Energy & Store
Development Conference

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HVAC Design Trends

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Energy Squared - Princeton, NJ

Supermarket HVAC Key Drivers

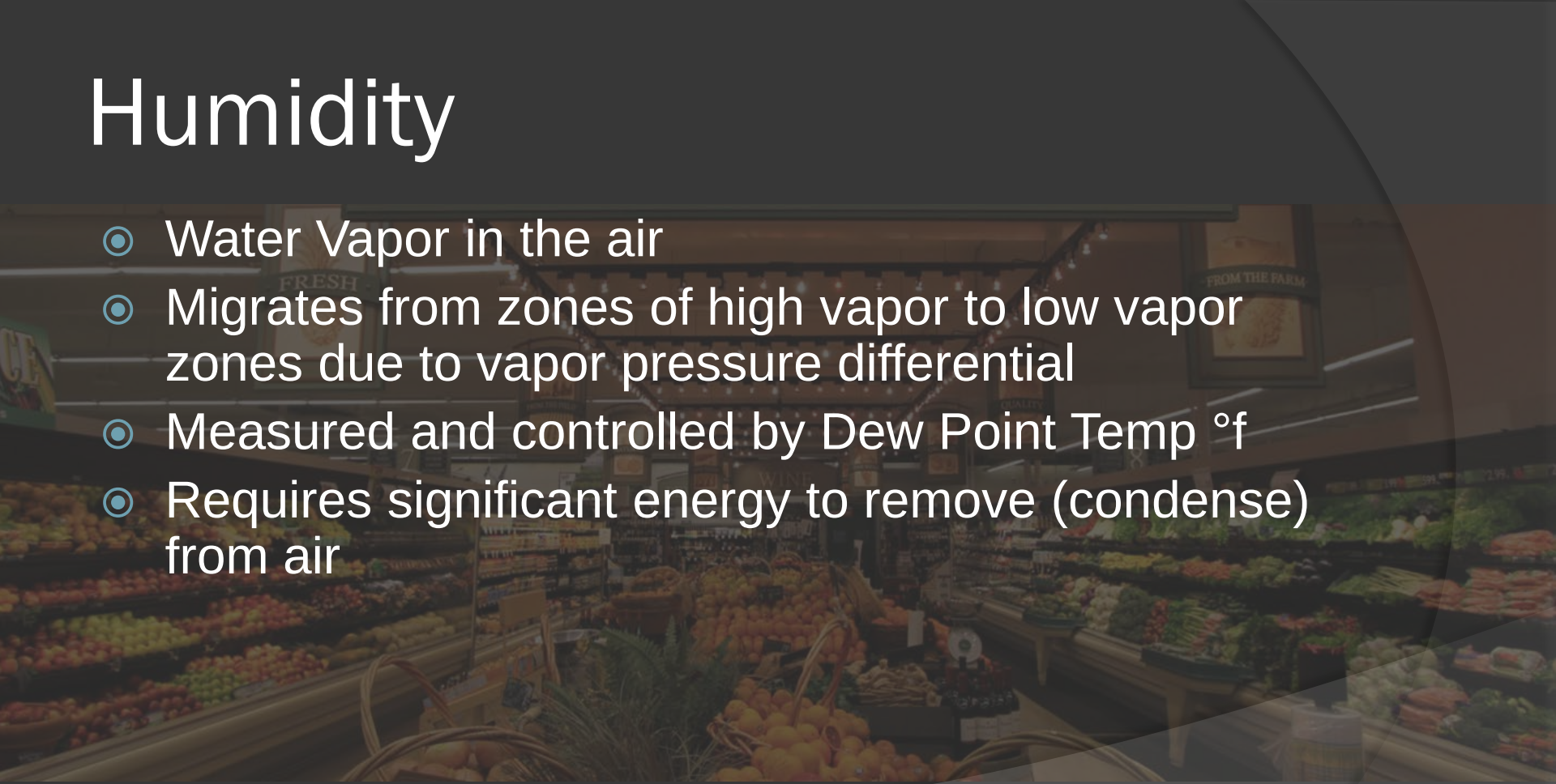
- Comfort
- Humidity
- Energy Efficiency
- First Cost
- IAQ

