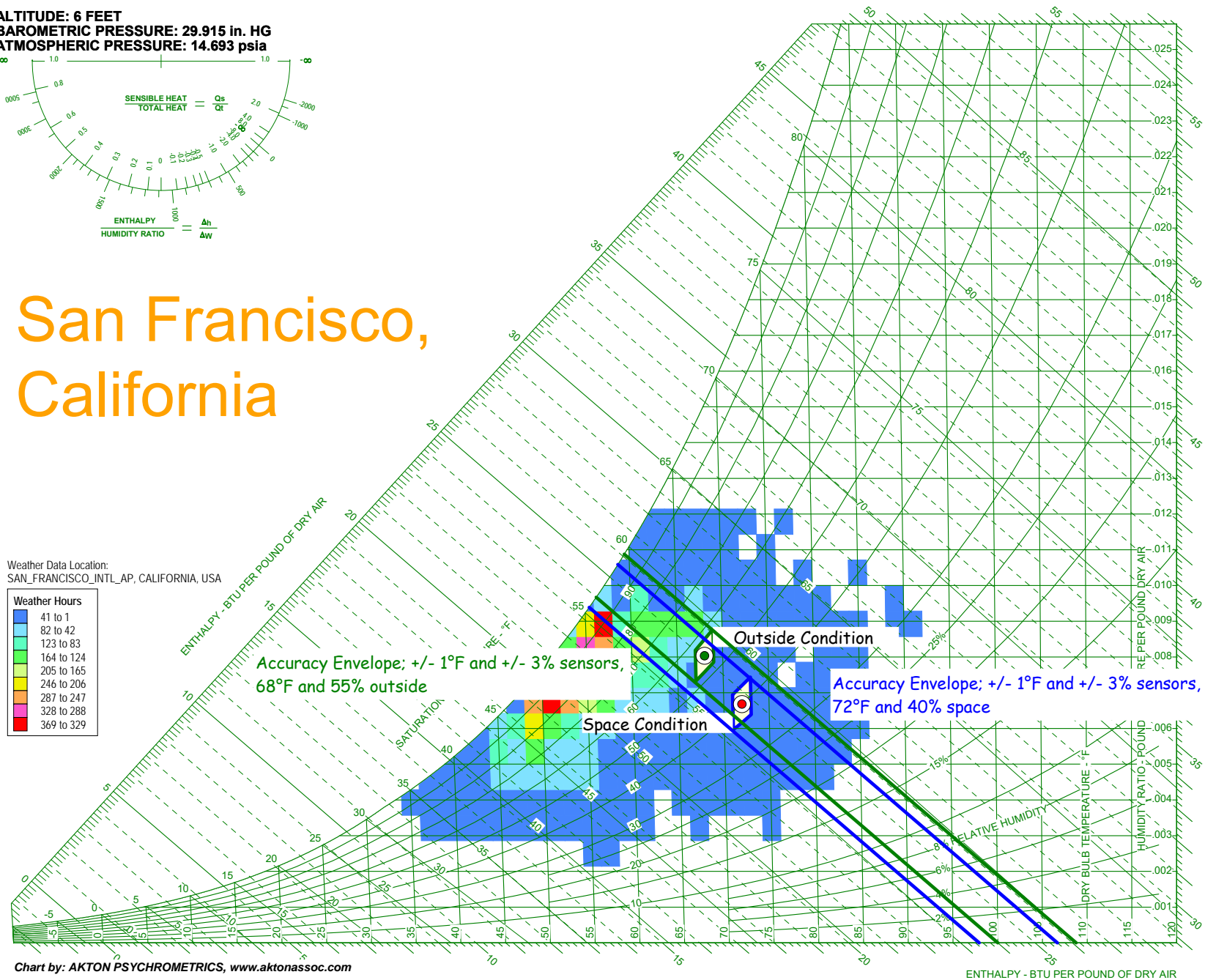
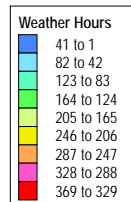


Chart by: AKTON PSYCHROMETRICS, [www.aktonassoc.com](http://www.aktonassoc.com)

