# VAV Systems

## Design, Performance and Commissioning Issues

### Minimum Flow Settings

**Instructor:**

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Facility Dynamics Engineering

March 7, 2018

# A Lower Mass Flow Rate Means a Given Load will Cause a Large Change in the State of the Air

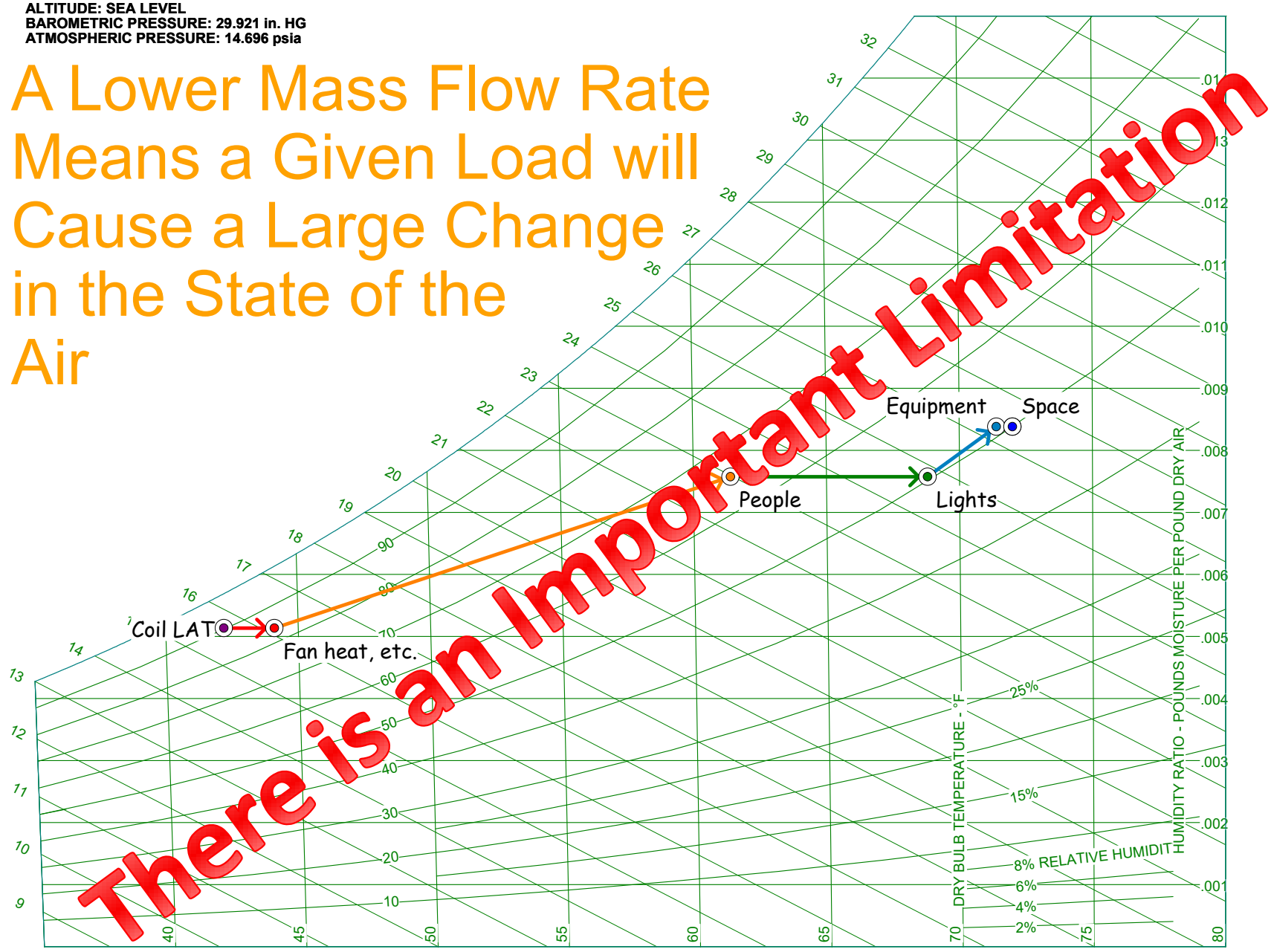



*Chart by: AKTON PSYCHROMETRICS, www.aktonassoc.com*

C:\Users\DSellers\Documents\FDE Tools\SketchUp\Marriott Ballroom AHU\Design Info Anahiem Marriott Basis\Ballroom Load Components - 10 - Less Flow.aad

# What is in This Module?

- What sets the minimum flow in a VAV zone
- What limits how low you can go in terms of minimum flow
- What limits how high you can go in terms of maximum supply temperature
- The impact of minimum flow on heating capability
- VAV systems and diffuser performance

# Setting Minimum Flow

Based on the ventilation requirement at the zone level

- Contaminant (IEQ) control
- Rule of thumb – 15 cfm of outdoor air required per person
- Could be set by a code or production required air change rate