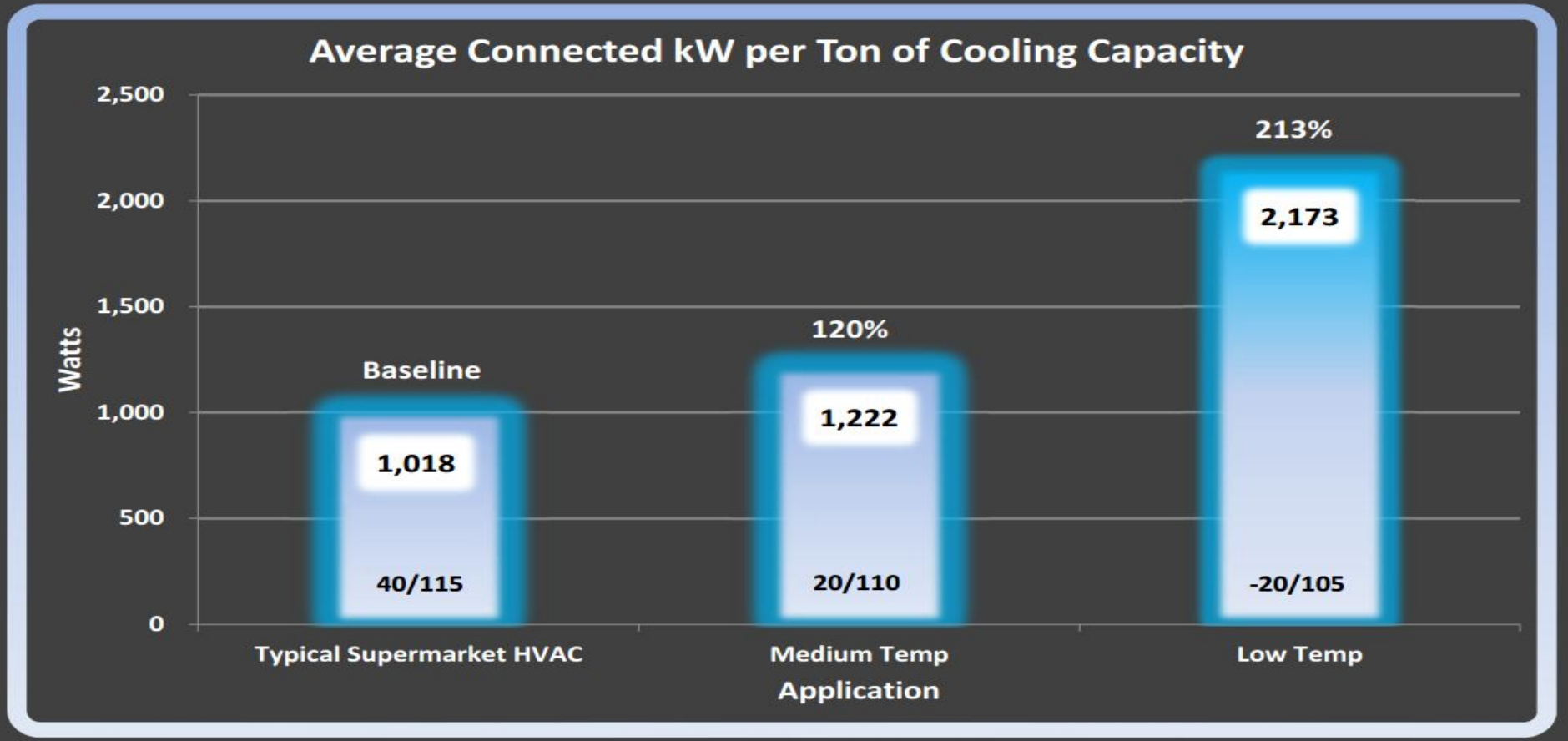
Thermal Comfort

- Temperature, Humidity, Radiant Temperature Air Velocity, Time
- Customer & Employee Comfort
  - Inviting
  - Keeps customers in the store
  - Greater Sales
  - Employee satisfaction and productivity

Humidity

- Water Vapor in the air
- Migrates from zones of high vapor to low vapor zones due to vapor pressure differential
- Measured and controlled by Dew Point Temp °f
- Requires significant energy to remove (condense) from air





Application	*Refrigerant*	*Condensing*	*Suction*	*Watts*
Typical Supermarket HVAC	R410a	115	+40	1,018
Medium Temp	R407a	110	+20	1,222
Low Temp	R407a	105	-20	2,173

Humidity

- Historical reference is 75/55
- Driven by open cases
- Landscape is changing with respect to open cases quantities
- Source of humidity primarily from infiltration and exhaust hoods/makeup

Supermarket HVAC

- Store Volume has a huge impact on the effects of infiltration and the ability to control it
- Relatively easy to pressurize a 10,000 ft^2 store
- Impractical to pressurize a 100,000 ft^2 store
- Air change in smaller stores occurs much faster-significant impact
- Mitigate by introducing conditioned fresh air
- Challenging with larger stores

Humidity Control

- Store Volume has a huge impact on the effect of infiltration and being able to control it
- Attempting to pressurize stores:
  - Typical 13,000 ft^2 supermarket, volume = 156,000 ft^3
    - 1,000 cfm fresh air = 1 Air Change every 2.5 hours
  - Typical 60,000 ft^2 supermarket, volume = 1,500,000 ft^3
    - 1,000cfm fresh air = 1 Air Change every 25 hours
- Smaller stores are far more susceptible to wind infiltration, but easier to control & mitigate

