

# Fans, Ducts and Air Handling Systems: Design, Performance and Commissioning Issues

## Diffusers and Grilles



Instructor:

David Sellers

Senior Engineer

Facility Dynamics Engineering

November 7, 2017



## Diffuser and Grill Functions

- Add character to the otherwise dull and featureless ceiling façade and thus, provide something for engineers to look at every time they walk into a building
- Maintain comfort
- Effectively ventilate the space
- Control general air flow patterns



# Grilles

A frame enclosing a set of either vertical or horizontal vanes



# Diffusers

Generate a radial or directional discharge pattern






# A Nearly Infinite Variety of Styles, Shapes, and Finishes

- Adjustable blade
- Fixed blade
- Linear bar
- Nozzle
- Round
- Square
- Perforated face
- Louvered face
- Plaque face

Hemispherical  
Laminar flow  
Variable geometry  
Linear slot  
T-bar slot  
Light troffer  
Swirl  
Displacement  
Active chilled beam

See the 2008 ASHRAE Handbook—HVAC Systems and Equipment chapter 19 Room Air Distribution Equipment Table 1. for an application summary



# A Nearly Infinite Variety of Styles, Shapes, and Finishes

**Adjustable blade**

**Fixed blade**

**Linear bar**

**Nozzle**

**Round**

**Square**

**Perforated face**

**Louvered face**

**Plaque face**

**Hemispherical**

**Laminar flow**

**Variable geometry**

**Linear slot**

**T-bar slot**

**Light troffer**

**Swirl**

**Displacement**

**Active chilled beam**

**BBQ**

See the *2008 ASHRAE Handbook—HVAC Systems and Equipment* chapter 19 *Room Air Distribution Equipment* Table 1 for an application summary