TAB 14-3 - ENTHALPY VS. OA DRYBULB ECONOMIZER LIMITS

# Differential Enthalpy

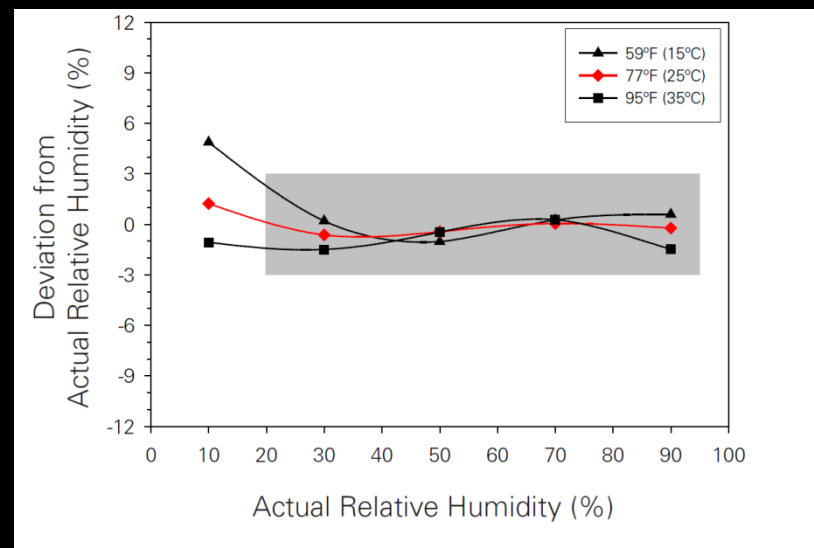
## The “Gold Standard”

Direct measurement and comparison of the energy content of the outdoor air stream vs. the return air stream

- **Good news:**
  - *Measuring temperature to  $\pm 1^\circ\text{F}$  or better is common and persistent*
- **Bad news:**
  - *Measuring humidity persistently and accurately is not so easy*

Is your humidity measurement accurate:

**Maybe ...**



# Differential Enthalpy

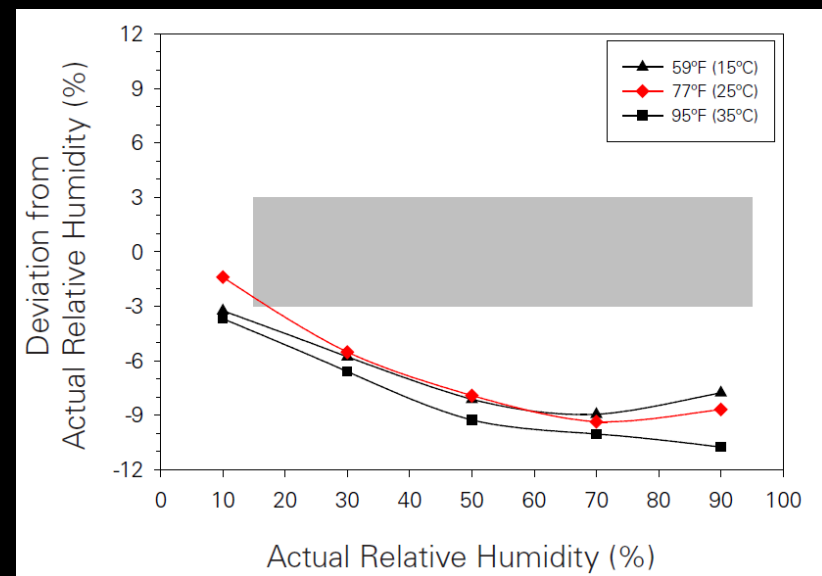
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  - *Measuring humidity persistently and accurately is not so easy*

Is your humidity measurement accurate:

**Maybe ... or maybe not**





ALTITUDE: 7 FEET  
 BAROMETRIC PRESSURE: 29.915 in. HG  
 ATMOSPHERIC PRESSURE: 14.693 psia

# Where Your Might End Up

## San Francisco, California

Weather Data Location:  
 SAN\_FRANCISCO\_INTL\_AP, CALIFORNIA, USA

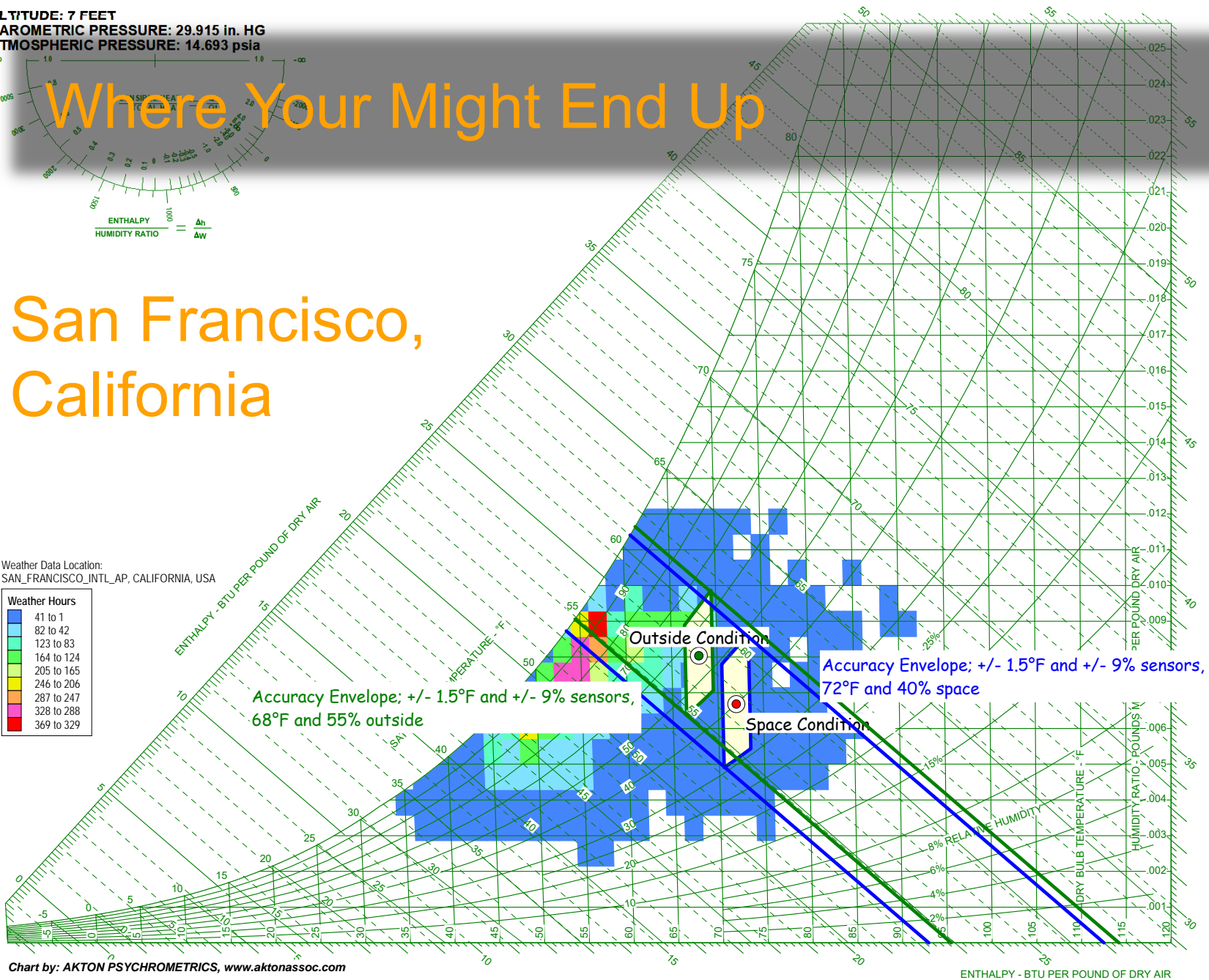
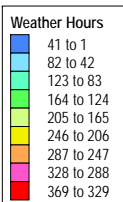


Chart by: AKTON PSYCHROMETRICS, [www.aktonassoc.com](http://www.aktonassoc.com)

