<u>Innovative, Sustainable, Resilient Solutions:</u>

New ASHRAE® Design Guide Overview Developed by USACE-CERL

<u>"Guide for Resilient Energy Systems Design in Hot and Humid Climates"</u>

Federal Government Technology Innovation Programs

&

Applying HVAC Technology to Solve Problems of Mold, Corrosion, Improve Indoor Air Quality (IAQ) & Save Energy Using Pretreatment of Outside Air for Chilled-Water Cooling & Dedicated Outside Air Systems (DOAS)

Agenda

- Introductions
- Academy Energy Group & Altaire Systems Overview
- New ASHRAE® Design Guide Review

"Guide for Resilient Energy Systems Design in Hot and Humid Climates"

- Federal Government Technology Innovation Programs
- The Humidity Problem
- Legacy Market Solutions
- Advanced Dehumidification Airstream Pretreat Technology (**ADAPT**™)
- Questions

AEG AT-A-GLANCE – Integrity

AEG Purpose: "We go into Battle Every Day to Protect & Serve our Partners."

ACADEMY ENERGY GROUP

GUIDING PRINCIPALS

- Integrity: Say/Do Ratio
- Ethics: Acting in Truth
- Service to Others
- Partnering to Win
- Innovate to Differentiate
- Collaborate to Deliver
- Adhering to The Higher Power

PRACTICES

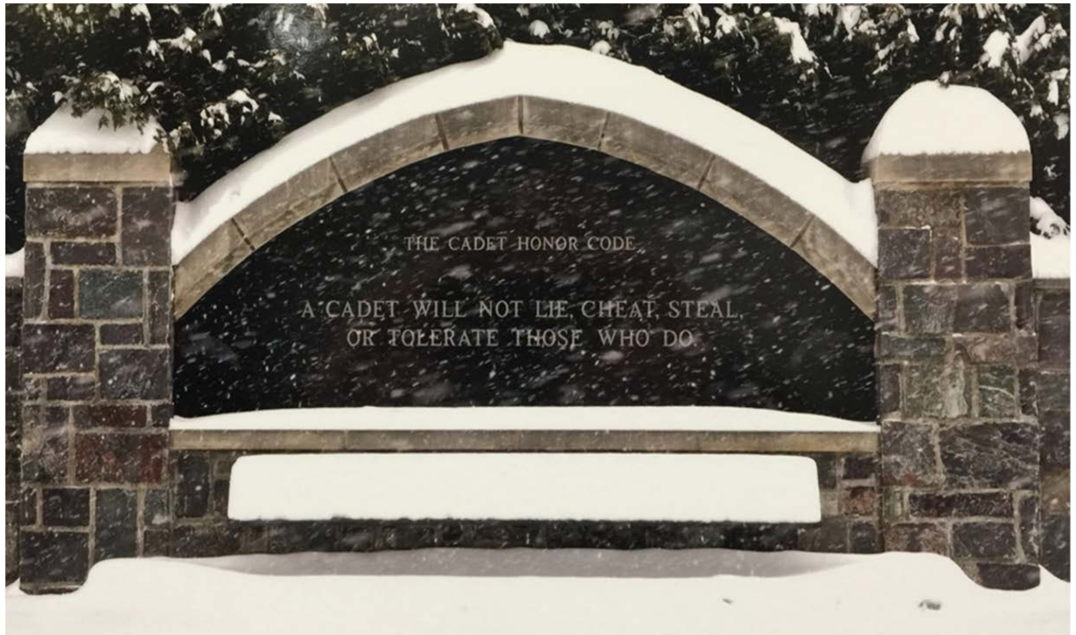
- Project Management
- Technical Compliance Framework
- Vendor Management Collaboration
- Contract Compliance
- Quality Control

SERVICES

- Pre-Construction Services
- Solar PV Design & Commissioning
- Energy & Lighting Consulting
- Indoor Air Quality (IAQ) Consulting
- Resiliency - Microgrid - Storage
- Power Quality Consulting
- Communications Design Support