# General Approaches

Fully mixed

Little or no thermal stratification within the occupied zone

Overhead air systems are an example

Fully stratified

Little or no mixing within the occupied zone

Displacement ventilation is an example

Partially mixed

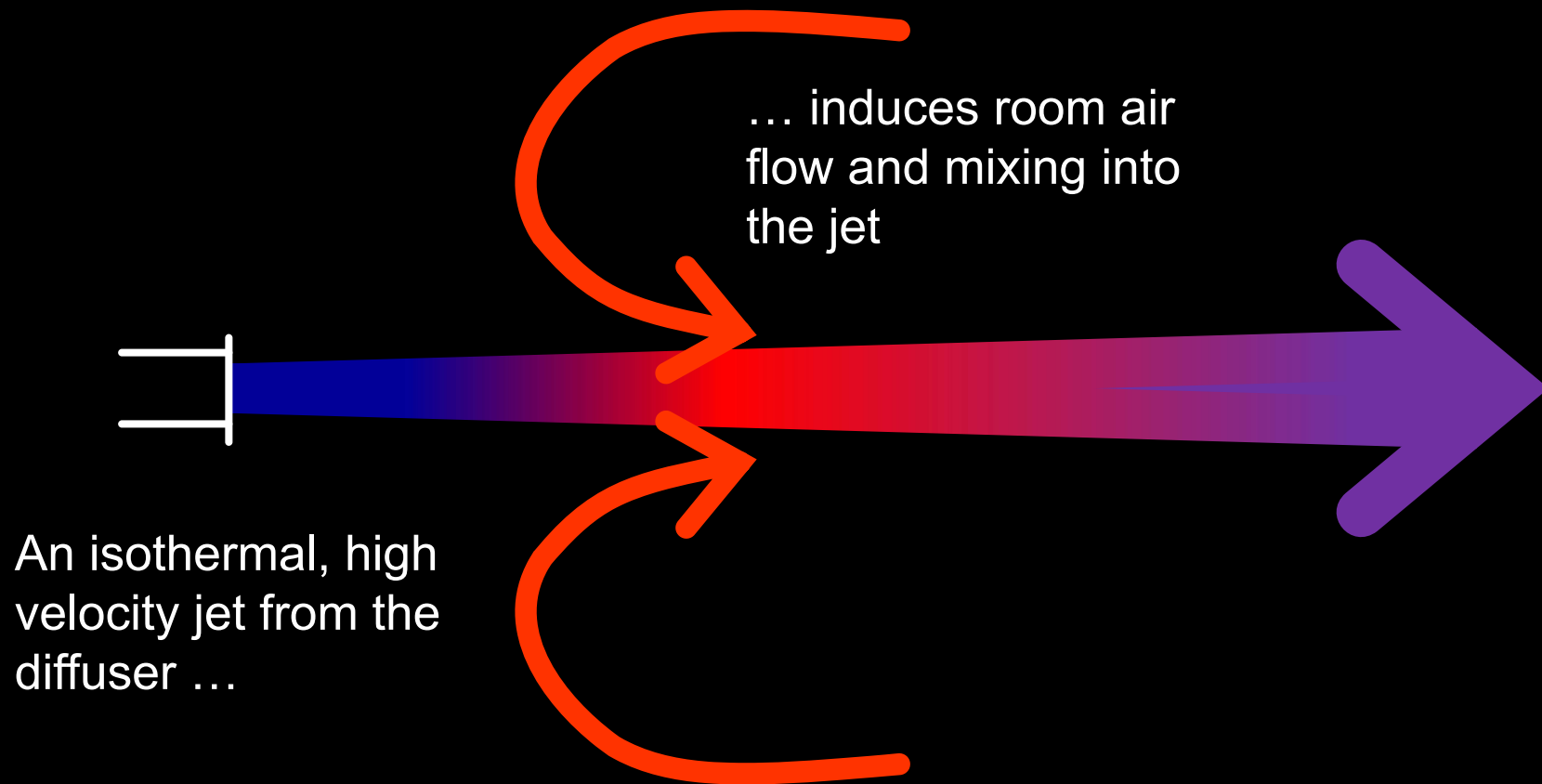
Limited mixing within the occupied zone

Underfloor air distribution is an example

Task

Condition a focused area

# Induction is a Key Concept for Any System that Targets Mixing





# Sizing/Selection is Critical to Comfort

- Distributing **hot air** is different from distributing **cold air**
- Velocities need to be at 40-50 fpm or less in the occupied zone
- Throw needs to cover the area but not hit anything
- VAV diffusers need to perform at both the maximum and minimum flow rates
  - Failing to consider minimum flows = poor induction = dumping
  - Failing to consider maximum flows = noise

# Selection Criteria

- Location (ceiling, sidewall, floor, etc.)
  - Often architecturally driven
- Overcome stratification and flows created by the loads in the space
- Acceptable sound levels
  - Not a noise source vs. white noise
- Maximum comfort

*You can please some of the people some of the time ...*



# Selection Criteria

## Selection based on noise criteria

- Distance related
- Impacted by louver settings and balancing damper settings and location
- Often architecturally driven

## Selection based on throw patterns

- Jet “attaches” to the ceiling
- Can fall away at about 100 fpm terminal velocity

## Selection based on comfort criteria

- Air Diffusion Performance Index
- Likely to become the preferred method in an ASHRAE 62 update

# An Important Consideration

Parameters we often vary in buildings and HVAC systems can have a significant impact on the performance of a diffuser

- Temperature difference between the supply and zone impacts the shape of the primary and secondary jets and the room air flow patterns
- Velocity has a similar impact to temperature and also impacts how the jet interacts with nearby surfaces
- Obstructions and variations in surfaces can impact the jet and the airflow patterns it generates



ALTITUDE: 1112 FEET  
BAROMETRIC PRESSURE: 28.738 in. HG  
ATMOSPHERIC PRESSURE: 14.115 psia

# ASHRAE Comfort Zones

ASHRAE Standard 55

ASHRAE Handbook of Fundamentals 2007, Chapter 9

*80% of sedentary or slightly active persons find the environment thermally acceptable*