TAB 14-3 - ENTHALPY VS. OA DRYBULB ECONOMIZER LIMITS



# Other Alternatives

## Outdoor air Dry Bulb Temperature

### Good News

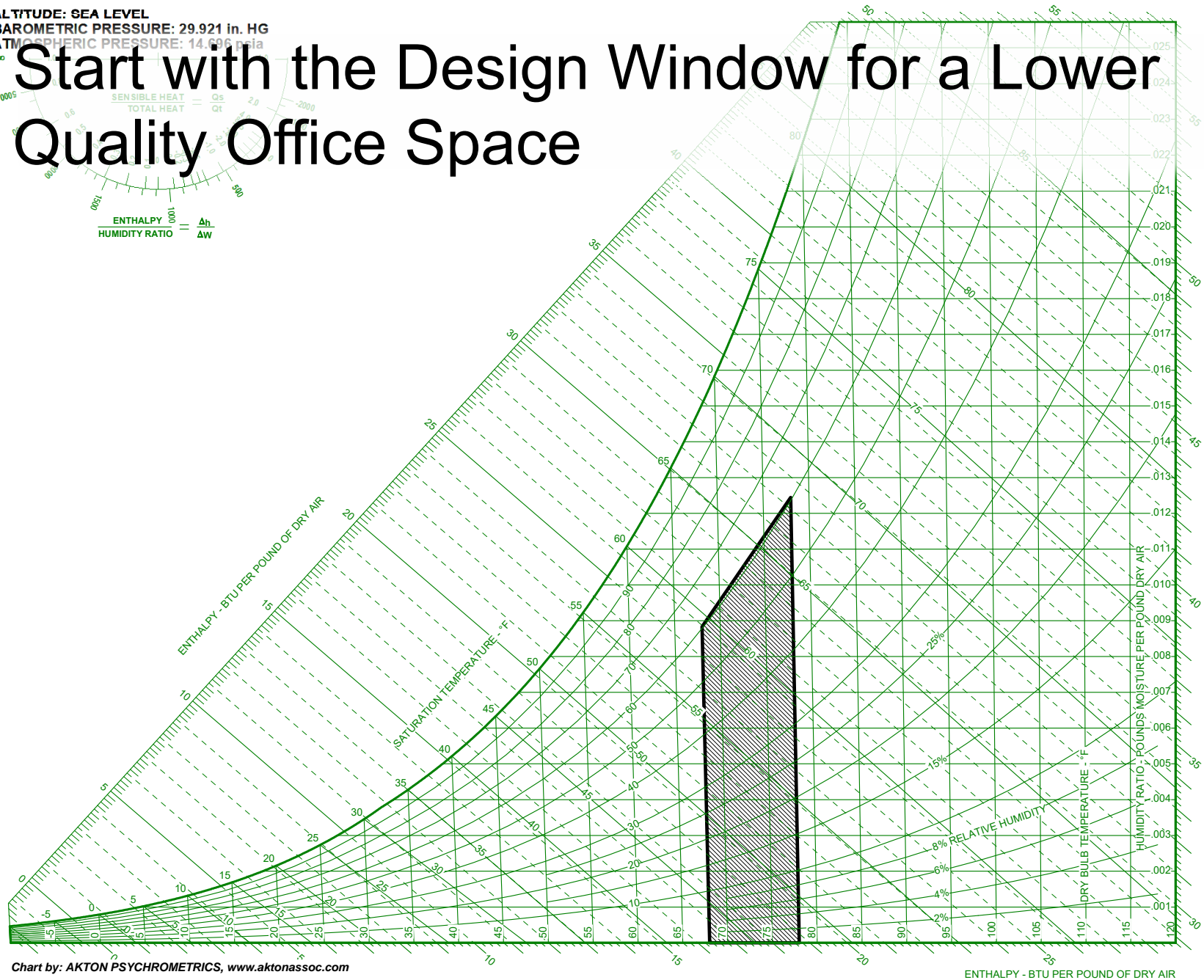
- Eliminates moisture sensors
- Uses a more stable, persistent measurement technology
- Uses just one sensor

### Bad News

- Does not consider latent effects and loads
- Only considers outdoor air, thus makes an assumption about what is going on in the building
- Have to know where the sensor is