Supermarket HVAC

HVAC technologies designed to control humidity:

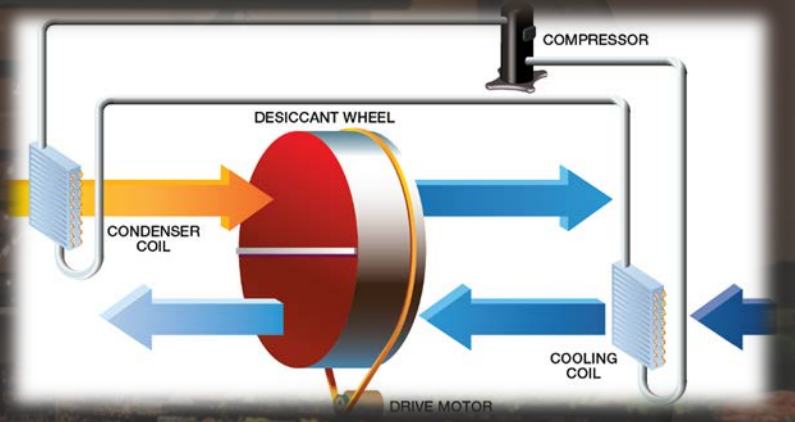
- Desiccant
- Dual Path/Multi-Path
- VSD Compressors & Fans

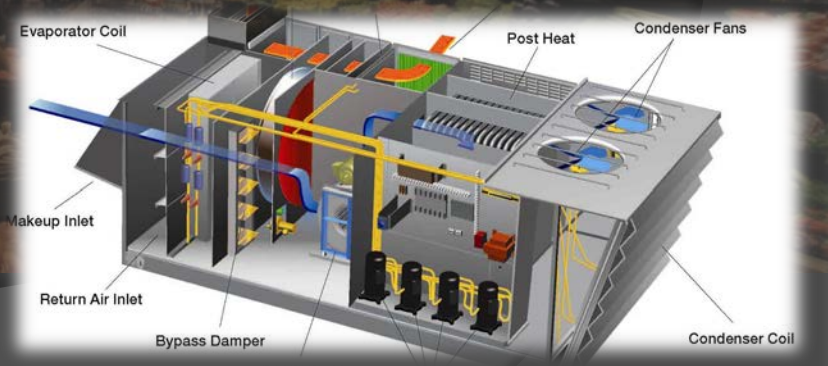
Desiccant Approach

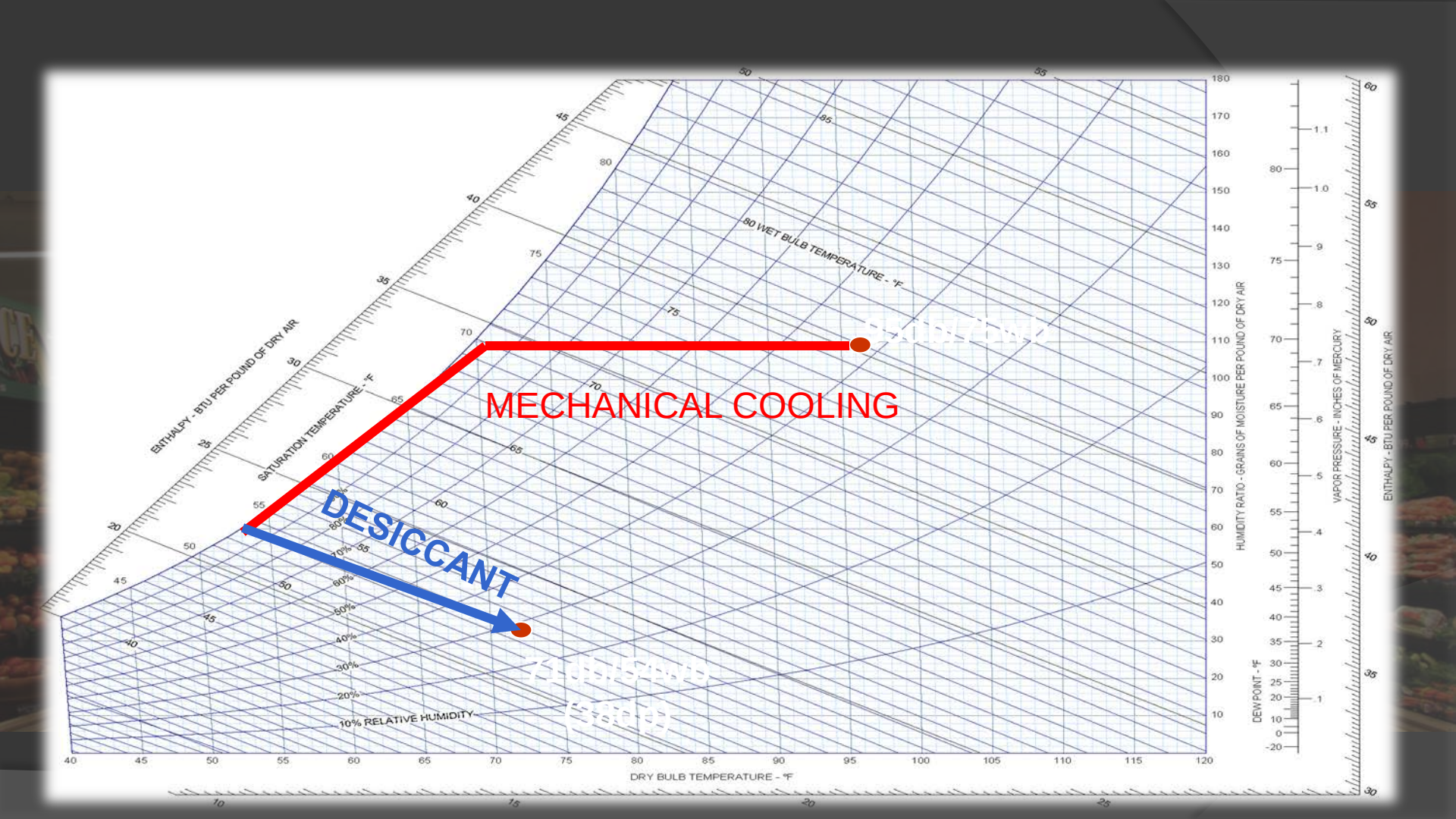
Stage 1 - Multiple DX evaporator coils cool and dehumidify the air to about 54° dew point