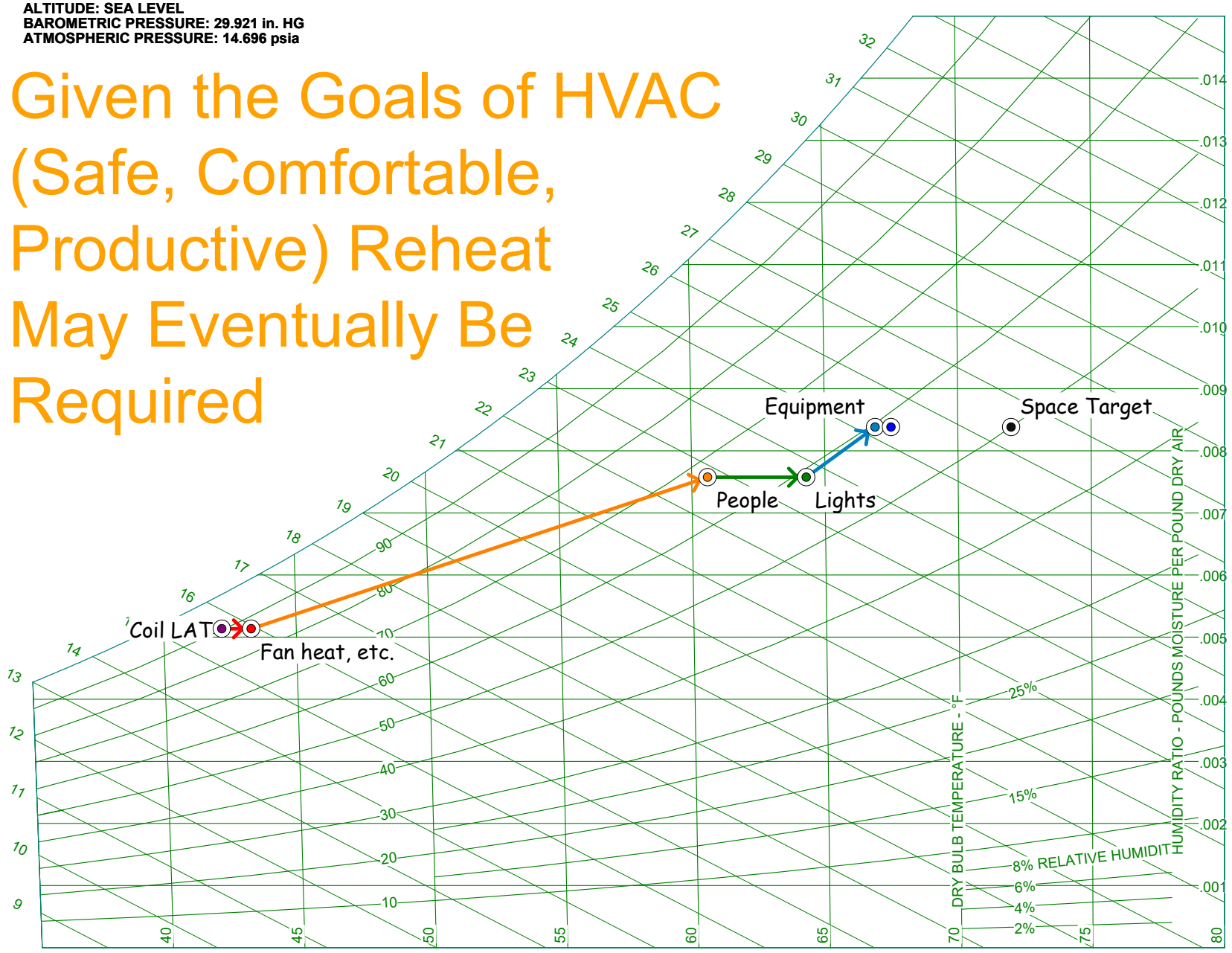
# Setting Minimum Flow

The volume required at the zone level is a function of the AHU's MOA setting

- For a 100% OA system
  - 15 cfm of OA at the zone equates to 15 cfm at the AHU intake
- For a system with a 10% MOA setting
  - To get 15 cfm of OA to the zone when the system is on MOA, the zone minimum needs to be set for 150 cfm

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

# Given the Goals of HVAC (Safe, Comfortable, Productive) Reheat May Eventually Be Required

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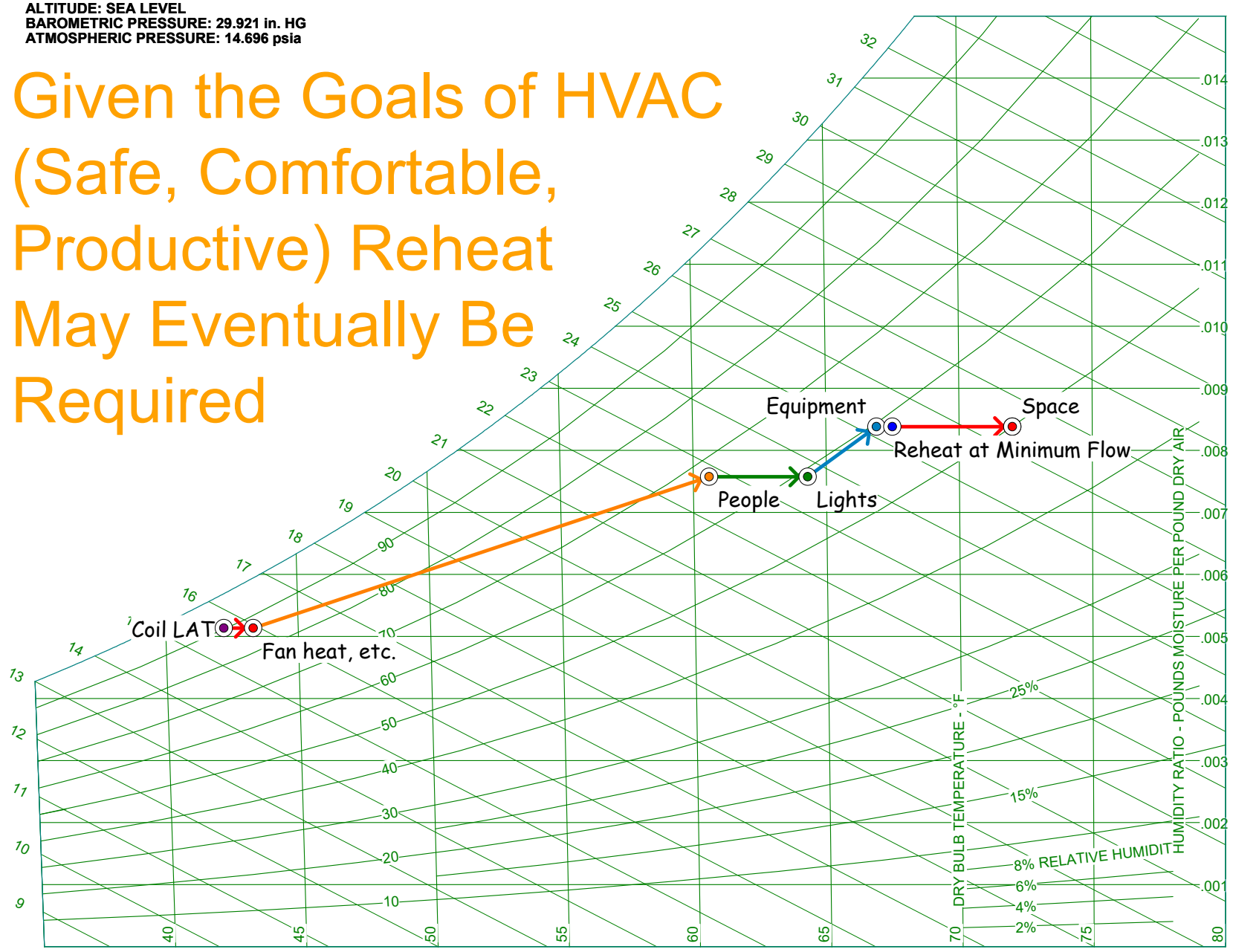