ALTITUDE: SEA LEVEL  
 BAROMETRIC PRESSURE: 29.921 in. HG  
 ATMOSPHERIC PRESSURE: 14.696 psia

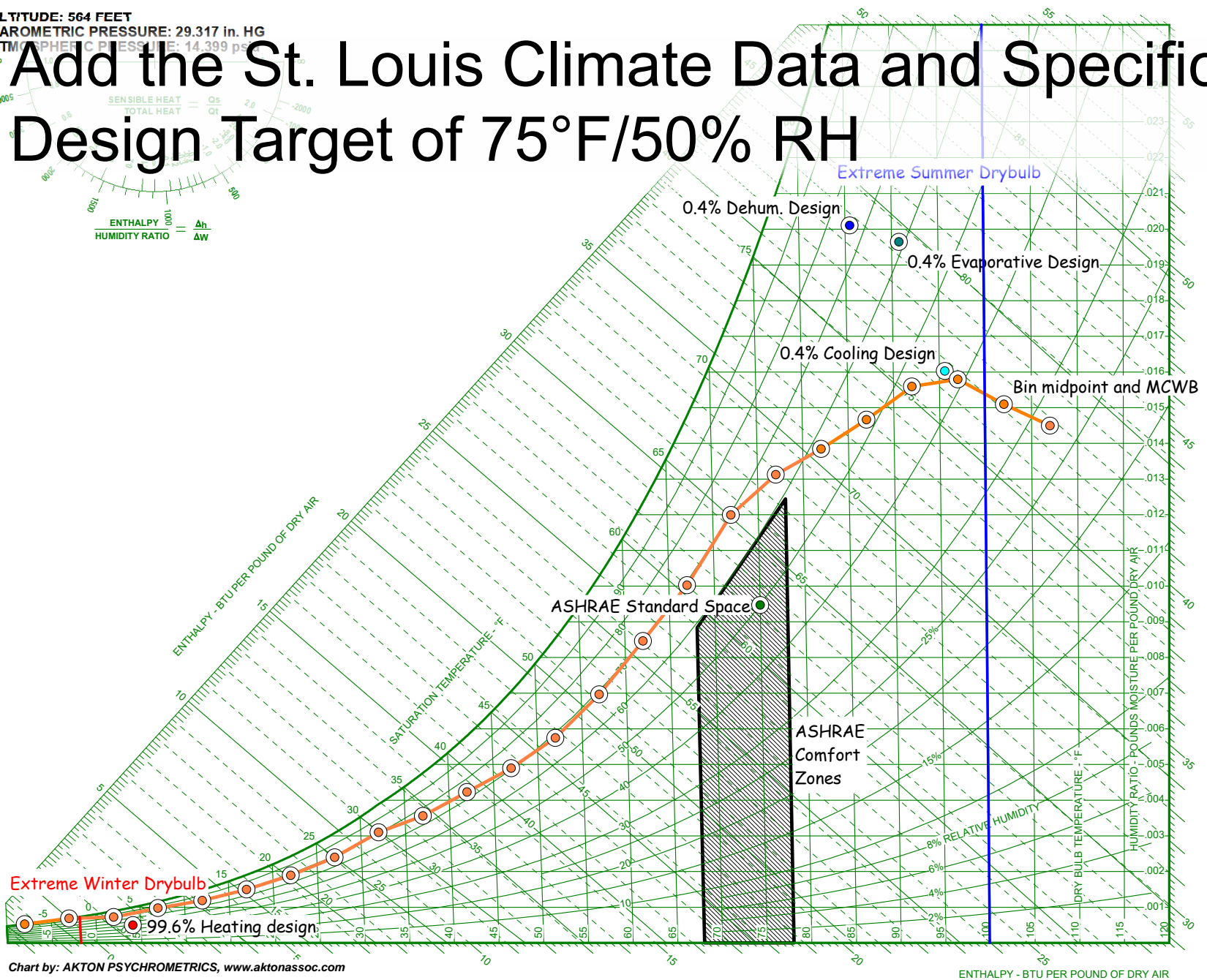
# Start with the Design Window for a Lower Quality Office Space