... which means 20% find it unacceptable

Depends on the level of clothing

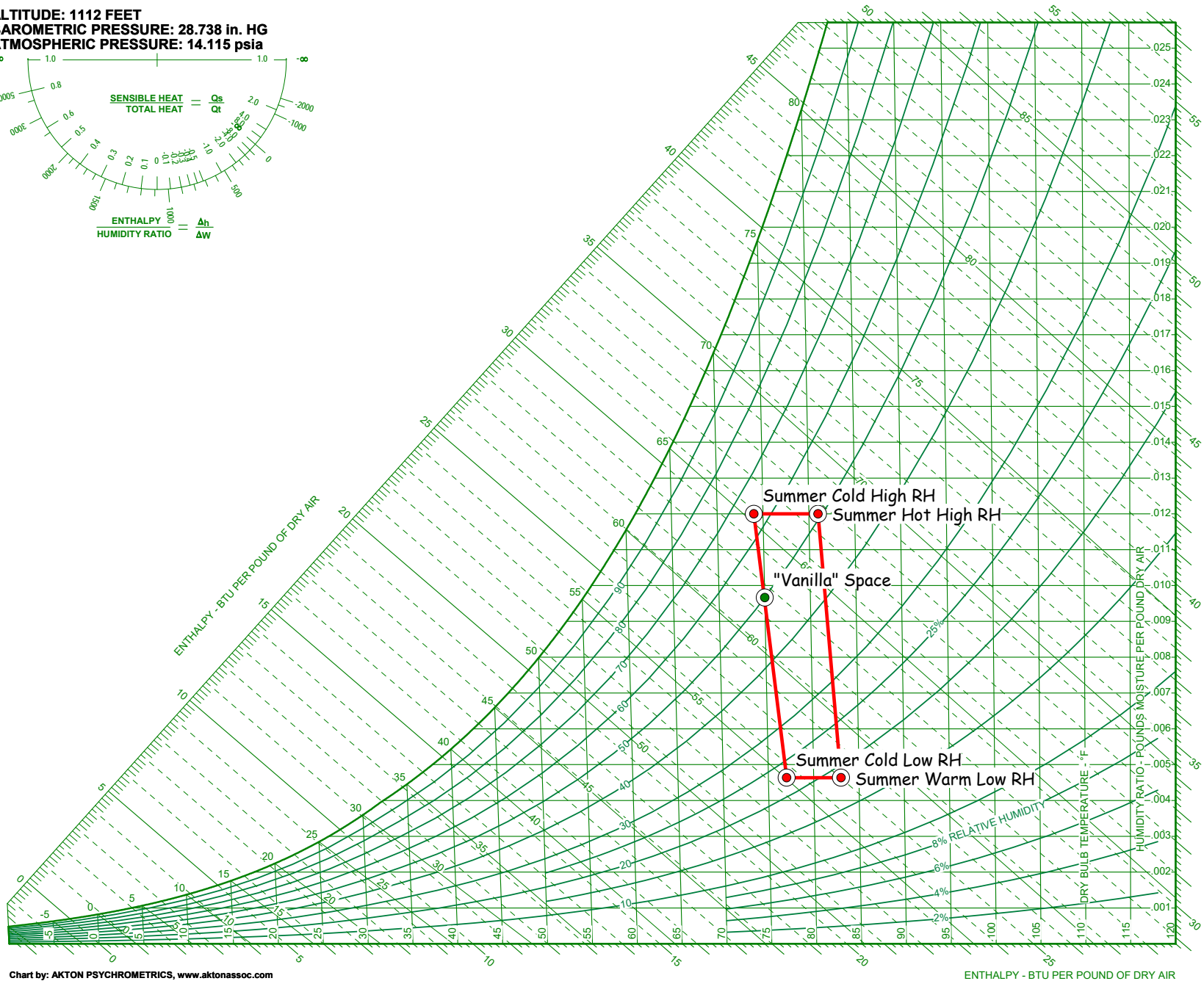
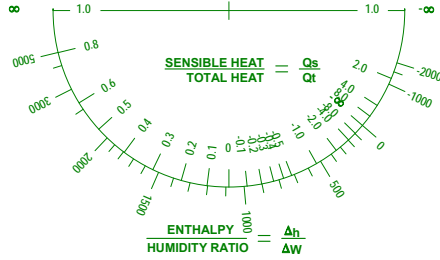
- Summer expectations might be different from winter
- Units of “clo” used to define the effect
  - a winter business suit has about 1 clo of insulation
  - a short-sleeved shirt and trousers has about 0.5 clo