PRODUCTS

- Power Distribution
- Solar PV
- Lighting & Controls
- UV Disinfection Lighting
- Electrical Materials
- HVAC & HVAC Dehumidification
- Communications



AEG President – Bill Morrison (USMA '97)

Altaire – Jim Johnston (former U.S. Marine)

"Semper Fi"

Altaire

Altaire Overview

- Engineered HVAC Products Manufacturer & Services Provider solving dehumidification issues in the most extreme environments
- Designed for environments where precise temperature and humidity control are critical
- Founded by a team of HVAC construction, Commissioning and Building BAS Optimization Subject Matter Experts with over 60 years of experience
- Veteran Founder

Altaire's suite of patented dehumidification products save energy, improve indoor air quality and occupant comfort, while providing a healthier, safer and more productive indoor environment.

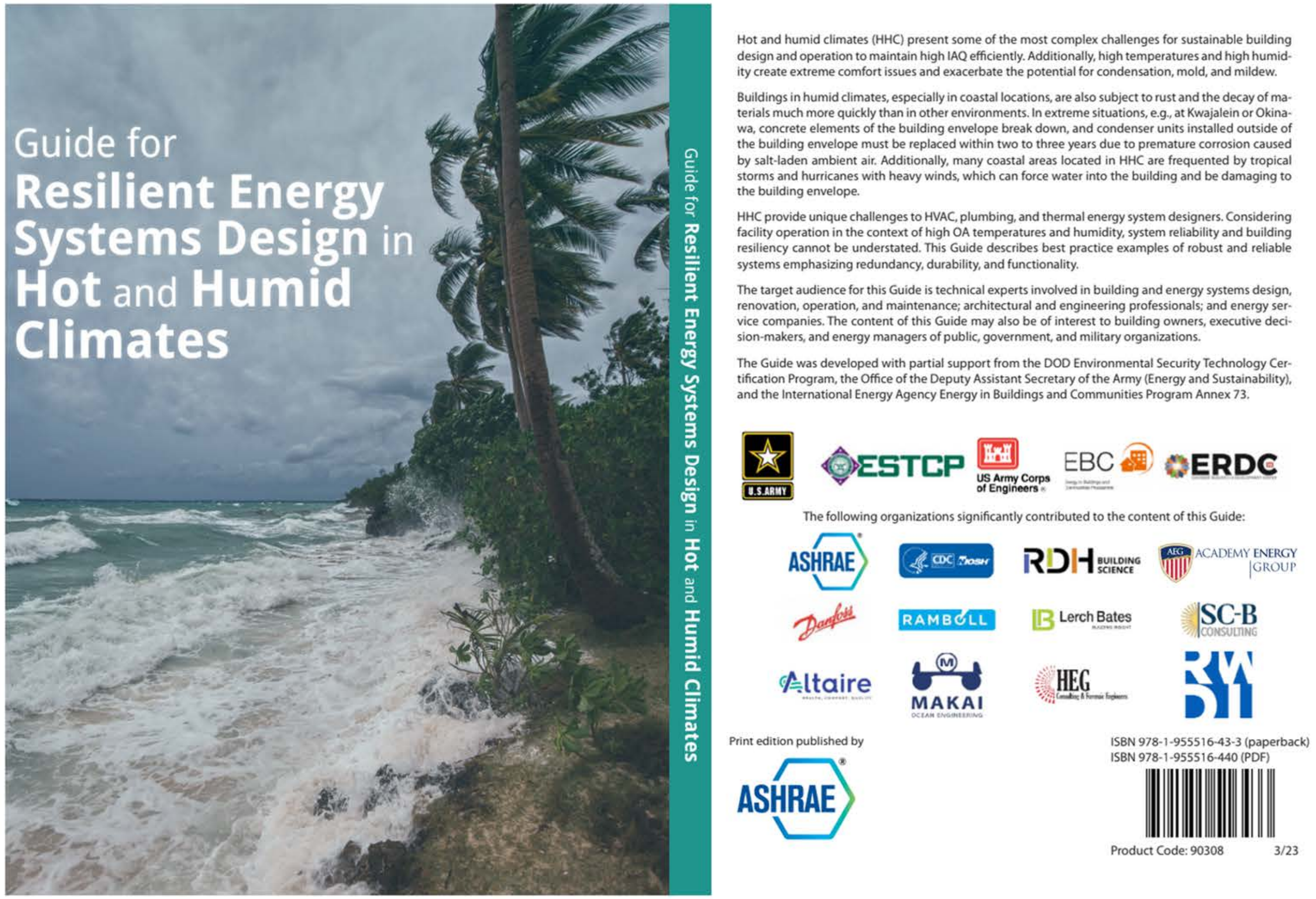
NEW ASHRAE® Design Guide Developed by USACE CERL