Stage 2 - Desiccant Wheel
Reduces the air to around 38° dew point and 72° dry bulb delivered to sales area
Neutralizes Cold Aisles

Rejected heat from Stage 1 re-generates the Desiccant Wheel






MECHANICAL COOLING
DESICCANT
80 WET BULB TEMPERATURE - °F
ENTHALPY - BTU PER POUND OF DRY AIR
SATURATION TEMPERATURE - °F
HUMIDITY RATIO - GRAINS OF MOISTURE PER POUND OF DRY AIR
VAPOR PRESSURE - INCHES OF MERCURY
DEW POINT - °F
ENTHALPY - BTU PER POUND OF DRY AIR
10% RELATIVE HUMIDITY
DRY BULB TEMPERATURE - °F

Desiccant Approach

Potential Application:

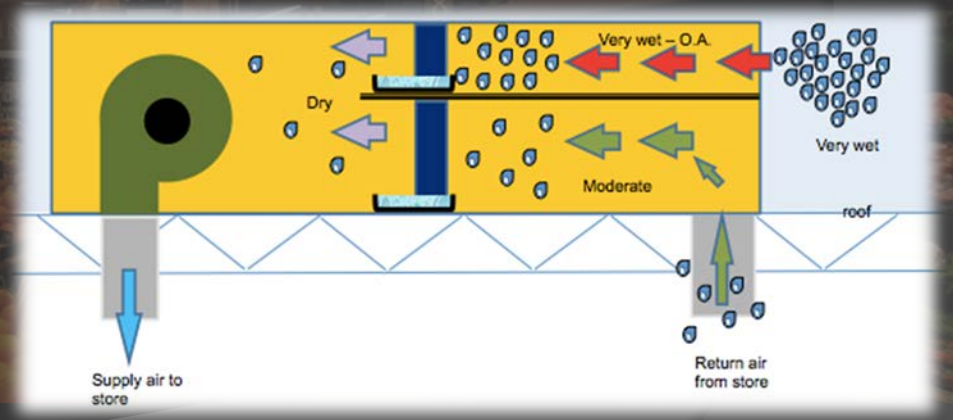
- DOAS - Manage all of the fresh air
- Deliver warm dry air in front of the cases
- Mitigates the cold aisle situation
- Can use conventional RTU’s for remainder

DX-Dual Path

Dedicated DX evaporator coil and compressors optimized for the outside air

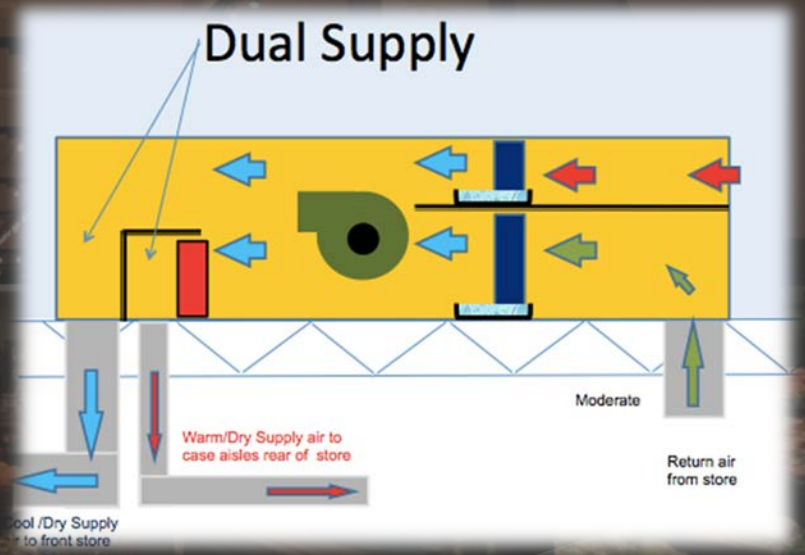
Second DX evaporator coil and compressors designed for return air