Airspeeds below 40 fpm

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

ENTHALPY - BTU PER POUND OF DRY AIR

ALTITUDE: 1112 FEET  
 BAROMETRIC PRESSURE: 28.738 in. HG  
 ATMOSPHERIC PRESSURE: 14.115 psia





ALTITUDE: 1112 FEET  
 BAROMETRIC PRESSURE: 28.738 in. HG  
 ATMOSPHERIC PRESSURE: 14.115 psia

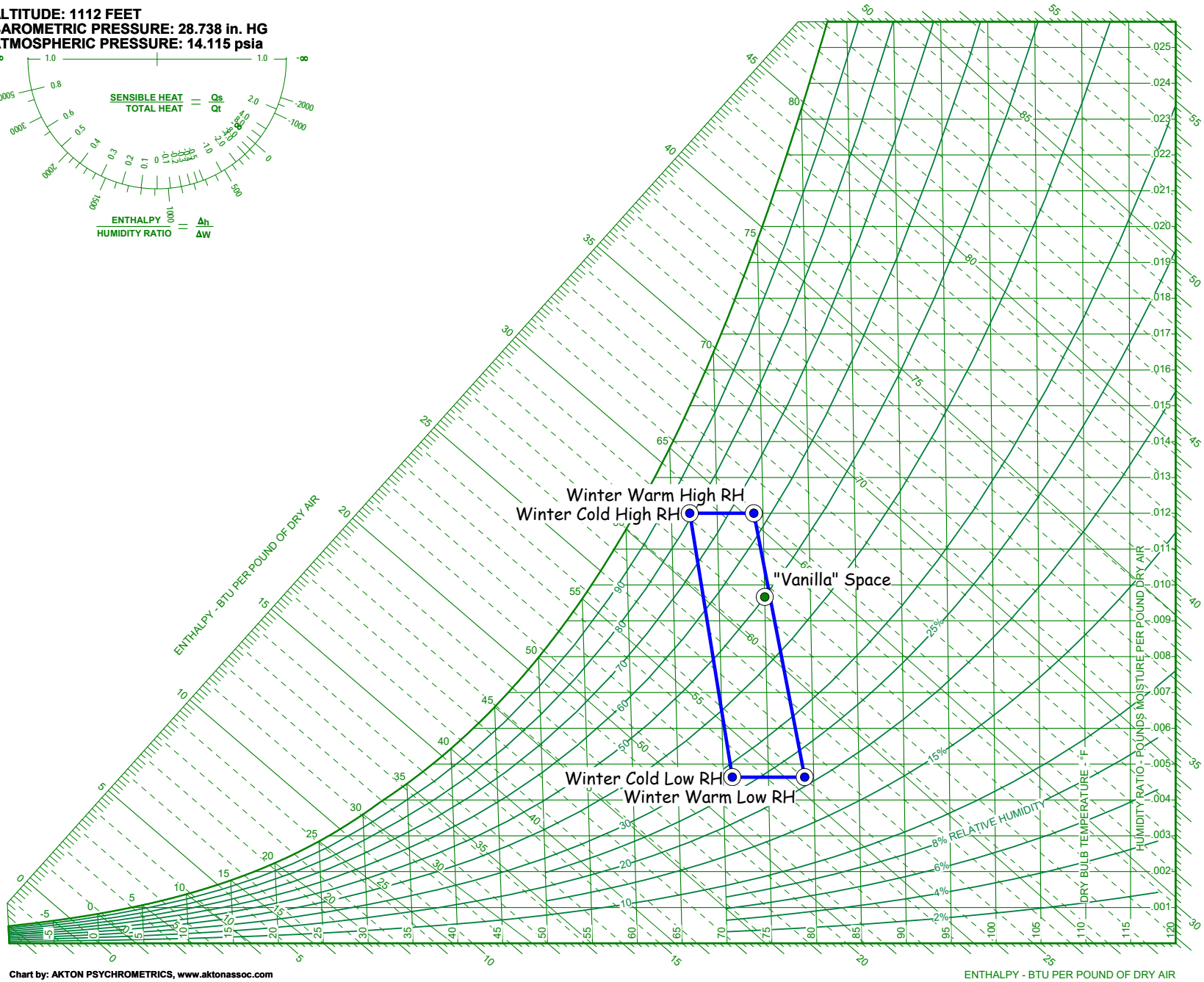
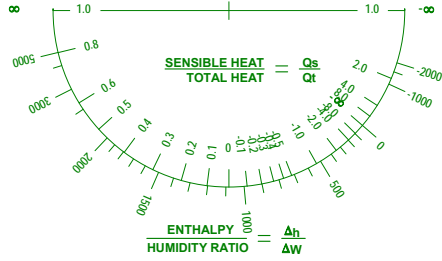
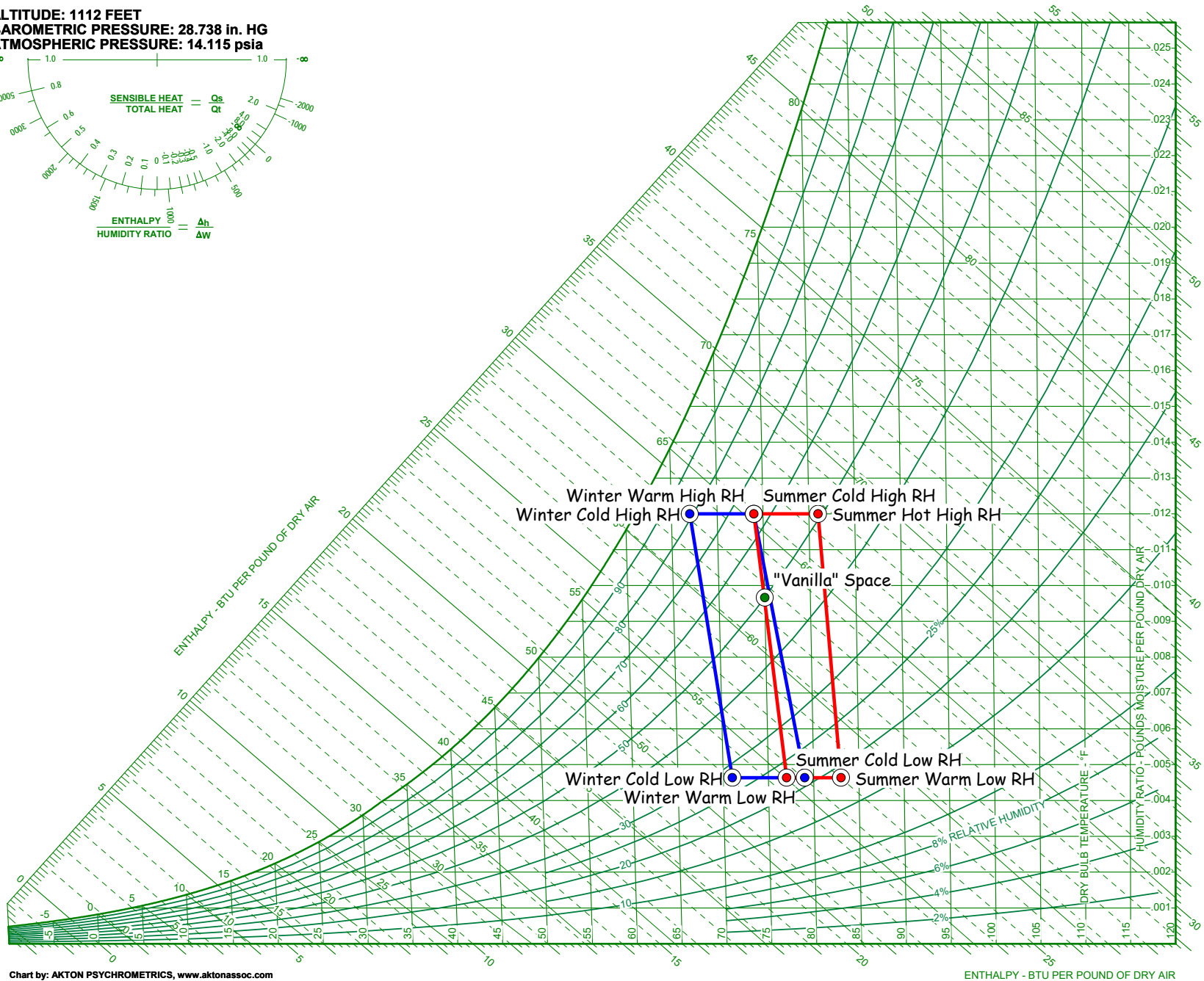
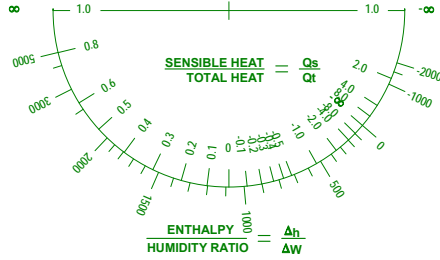
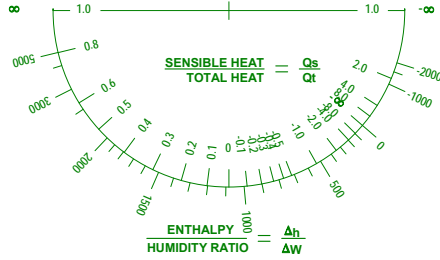