ACADEMY ENERGY GROUP

ASHRAE®

US Army Corps of Engineers®

CERL CONSTRUCTION ENGINEERING RESEARCH LABORATORY ERDC



Editor: Dr. Alexander Zhivov

"Guide for Resilient Energy Systems Design in Hot and Humid Climates"

Editor: Dr. Alexander Zhivov, Ph.D, MBA

U.S. Army Engineer R&D Center, Champaign, IL
Ph.D in Mechanical Engineer
USACE / CERL
Army Network Enterprise Technology Command

- ASHRAE® Distinguished Service Award
- ASHRAE® Exceptional Service Award
- ASHRAE® Fellow
- International Forum on Energy Security Leader
- 250+ Books and Tech Papers

Reference Material for Whole Building Design Guide / Unified Facility Criteria (UFC) – 3-410-01 HVAC

WBDG Whole Building Design Guide

LOGIN CREATE ACCOUNT SEARCH

DESIGN RECOMMENDATIONS | PROJECT MANAGEMENT - O & M | FEDERAL FACILITY CRITERIA | CONTINUING EDUCATION | ADDITIONAL RESOURCES

DEPARTMENT OF DEFENSE / UNIFIED FACILITIES CRITERIA (UFC) / UFC 3-410-01 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS, WITH CHANGE 8

UFC 3-410-01 Heating, Ventilating, And Air Conditioning Systems, With Change 8

Date: 07-01-2013

Change / Revision Date: 07-21-2021

Series: 3 - DISCIPLINE-SPECIFIC CRITERIA
3-400: MECHANICAL

Status: Active

This UFC provides requirements and guidance in the design of heating, ventilating, and air-conditioning (HVAC) systems, together with the criteria for selecting HVAC materials and equipment.

Page(s): 101

View/Download: PDF

Related Materials: Guide for Air Supply Strategies in Spaces (02-2023)
Guide for Resilient Energy Systems Design in Hot and Humid Climates (11-2022)

Criteria Change Request: CCR

Related Links

- Non-Government Standards (Limited Access)
- Military Standards: ASSIST database
- Corrosion Prevention & Control (CPC) Source
- Tri-Services Building Technology Vendor Portal
- Tri-Services Sustainability Program

Table of Contents:
"Guide for Resilient Energy Systems Design in Hot and Humid Climates"

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Altaire

Chapter 1: 1.1 Geographical Areas
Focus ASHRAE® Climate Zones (0A, 1B, 2A, 3A)