TAB 14-3 - ENTHALPY VS. OA DRYBULB ECONOMIZER LIMITS

ALTITUDE: 564 FEET  
 BAROMETRIC PRESSURE: 29.317 in. HG  
 ATMOSPHERIC PRESSURE: 14.399 psia

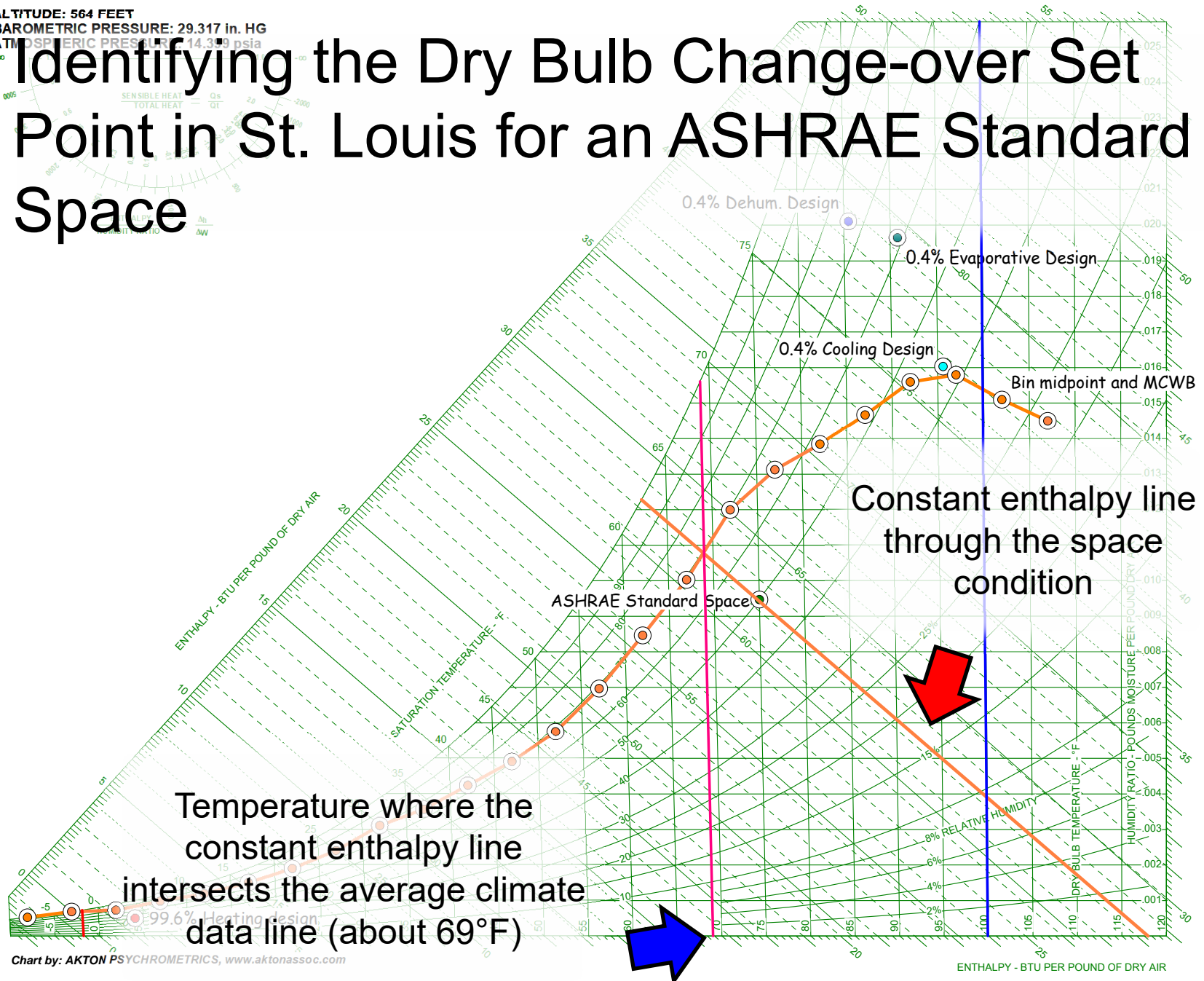
# Add the St. Louis Climate Data and Specific Design Target of 75°F/50% RH



TAB 14-3 - ENTHALPY VS. OA DRYBULB ECONOMIZER LIMITS

ALTITUDE: 564 FEET  
BAROMETRIC PRESSURE: 29.317 in. HG  
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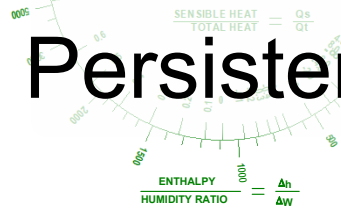
# Identifying the Dry Bulb Change-over Set Point in St. Louis for an ASHRAE Standard Space