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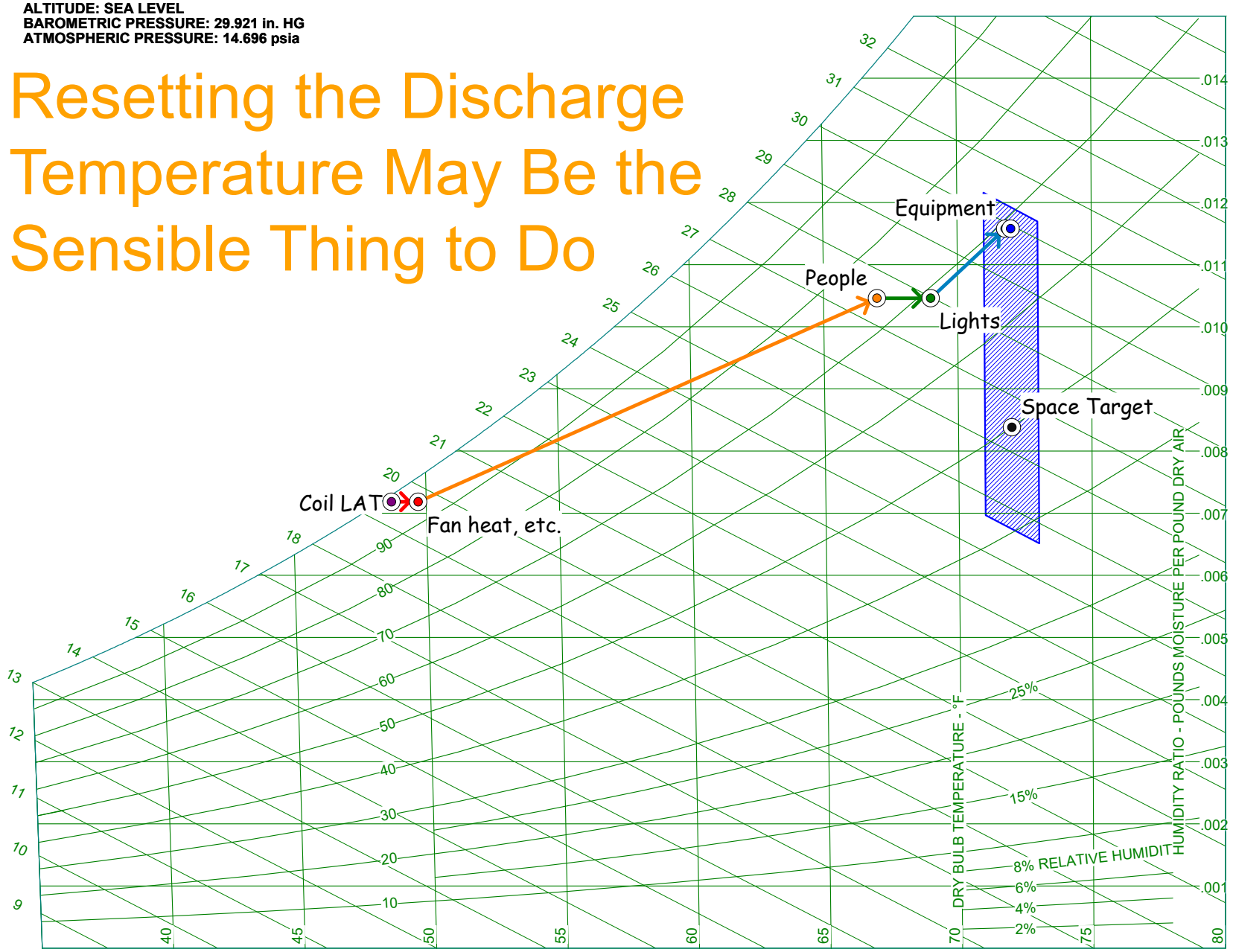
# Resetting the Discharge Temperature May Be the Sensible Thing to Do

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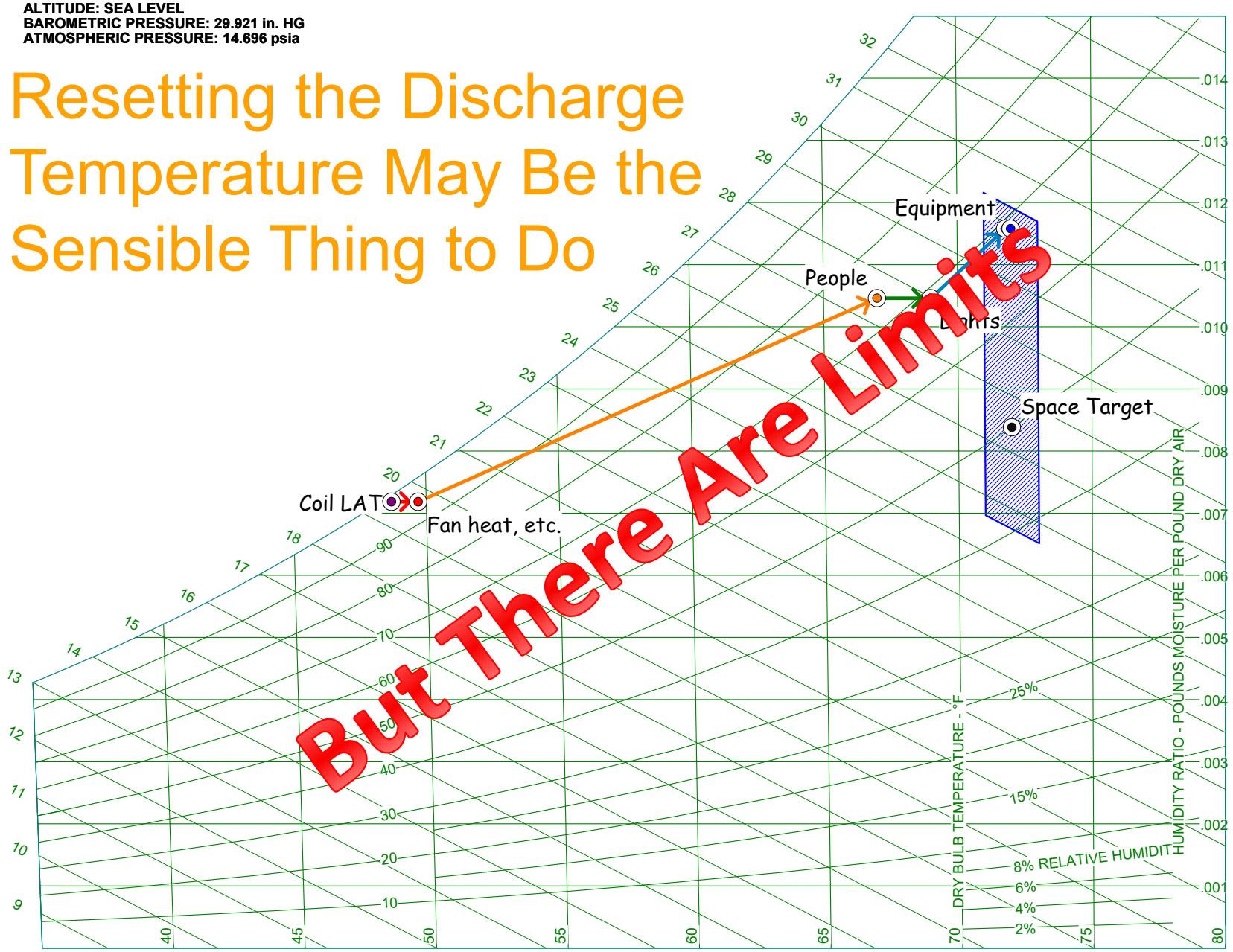