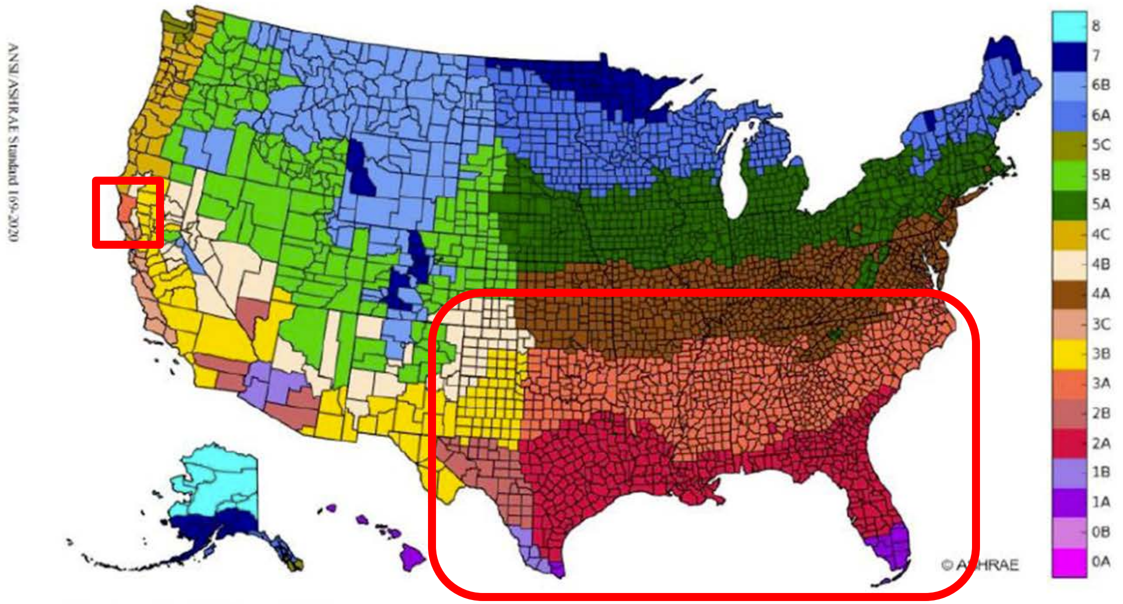

Figure 1-1. U.S. Department of Energy (DOE) climate zones.

Table 1-1. Thermal climate zone definitions (ASHRAE Standard 169-2020).

Thermal Zone	Name	I-P Units	SI Units
0	Extremely Hot	10,800 < CDD50 °F	6000 < CDD10 °C
1	Very Hot	9000 < CDD50 °F ≤ 10,800	5000 < CDD10 °C ≤ 6000
2	Hot	6300 < CDD50 °F ≤ 9000	3500 < CDD10 °C ≤ 5000
3	Warm	CDD50 °F ≤ 6300 and HDD65 °F ≤ 3600	CDD10 °C < 3500 and HDD18 °C ≤ 2000

Table 1-2. Examples cities located in the Equatorial region that represent ASHRAE climate zones 0A, 1A, 2A, and 3A.

Country	City	ASHRAE Climate Zone
Brazil	Barranquilla	0-A
Brazil	Manaus	0-A
Colombia	Monteria	0-A
	Providencia	0-A
	San Andrés	0-A
	Quibdo	0-A
	Recife	0-A
	Valledupar	0-A
	Villavicencio	0-A
	Neiva	0-A
Guam	Guam	0-A
India	Coimbatore	0-A
	Nagpur	0-A
Indonesia	Bali Ngurah Rai	0-A
Jamaica	Kingston-Norman Manley	0-A
Kenya	Mombasa	0-A
Malaysia	Kuala Lumpur	0-A

Country	City	ASHRAE Climate Zone
Marshall Islands	Kwajalein	0-A
Mexico	Acapulco	0-A
Nigeria	Lagos	0-A
Panama	Panama City-Tocumen	0-A
Philippines	Manila	0-A
Puerto Rico	San Juan-Luis Muñoz	0-A
Singapore	Singapore Changhi	0-A
Sri Lanka	Colombo-Bandanariake	0-A
Thailand	Bangkok	0-A
Tanzania	Dar Es Salaam	0-A
Brazil	Belo Horizonte	1-A
Colombia	Cali	1-A
Japan	Iwo Jima	1-A
Vietnam	Da Nang	1-A
Honduras	Tocontin/Tegucigalpa	2-A
Japan	Kadena	2-A
	Kumaijima	2-A
	Naha	2-A
Colombia	Bacaramanga	2-A
	Medellin	2-A
	Pasto	2-A
	Pereira	2-A
Japan	Kure	3-A
	Kobe	3-A
Mexico	Mexico City	3-A
Mexico	Tuluca	3-A
Zimbabwe	Harare	3-A