Chart by: AKTON PSYCHROMETRICS, [www.aktonassoc.com](http://www.aktonassoc.com)

ALTITUDE: 1112 FEET  
 BAROMETRIC PRESSURE: 28.738 in. HG  
 ATMOSPHERIC PRESSURE: 14.115 psia



ALTITUDE: 1112 FEET  
 BAROMETRIC PRESSURE: 28.738 in. HG  
 ATMOSPHERIC PRESSURE: 14.115 psia



Profile Presentation Control

Page Setup | Chart Settings | Chart Lines | Point/Process Lines | Comfort Zones | Paper-Chart Colors | Data Processing Zones

☒ Show Summer Comfort Zone

Minimum Dewpoint Temp. 36.0 °F  
 Maximum DP Dry-Bulb 81.0 °F  
 Minimum DP Dry-Bulb 74.0 °F  
 Maximum Wet-Bulb Temp. 68.0 °F  
 Maximum WB Dry-Bulb 79.0 °F  
 Minimum WB Dry-Bulb 73.0 °F

Load Summer Zone Defaults

Pen Color Pen Weight 10 Fill Color

☒ Show Winter Comfort Zone

Minimum Dewpoint Temp. 36.0 °F  
 Maximum DP Dry-Bulb 76.0 °F  
 Minimum DP Dry-Bulb 69.0 °F  
 Maximum Wet-Bulb Temp. 64.0 °F  
 Maximum WB Dry-Bulb 74.0 °F  
 Minimum WB Dry-Bulb 68.0 °F