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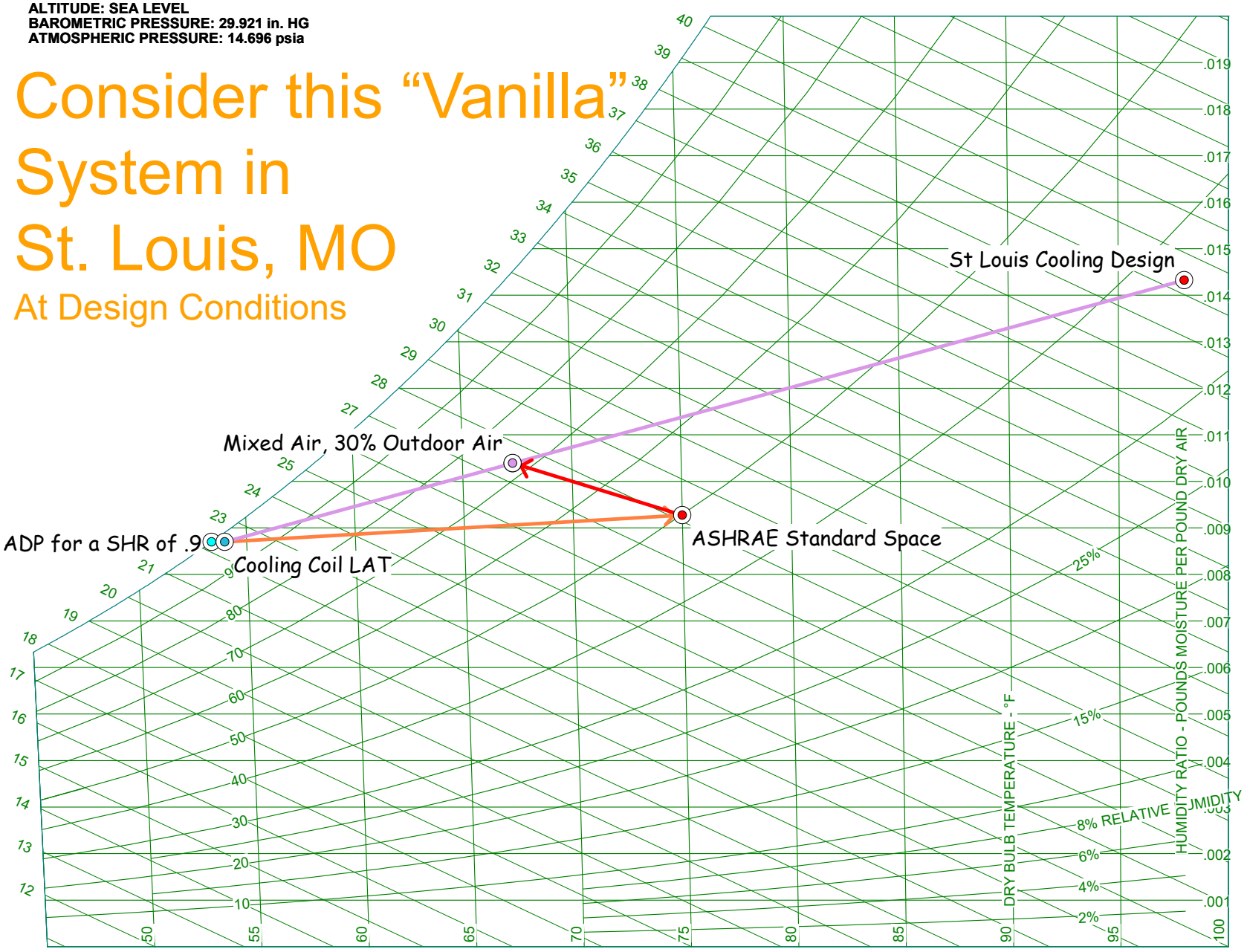
# Consider this "Vanilla" System in St. Louis, MO

## At Design Conditions



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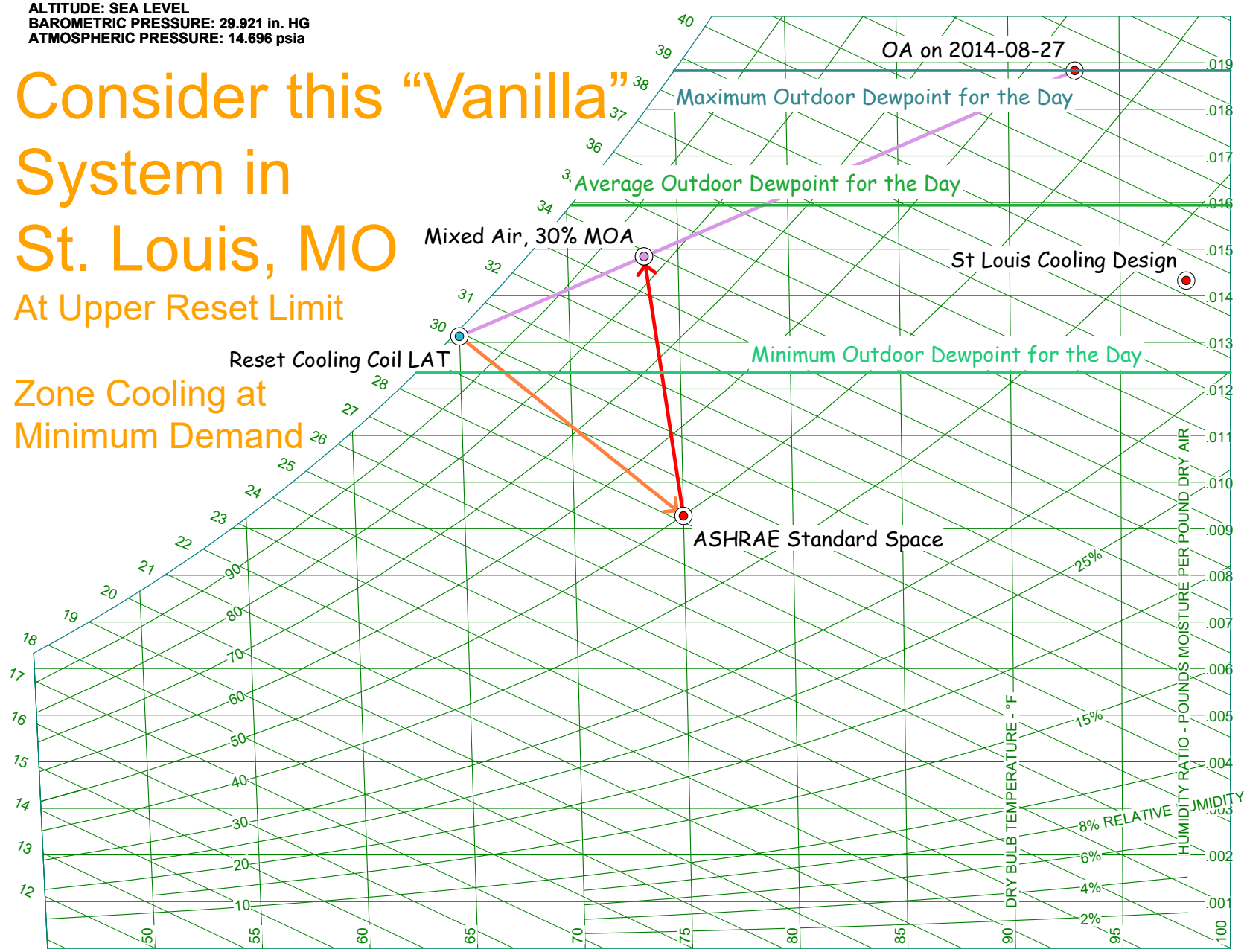
# Consider this "Vanilla" System in St. Louis, MO