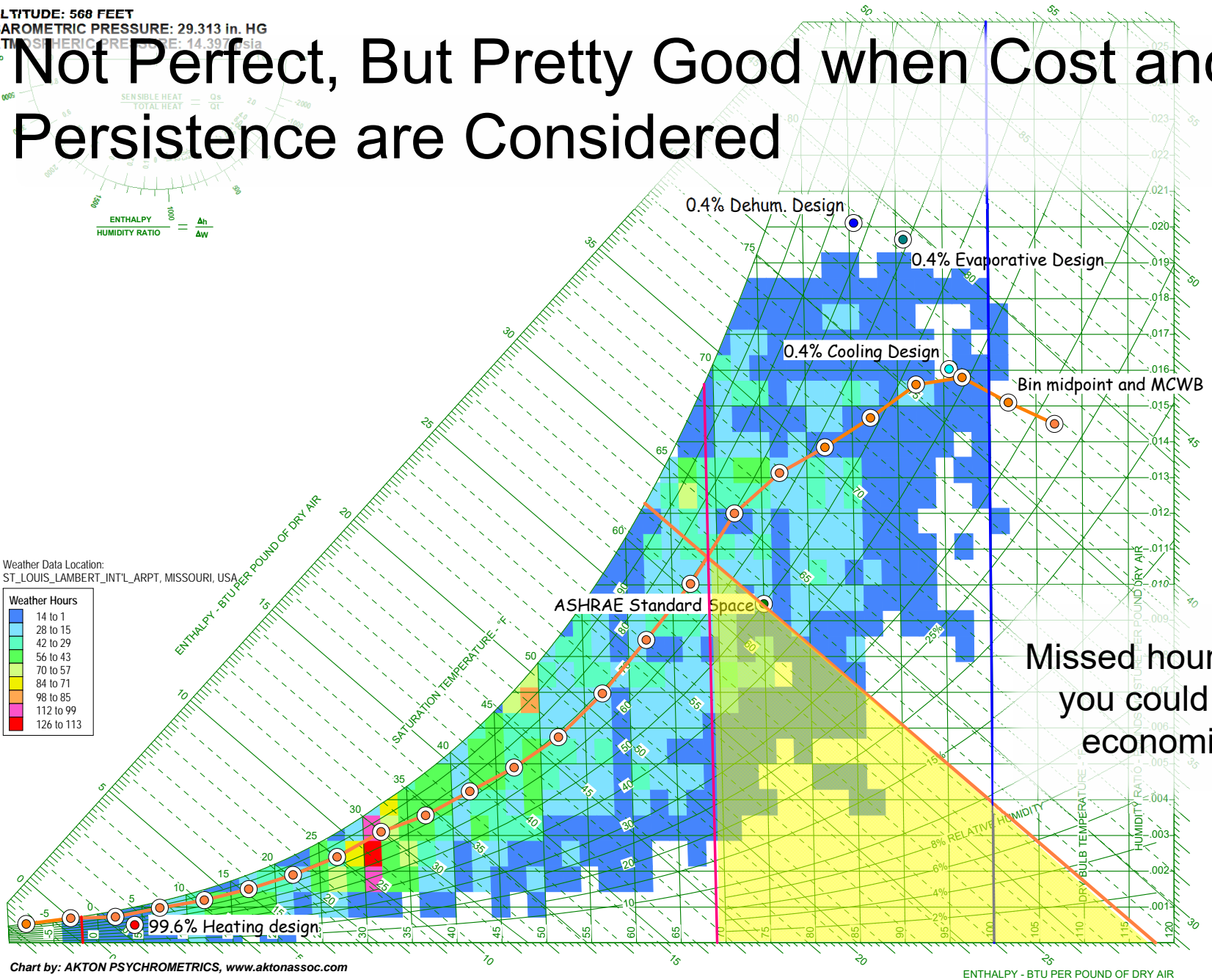
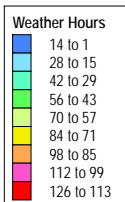
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ALTITUDE: 568 FEET  
 BAROMETRIC PRESSURE: 29.313 in. HG  
 ATMOSPHERIC PRESSURE: 14.397 psia