1.2. Hazards Specific to Construction in Hot, Humid Climates

1.2.1. High Ambient Temperature, Humidity, and Dewpoint

1.2.2. Intense Rain Periods

1.2.3. Monsoons

1.2.4. Tropical Storms, Typhoons, and Hurricanes

1.2.5. Storm Surges

1.2.6. Floods

1.2.7. High Water Table

1.2.8. Seismic Considerations

1.3. Special Issues Related to Coastal Areas

1.3.1. Tsunamis

1.3.2. Prolonged Elevated Temperatures

1.3.3. Salt-Laden Air

1.3.4. Severe Tidal Fluctuations

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1.4.1. Mold Considerations - Conditions for Mold Growth

High Heat 80°F to 100°F

+

Relative Humidity (RH) 70-100%

=

Ideal Conditions for Mold Growth

Altaire

1.4.1. Mold Considerations - How Mold Grows

HOW MOLD GROWS

1. MOLD SPORE LANDS ON SURFACE
2. MOLD SPORE GERMINATES
3. ADD MOISTURE
4. MOLD GROWS

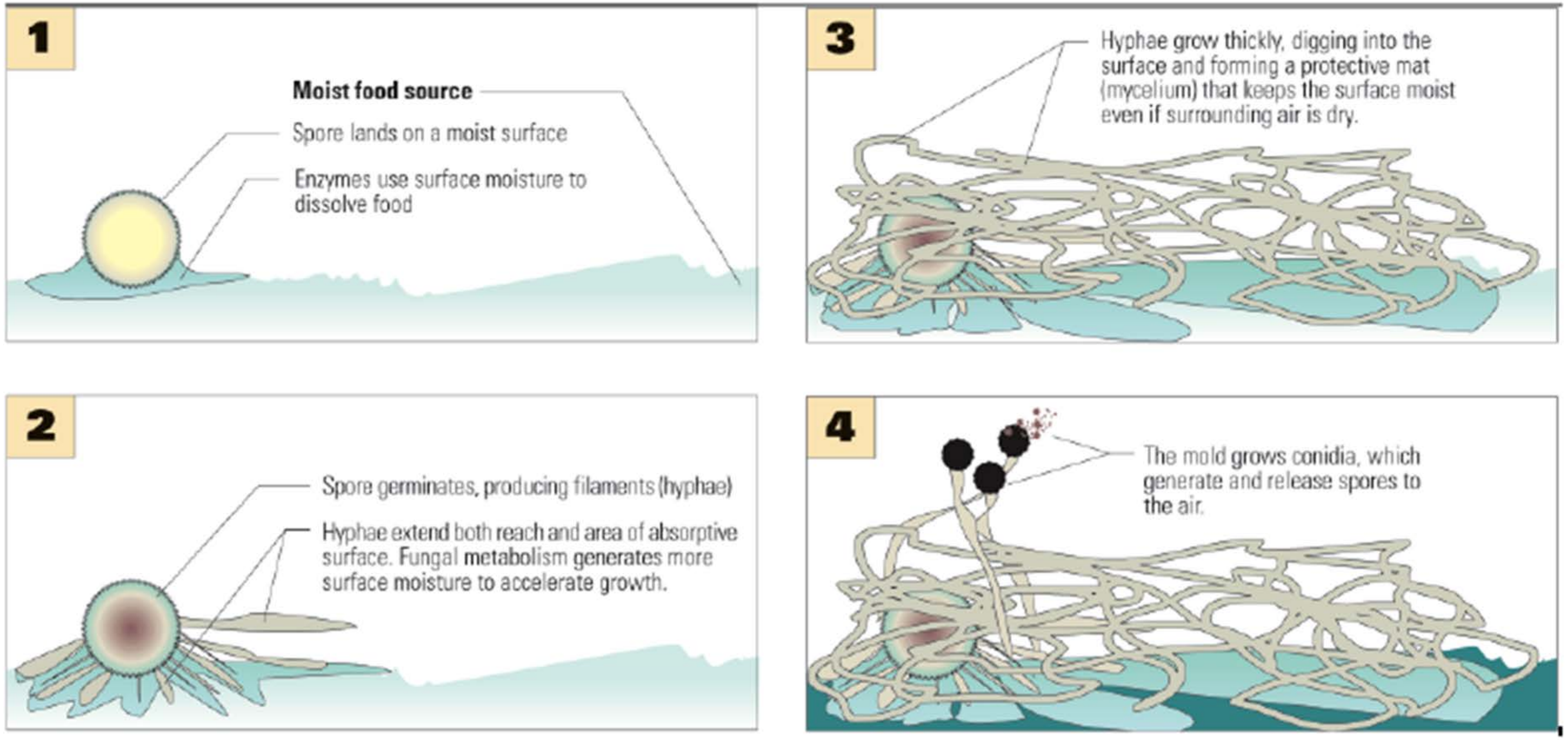


Figure 1-3. Mold growth stages (courtesy of Lew Harriman, Mason-Grant).

Army Finds Mold in Over 2,000 Facilities after Service-Wide Inspection
CREDIT: ArmyTimes.com by: Jonathan Lehrfeld