## At Upper Reset Limit

## Zone Cooling at Minimum Demand

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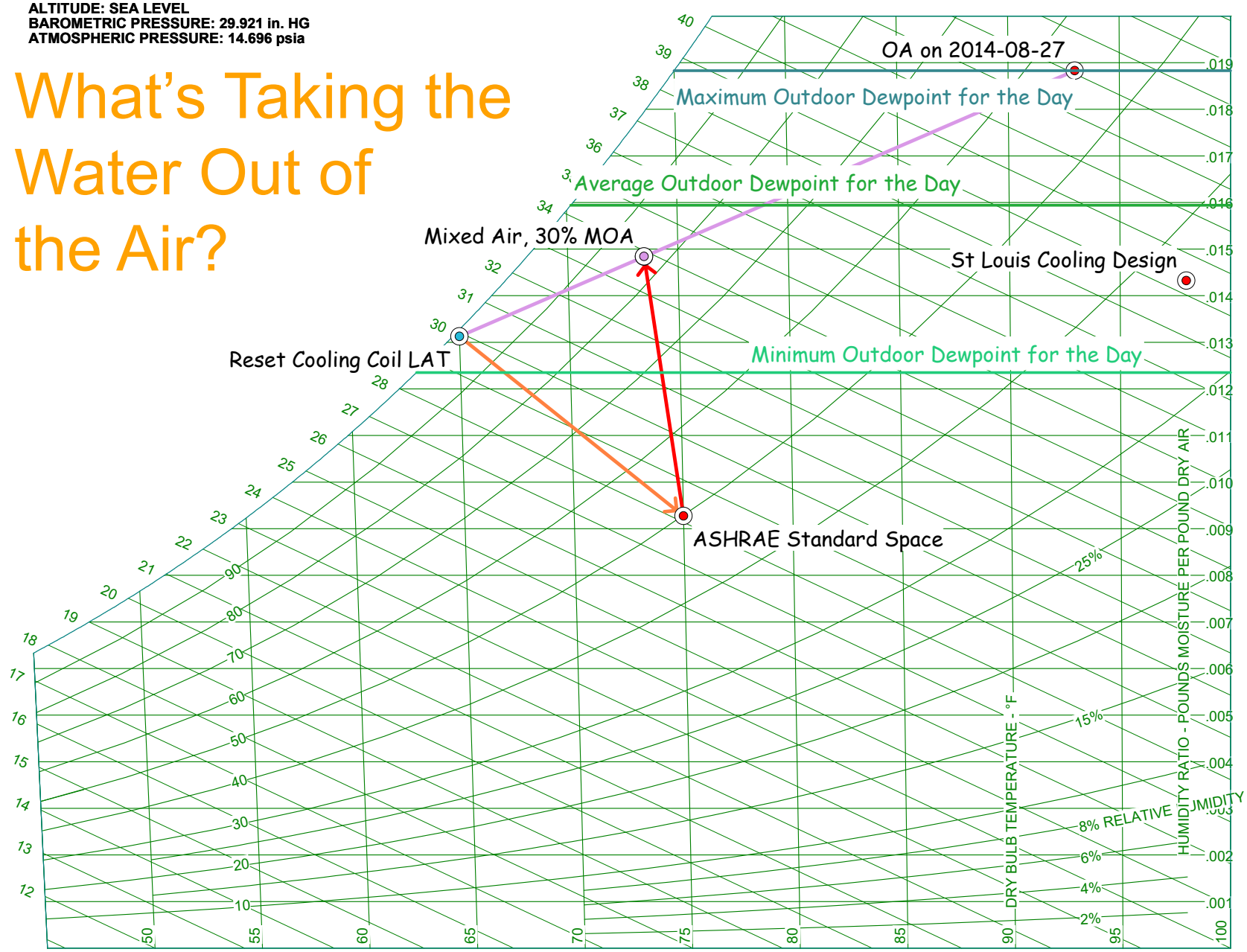
# What's Taking the Water Out of the Air?

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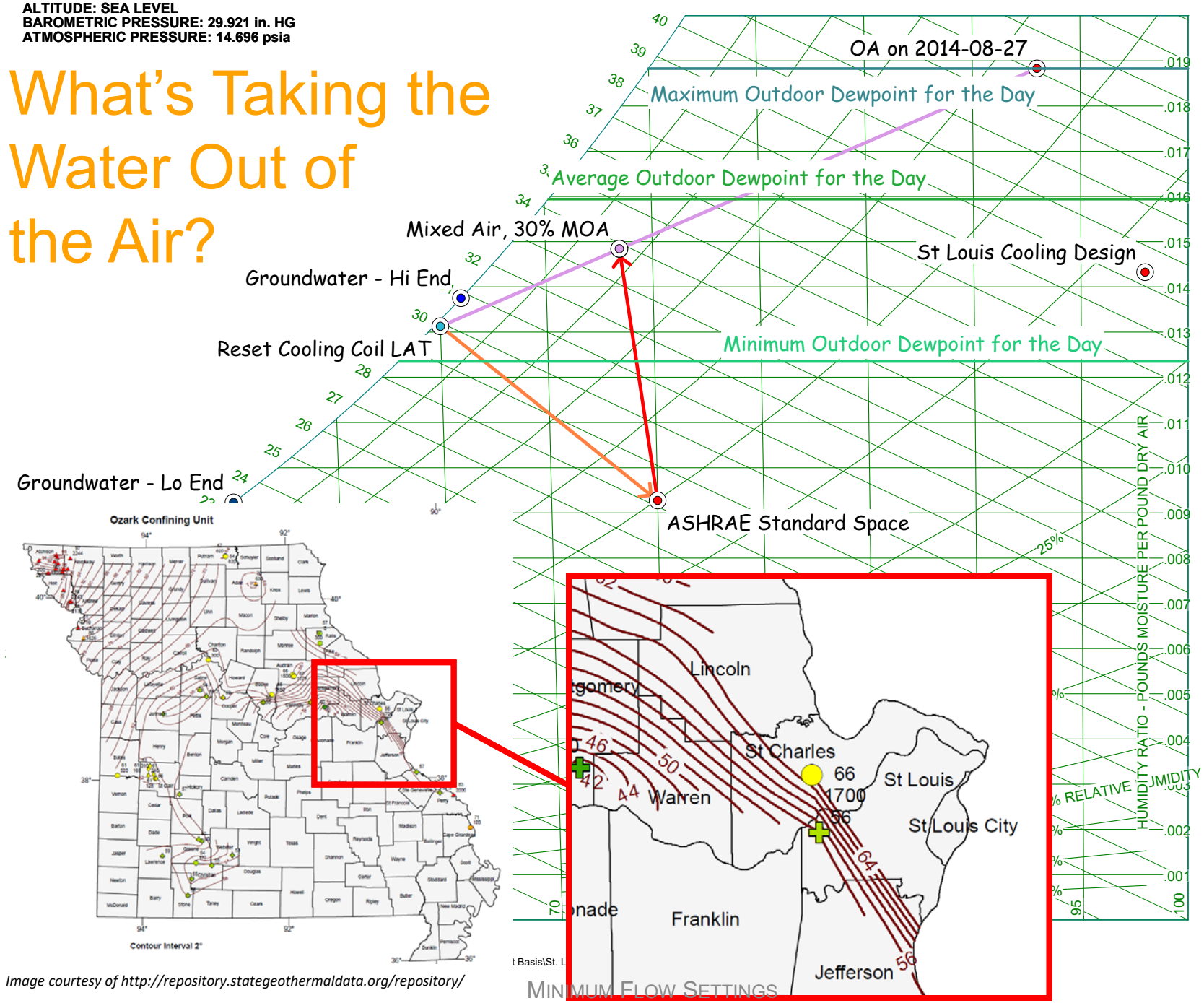