Load Winter Zone Defaults

Pen Color Pen Weight 10 Fill Color

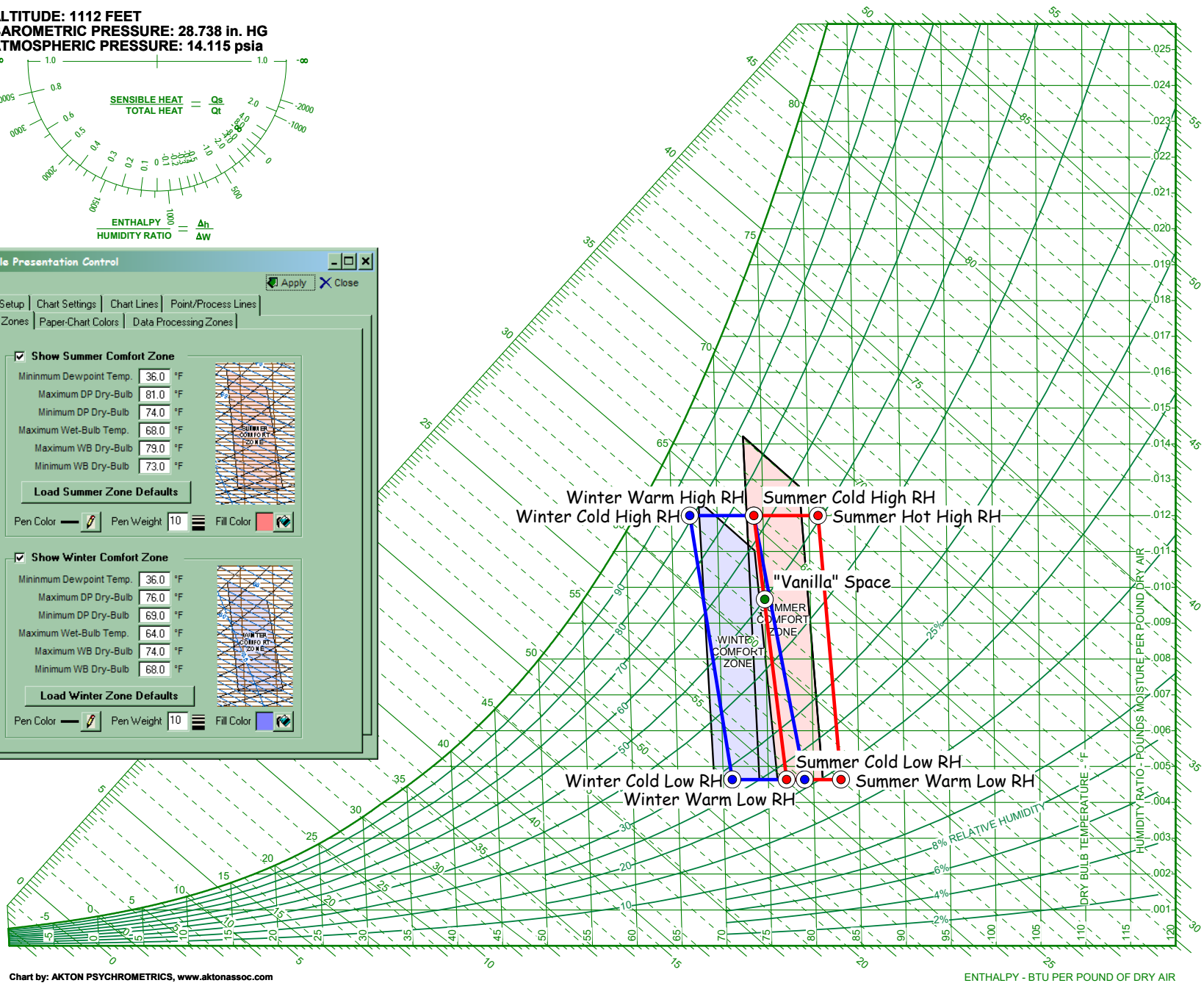
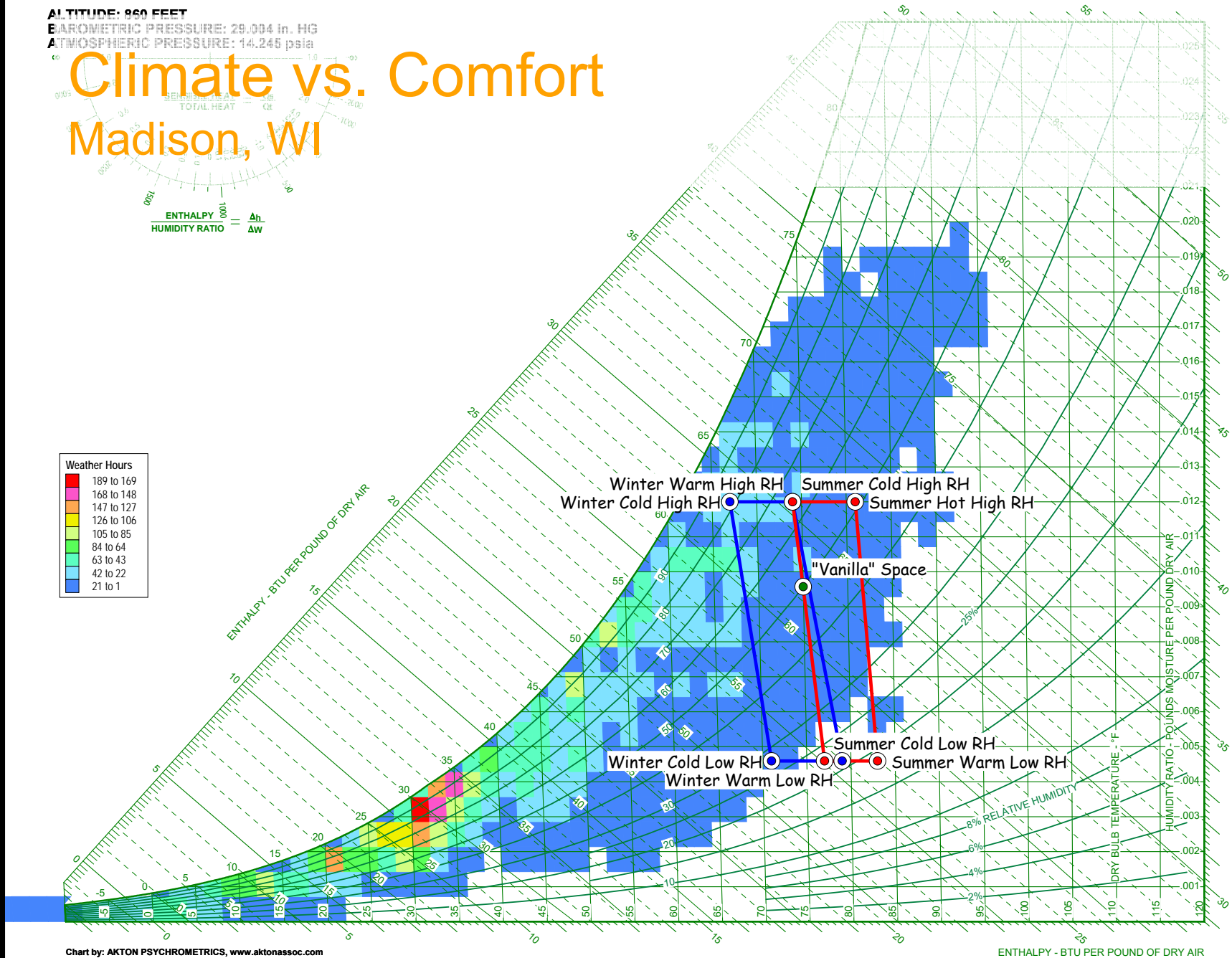
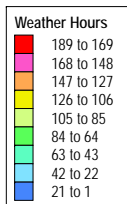