- Each airstream can be separately controlled, based on the space sensible and latent requirements
- Excellent humidity control since OA circuit is at a lower evap. temp with deeper coils lower air velocity



Dual Path-Dual Supply

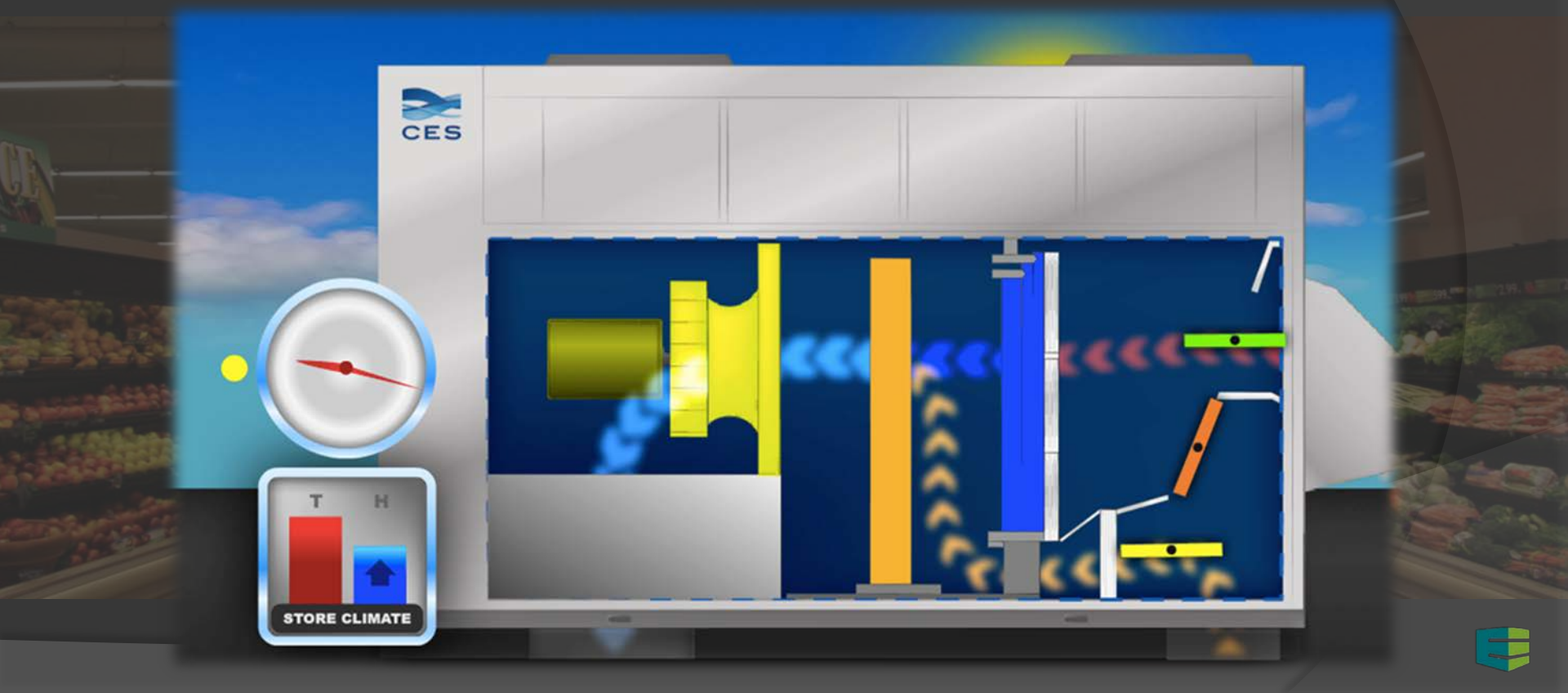
- Dual supply airstream
- Stream A at low temp delivered to front of store
- Stream B uses a heat reclaim coil to temper air delivered around open cases