*Image courtesy of http://repository.stategeothermaldata.org/repository/*

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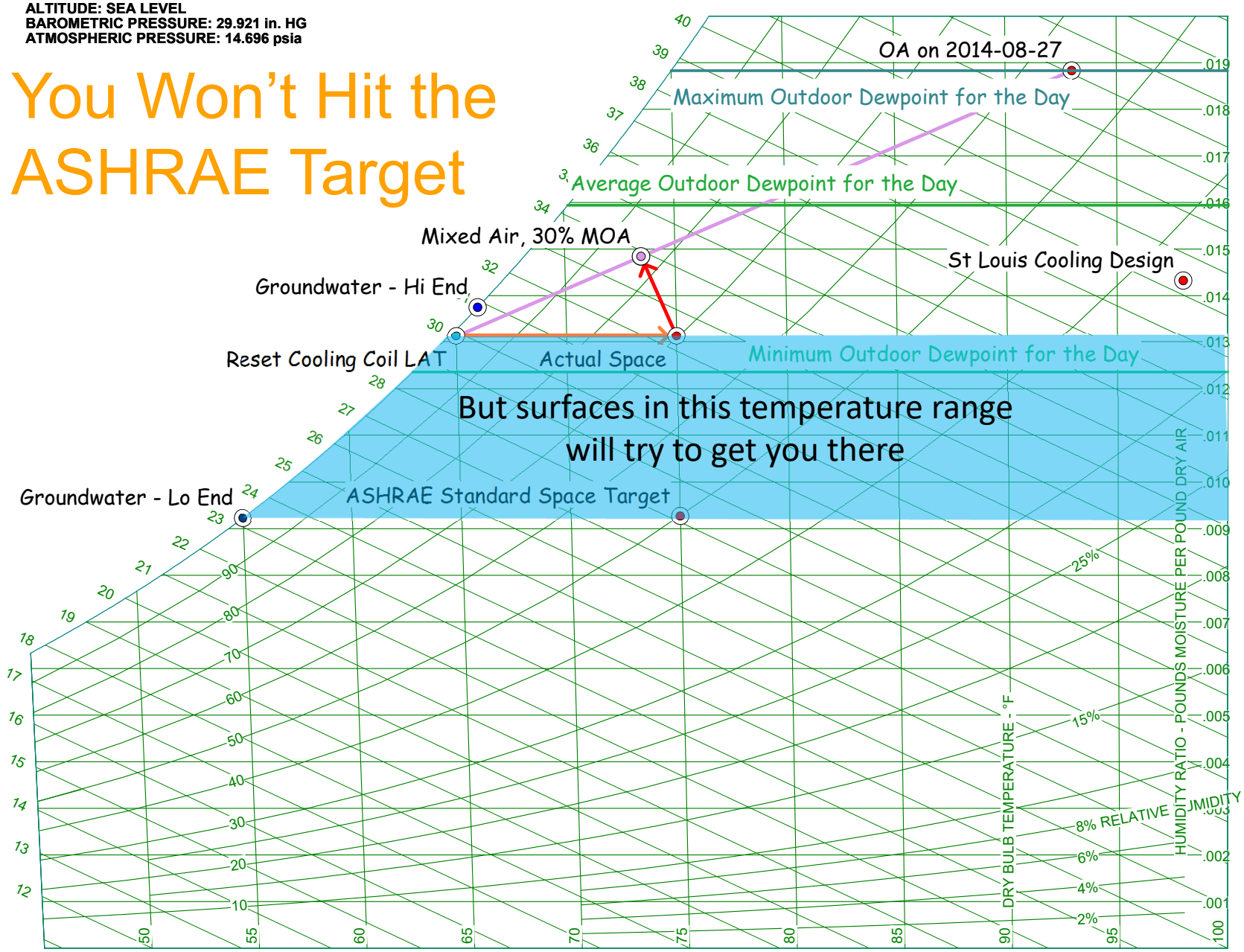
# You Won't Hit the ASHRAE Target

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C:\Users\DSellers\Documents\FDE Tools\SketchUp\Marriott Ballroom AHU\Design Info Anahiem Marriott Basis\St. Louis 2014-08-27 - Ground Water Temperatures High RH.aad

# Heating versus Reheat

## Heating

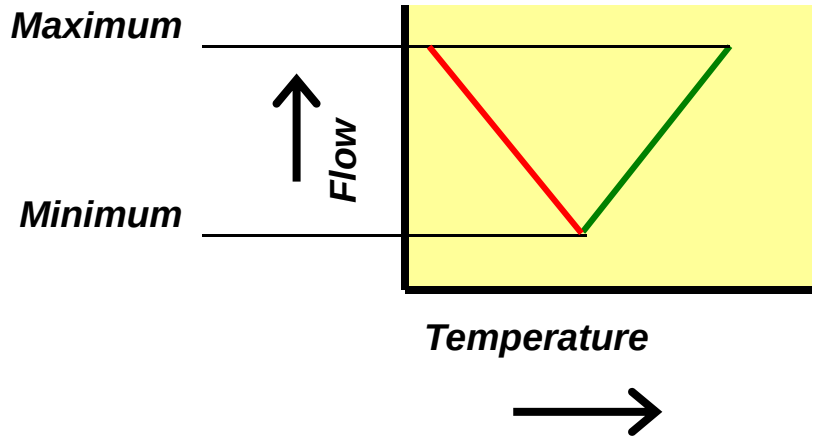
- Off set a loss of energy from the
- Occurs when ambient temperatures are below the room set point
- Deliver air at a temperature above the space temperature
- Diffusion of warm air can be an issue