# Not Perfect, But Pretty Good when Cost and Persistence are Considered



Weather Data Location:  
 ST LOUIS LAMBERT INT'L ARPT, MISSOURI, USA



Missed hours when  
 you could have  
 economized

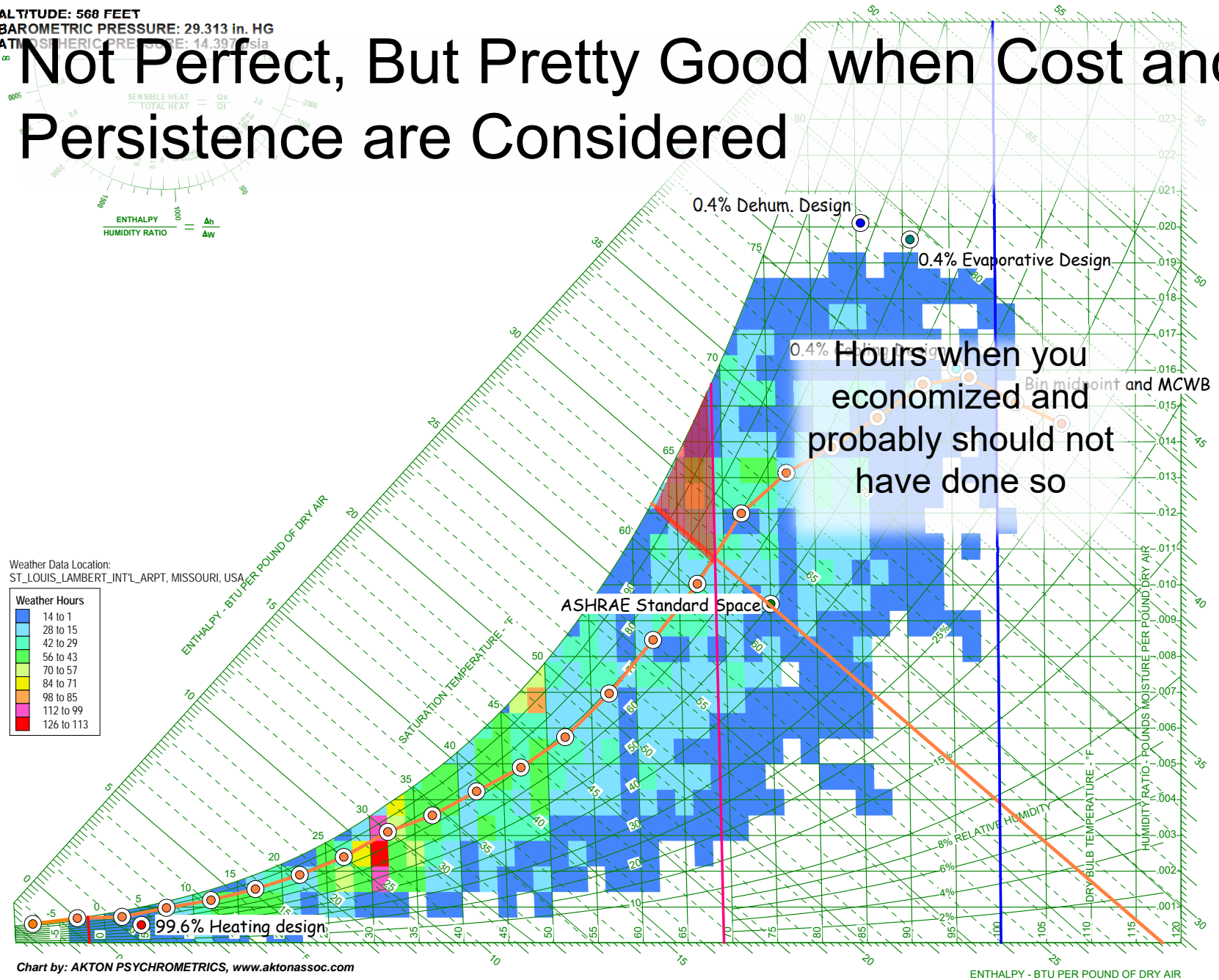
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TAB 14-3 - ENTHALPY VS. OA DRYBULB ECONOMIZER LIMITS

# Not Perfect, But Pretty Good when Cost and Persistence are Considered

For more information, see *Economizer High Limit Devices and Why Enthalpy Economizers Don't Work* at <http://tinyurl.com/SteveTaylorsArticle> (November 2010 ASHRAE Journal)