Chart by: AKTON PSYCHROMETRICS, www.aktonassoc.com

ALTITUDE: 860 FEET  
 BAROMETRIC PRESSURE: 29.004 in. HG  
 ATMOSPHERIC PRESSURE: 14.245 psia

# Climate vs. Comfort

## Madison, WI

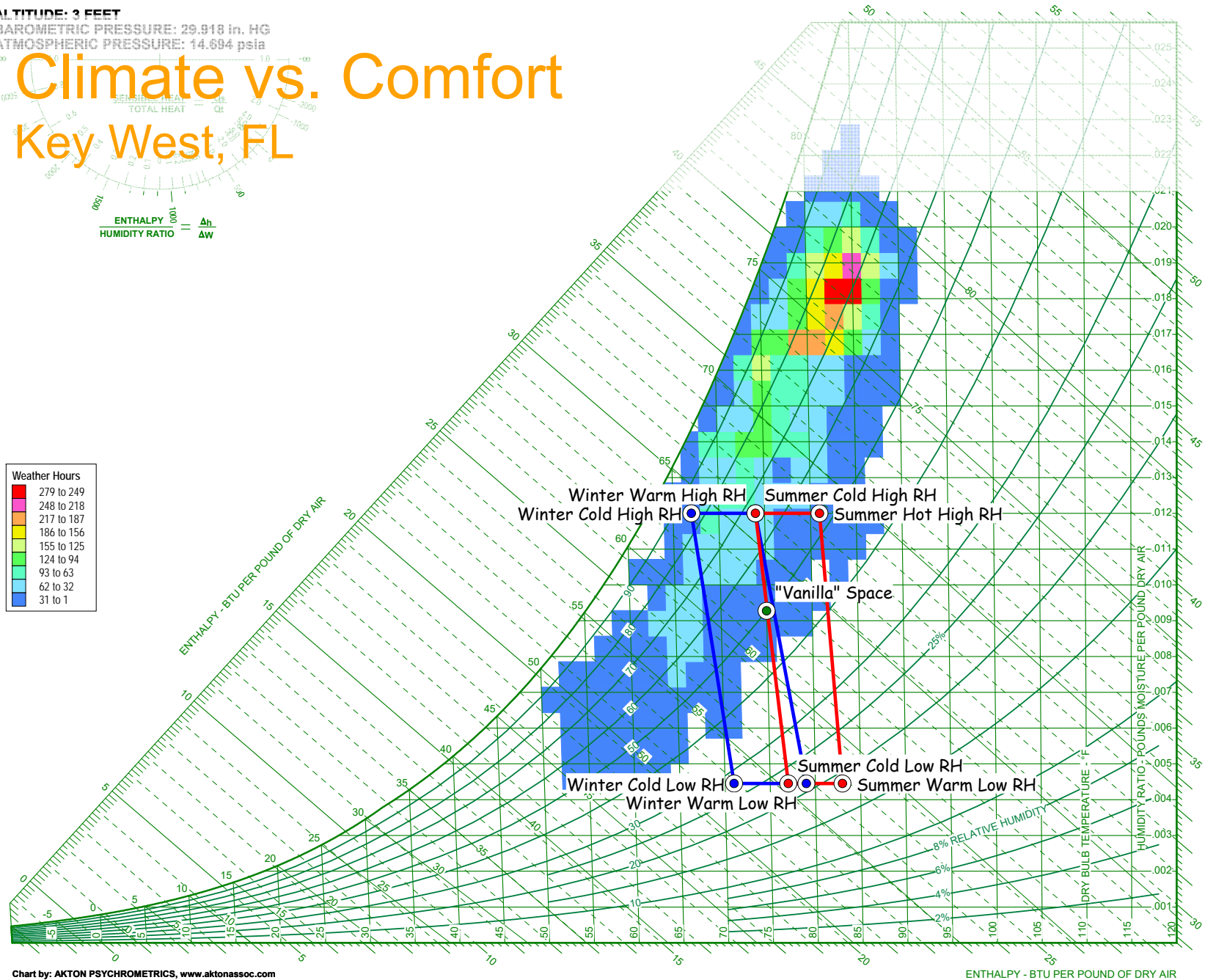




ALTITUDE: 3 FEET  
 BAROMETRIC PRESSURE: 29.918 in. HG  
 ATMOSPHERIC PRESSURE: 14.694 psia

# Climate vs. Comfort

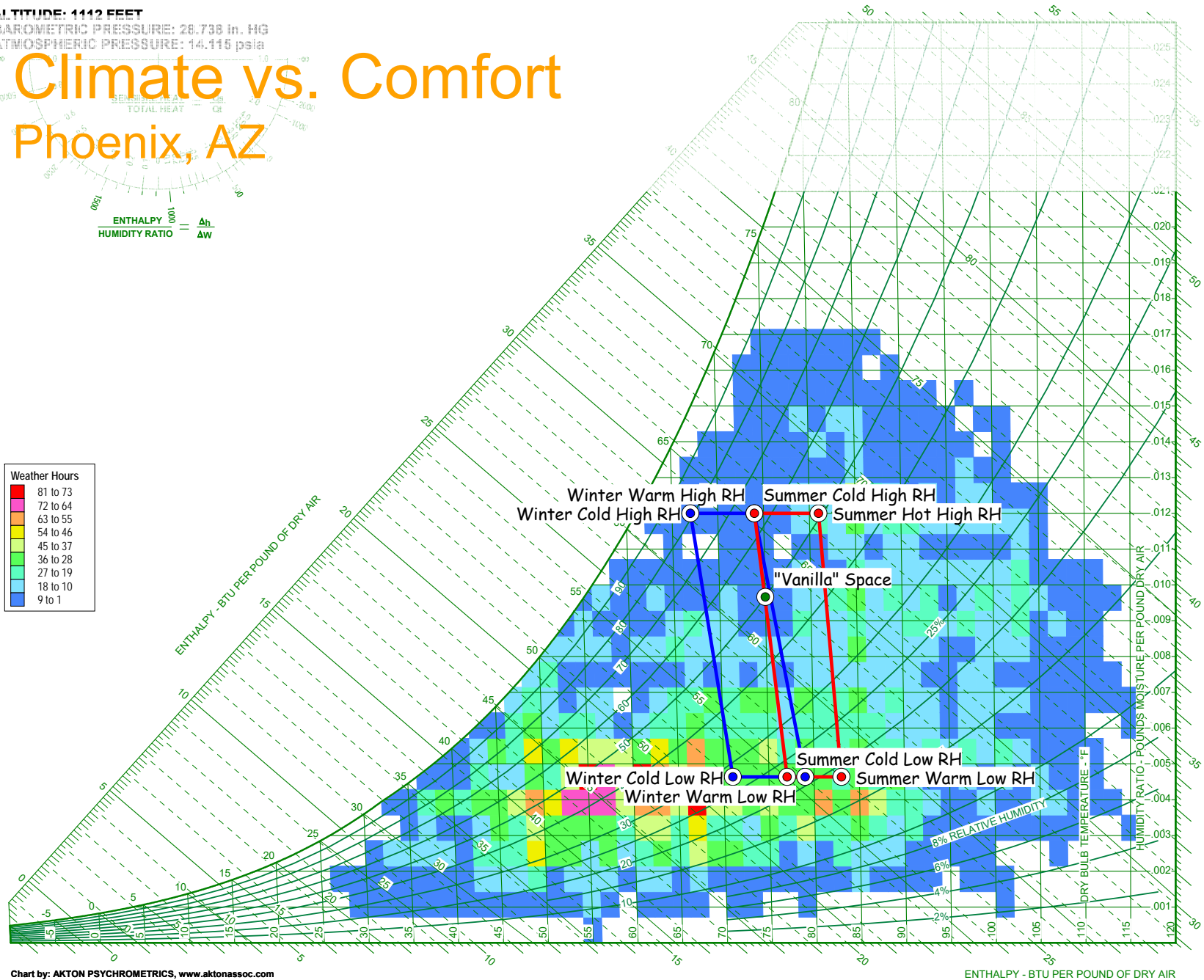
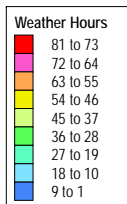
## Key West, FL



ALTITUDE: 1112 FEET  
 BAROMETRIC PRESSURE: 28.738 in. HG  
 ATMOSPHERIC PRESSURE: 14.115 psia

# Climate vs. Comfort

## Phoenix, AZ



ALTITUDE: 16 FEET  
 BAROMETRIC PRESSURE: 29.904 in. HG  
 ATMOSPHERIC PRESSURE: 14.687 psia

# Climate vs. Comfort San Francisco, CA