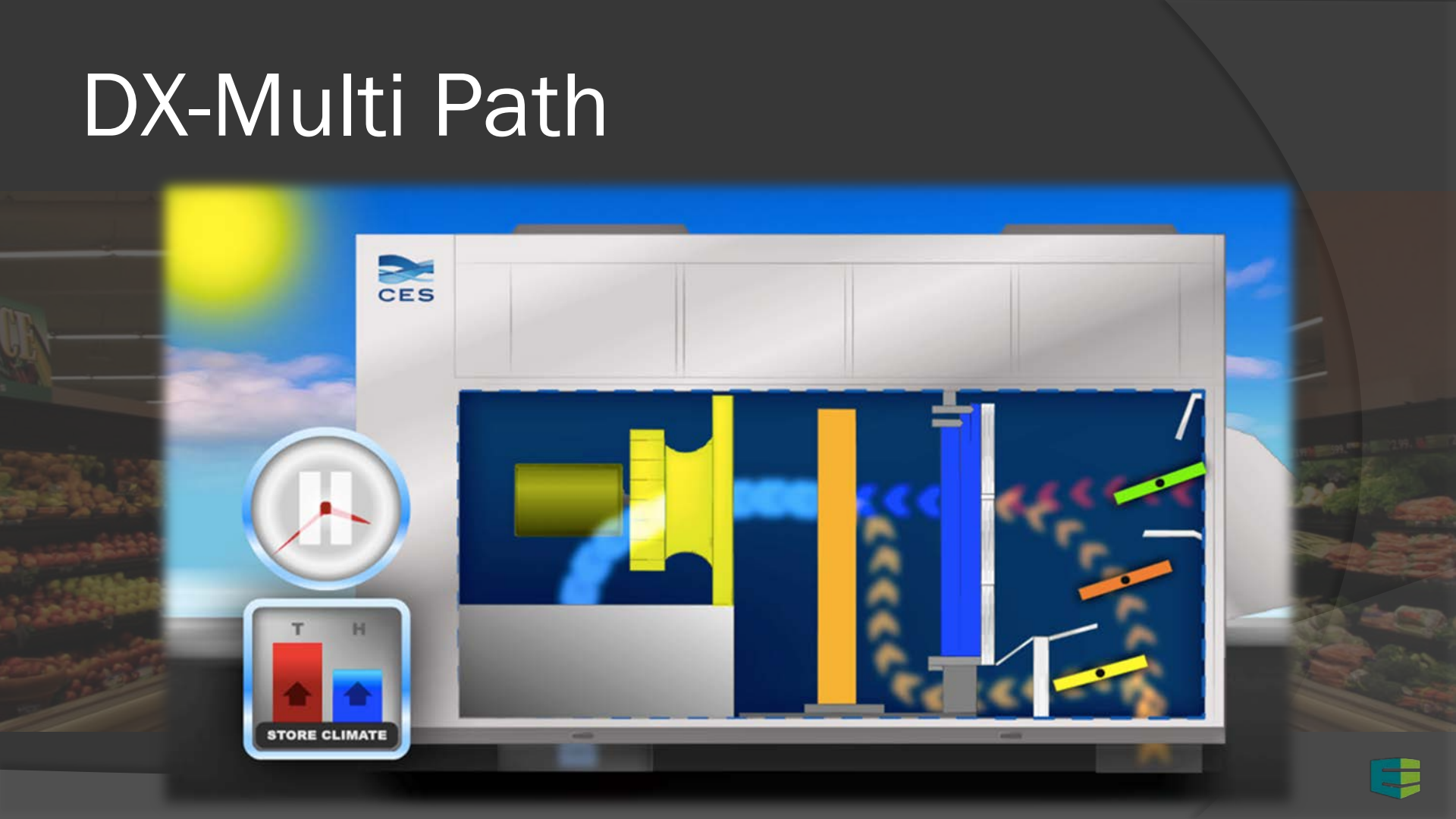
DX-Multi Path

- Operational philosophy similar to dual path
- Uses only one evaporator
- Applies continuous modulation of return air through and around the evaporator
- Depresses the coil temperature during dehumidification operation

DX-Multi Path



DX-Multi Path



DX-Multi Path

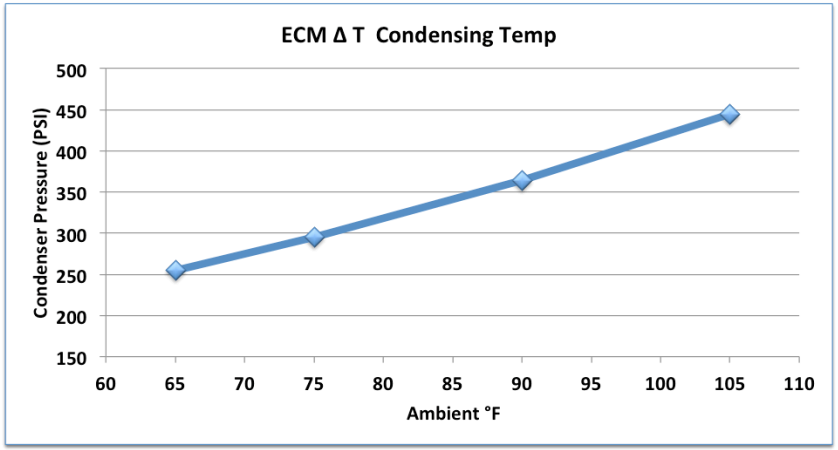
DX-Multi Path

- Able to continuously modulate the volume of return air traversing the evaporator
- High latent conditions will result in less return air through the coil
  - Lower air velocity through coil result in greater latent removal
  - Simultaneously the coil temperature is depressed
- High sensible conditions, entire airstream through the coil
- Relies on independent dampers/motors and unique control algorithms to perform this function