## Reheat

- Offset unnecessary cooling provided by the required minimum flow rate
- Occurs year round
- Air frequently delivered below room temperature but above AHU discharge temperature
- Diffusion still can be an issue

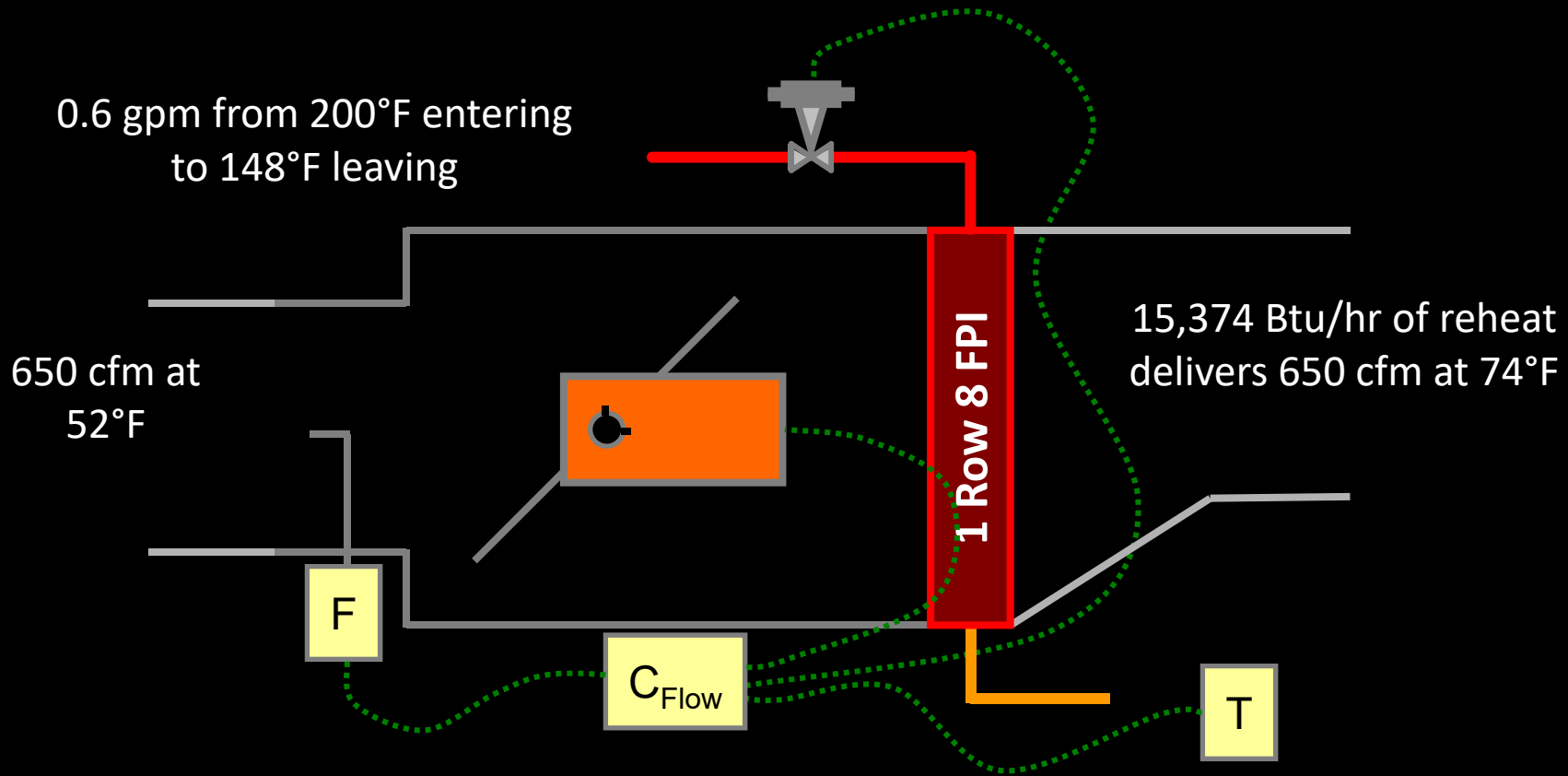
# More Flow ≠ More Heating

What happens with this terminal unit control strategy if the minimum flow rate delivers more cooling than the space requires under most of the load conditions it might see?



# More Flow ≠ More Heating

| Flow, cfm | Space Temperature, °F | Entering Air, °F | Leaving Air, °F | Capacity, Btu/hr | Simultaneous Heating and Cooling | | Heat Available to Offset Losses | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Btu/hr | % of Total | Btu/hr | % of Total |
| 650 | 72 | 52 | 74 | 15,374 | 14,321 | 93% | 1,053 | 7% |



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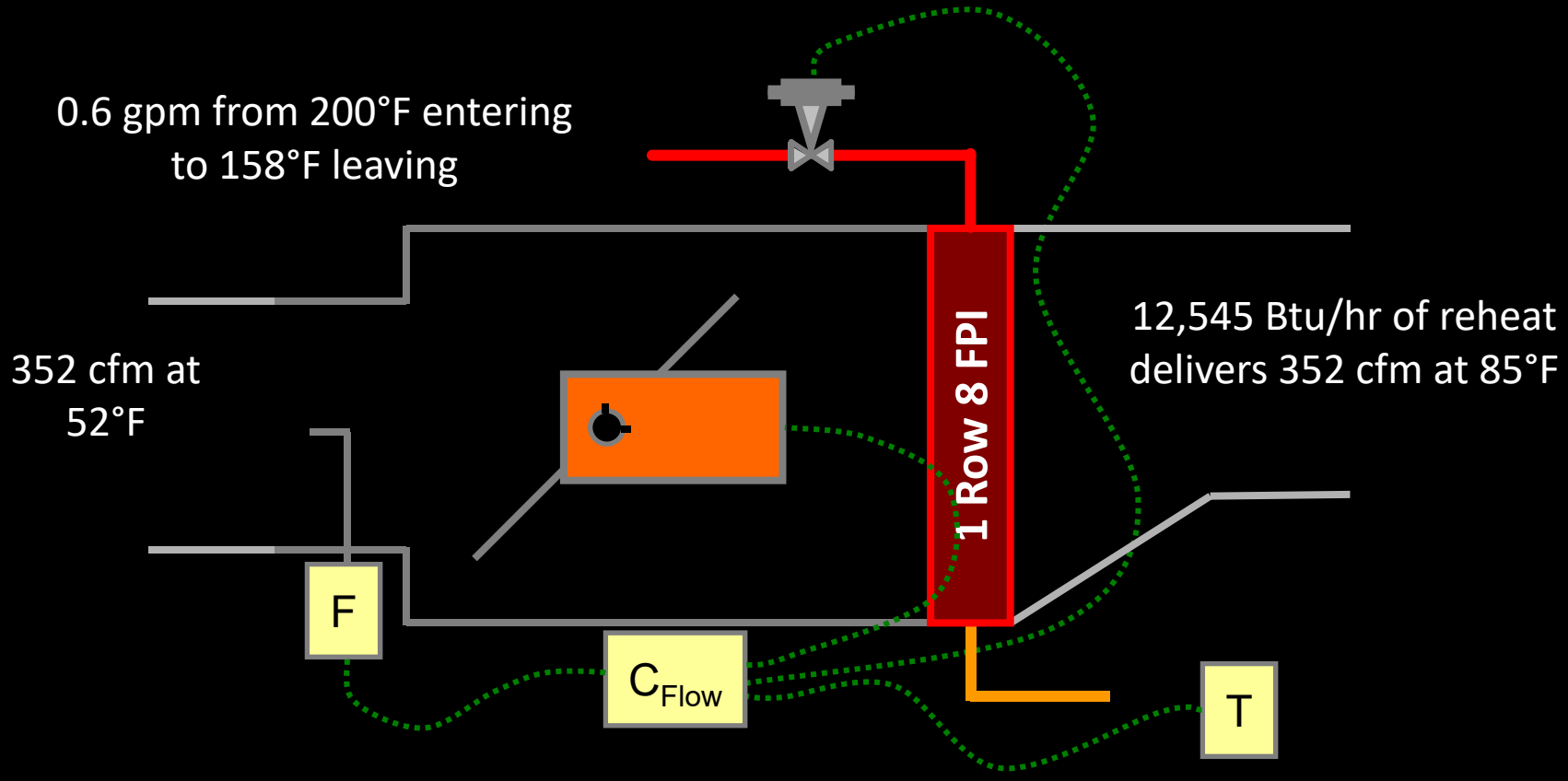
| 352 | 72 | 52 | 85 | 12,545 | 7,755 | 62% | 4,790 | 38% |



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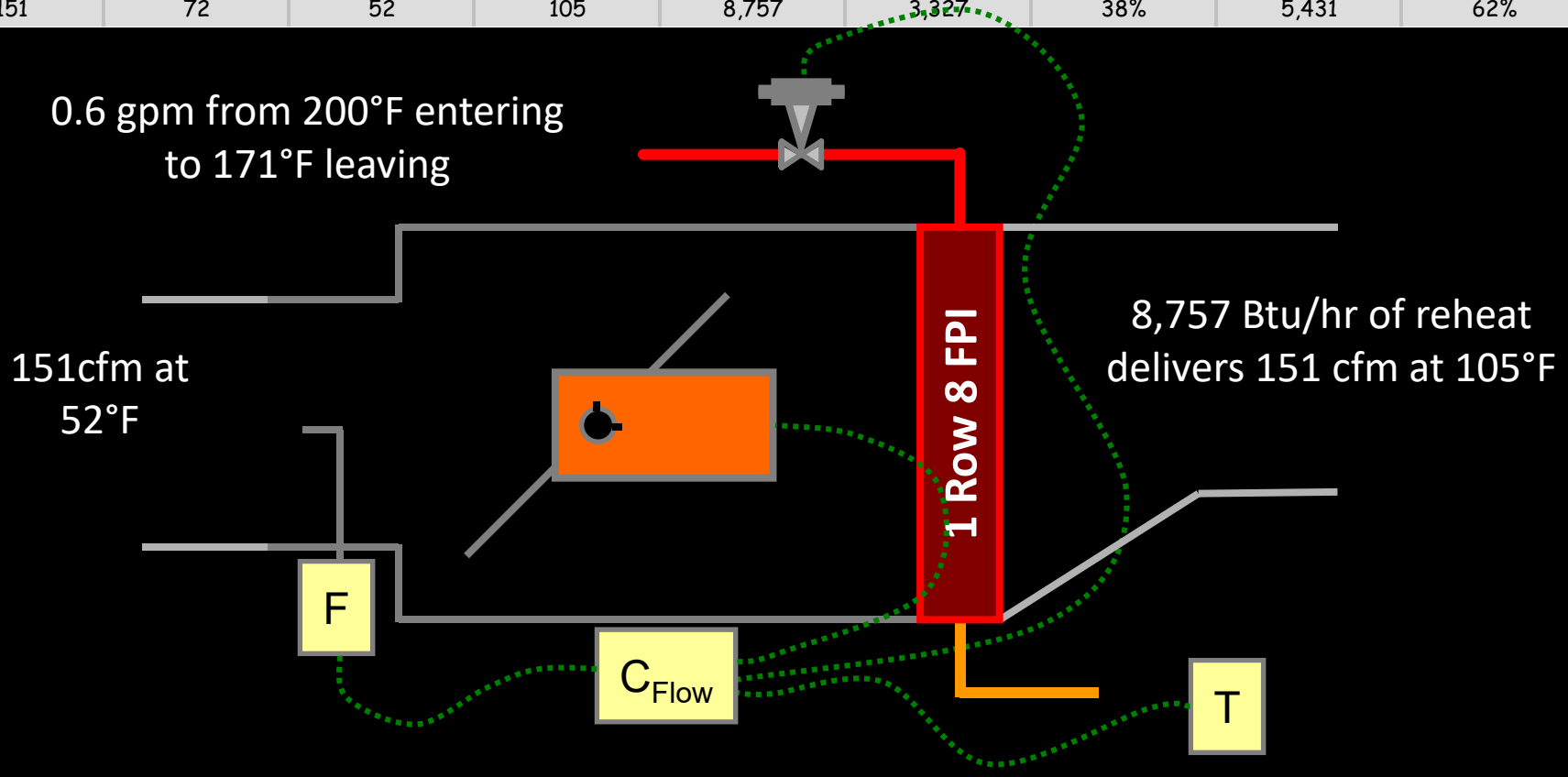
| 151 | 72 | 52 | 105 | 8,757 | 3,327 | 38% | 5,431 | 62% |



# Diffusers and Flow Variation

- Need to be designed for the full range of supply flow
- Performance with hot air different from performance with cold air
- Lower average velocity at lower flow rates
  - Less throw
  - Less mixing
  - “Dumping”

# Bottom  Lines?

- Zone loads have to general components
  - Sensible load
  - Latent load
- Zone loads can vary quite a bit
- The coil leaving air temperature is driven by the dehumidification requirement (so is the plant leaving chilled water temperature)
- The zone flows are set based on the maximum sensible load, the coil leaving condition, and heat gains between the coil and the diffuser
- There are a lot of variable associated with designing and operating a Variable Air Volume system