HVAC Unit Specifications

- Use EC condenser fan motors controlled to maintain 20°f max ∆t (condensing – ambient temp floating head pressure)

- ECM Condenser Fans
  - Modulate to maintain ΔT= 20°F



HVAC Unit Specifications

Blower fans typically operate 24/7/365

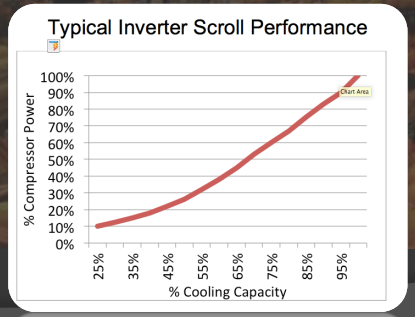
Depending on unit size and cfm

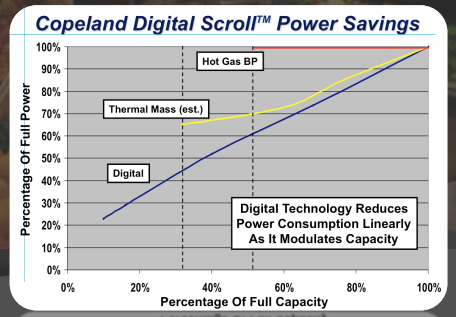
- Variable speed EC motors
  - No VFD and belt losses with benefit of flow control
- Airfoil fans with premium efficiency motors
- Low internal pressure loss

HVAC Unit Specifications

Compression

- Continuously varying capacity
- Maintain coil temp below dew point to prevent re-evaporation of coil moisture
- Modulating compressors dramatically improve overall system efficiency and moisture control





HVAC Unit Specifications

- Electronic Expansion Valves
  - Optimize superheat control
  - Improve heat transfer between coil and supply air

HVAC Control

- Commence dehumidification based on exterior dew point which is an accurate precursor of the pending store conditions
- Depress evaporator temperature during dehumidification
- Reduce air velocity across the coil
- Maximize evap. primary surface area 6/8 rows
- Modulate the fresh air volume based on the actual store requirements

Controlling The Latent Load

- Primarily comes from the outside
- Cooking ventilation often a huge contributor
- Best practices to mitigate impact of raw make up air
- HVAC specifically designed to condition the fresh air
- Hood design and application

Controlling The Latent Load

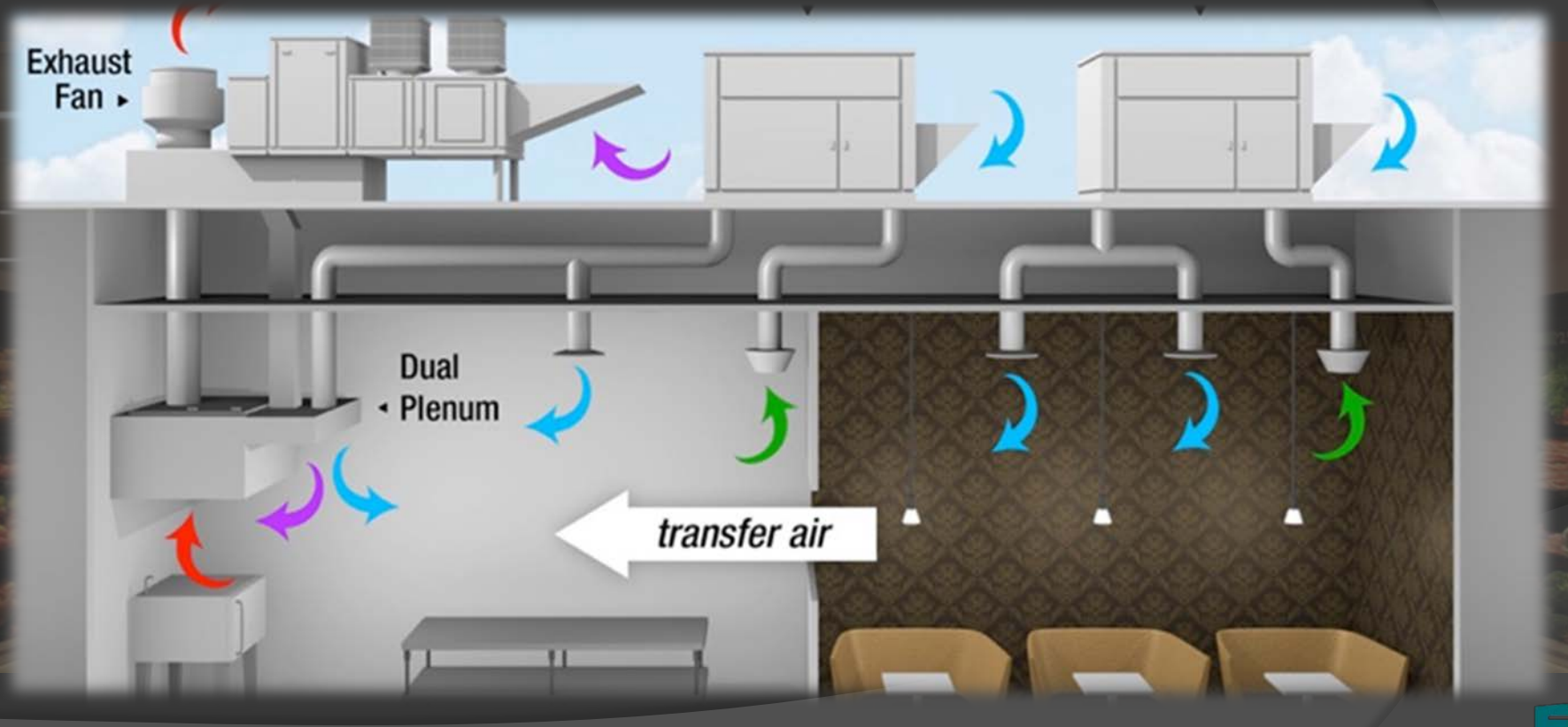
Best Practice:

20% of the make up air latent heat (moisture) penetrates the store

Hood plenum best for make up air

Demand control ventilation automatically modulates exhaust and make up airflow
Temperature and other sensors using variable frequency drives control fan speed

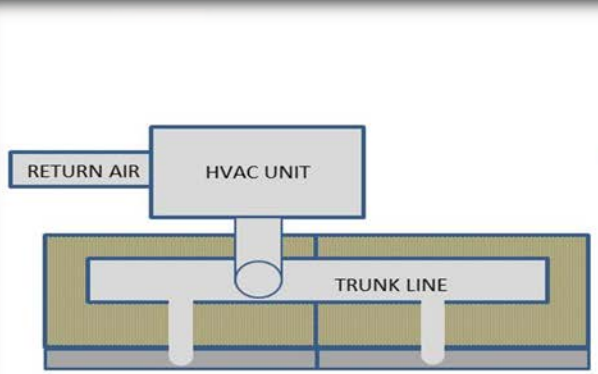
Controlling The Latent Load



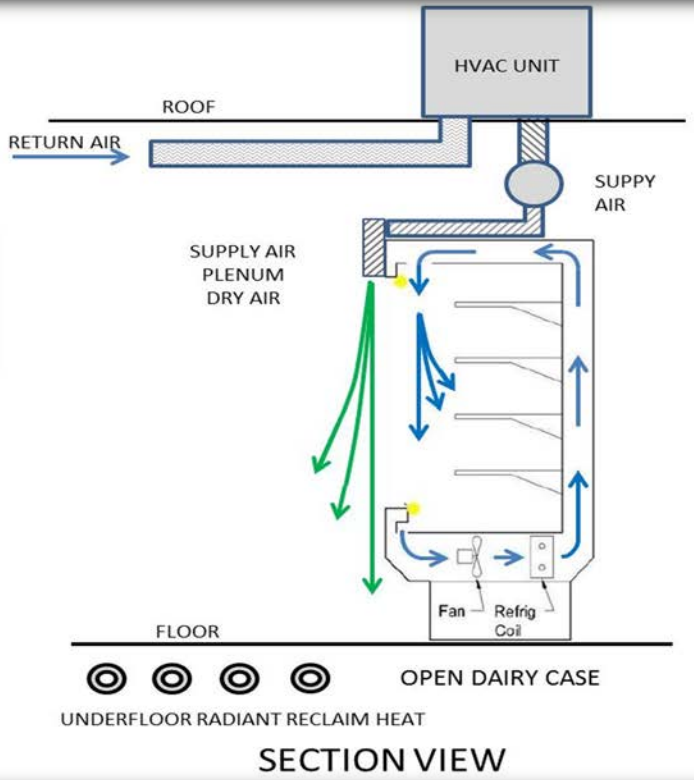
Cooking Hoods

Air Balancing is critical proper performance

HVAC Concept



TOP VIEW



SECTION VIEW

Conclusions

- Establish the true sensible and latent loads
- Minimize air infiltration
  - Not necessary to add significant OA in an attempt to pressurize larger stores
- Select equipment optimized to deal with the fresh air and specifically the latent requirements
- Proper air distribution
- Optimized control of the system and compressors
- **Consider lifecycle cost when purchasing HVAC units**