Senior Leaders at Fort Stewart and Hunter Army Airfield, Georgia, check barracks facilities for mold and other maintenance concerns.

1.4.1. Mold Considerations - Health Effects of Toxigenic Molds and Mycotoxins.

1. **ALLERGY:**
   Type-1 allergy or immediate type hypersensitivity
2. **REACTIONS:**
   Delayed-type hypersensitivity reactions
3. **INFECTION**
4. **NERVE IRRATION:**
   Mucous membrane and trigeminal* nerve irritation (sensory info to skin/sinuses/face)
5. **HEADACHES, NASAL STUFFINESS, NAUSEA, VOMITING:**
   Adverse reactions to odor or pseudo allergy
6. **TOXICITY & DAMAGE SKIN, LUNGS, GUT, VASCULAR SYSTEM, BRAIN-CENTRAL NERVOUS SYSTEM:**
   Toxicity or neurotoxicity by molds and mycotoxins
7. **IMMUNE SYSTEM DAMAGE:**
   Immunotoxicity induced by molds and mycotoxins.

1.5. Corrosion
PROBLEM: Corrosion

PROBLEMS:

Rapid Rust

Rapid Decay

Premature Failure / Increased Life Cycle Costs

Problems Across Many Systems

- Building Envelopes
- HVAC Systems
- Cooling Energy Generation, Storage, and Distribution Systems

SOLUTIONS:

Build With: Minimal Exposure to Corrosive Environment

Corrosion-Resistant Materials

Corrosion-Resistant Coatings

Humidity Control

PROBLEM: Corrosion

CORROSION POLICY AND OVERSIGHT

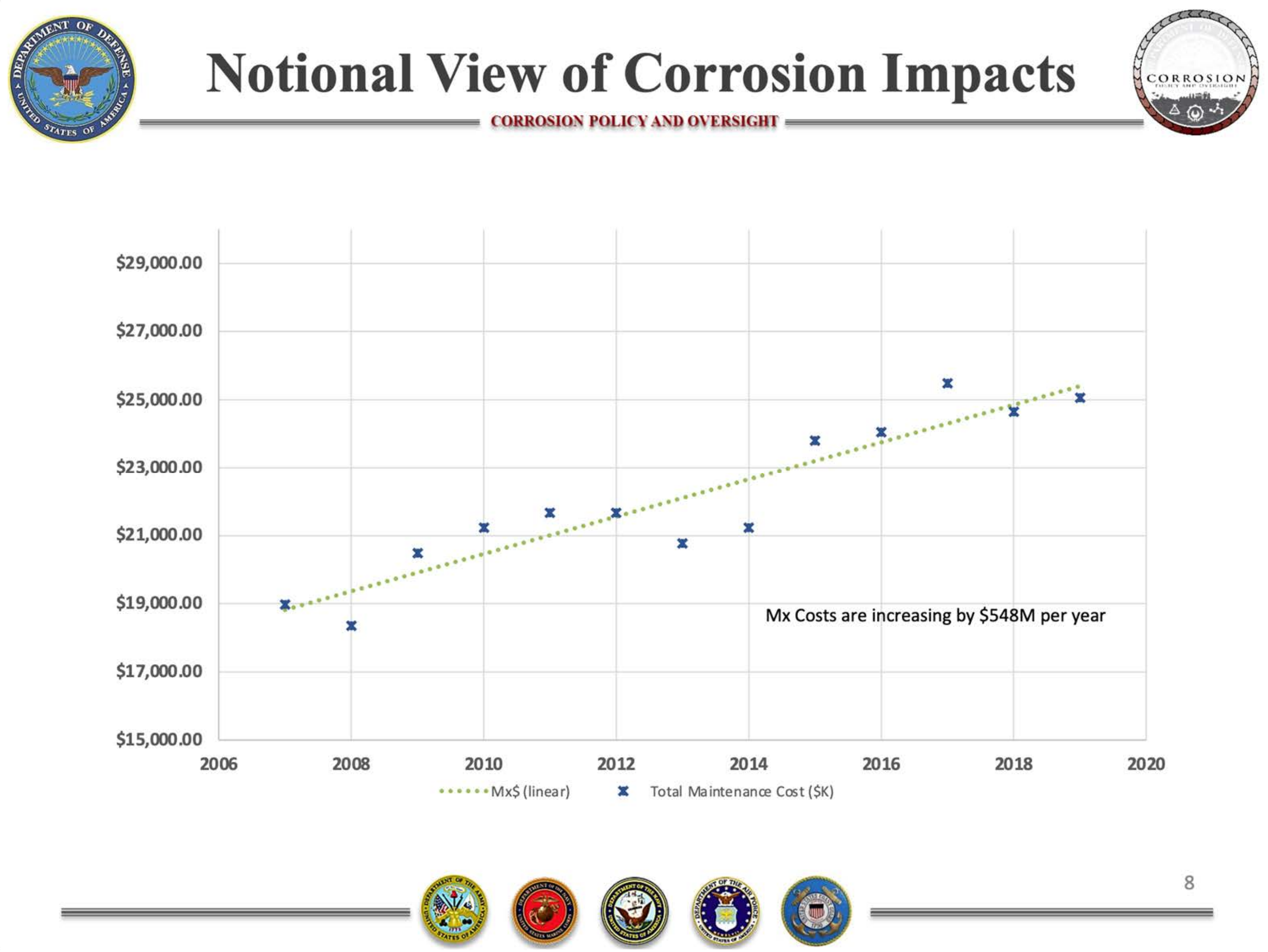
OFFICE OF THE DEPUTY ASSISTANT SECRETARY OF DEFENSE FOR MATERIEL READINESS

Director, Corrosion Policy and Oversight

Mr. Robert A. Herron

4 August 2020

PROBLEM: Corrosion Cost Impacts are Increasing



Proper Design

+

Resilient Equipment Specification

+

Communication of Operational Requirements

+

Operation in Accordance with Design Requirements

+

Maintenance

=

HVAC can Protect Interior of Building that Envelope Alone Cannot

SOLUTION: Separate Outdoor Air Pretreatment Dehumidification (Latent Load) & Building Cooling Load (Sensible Load)

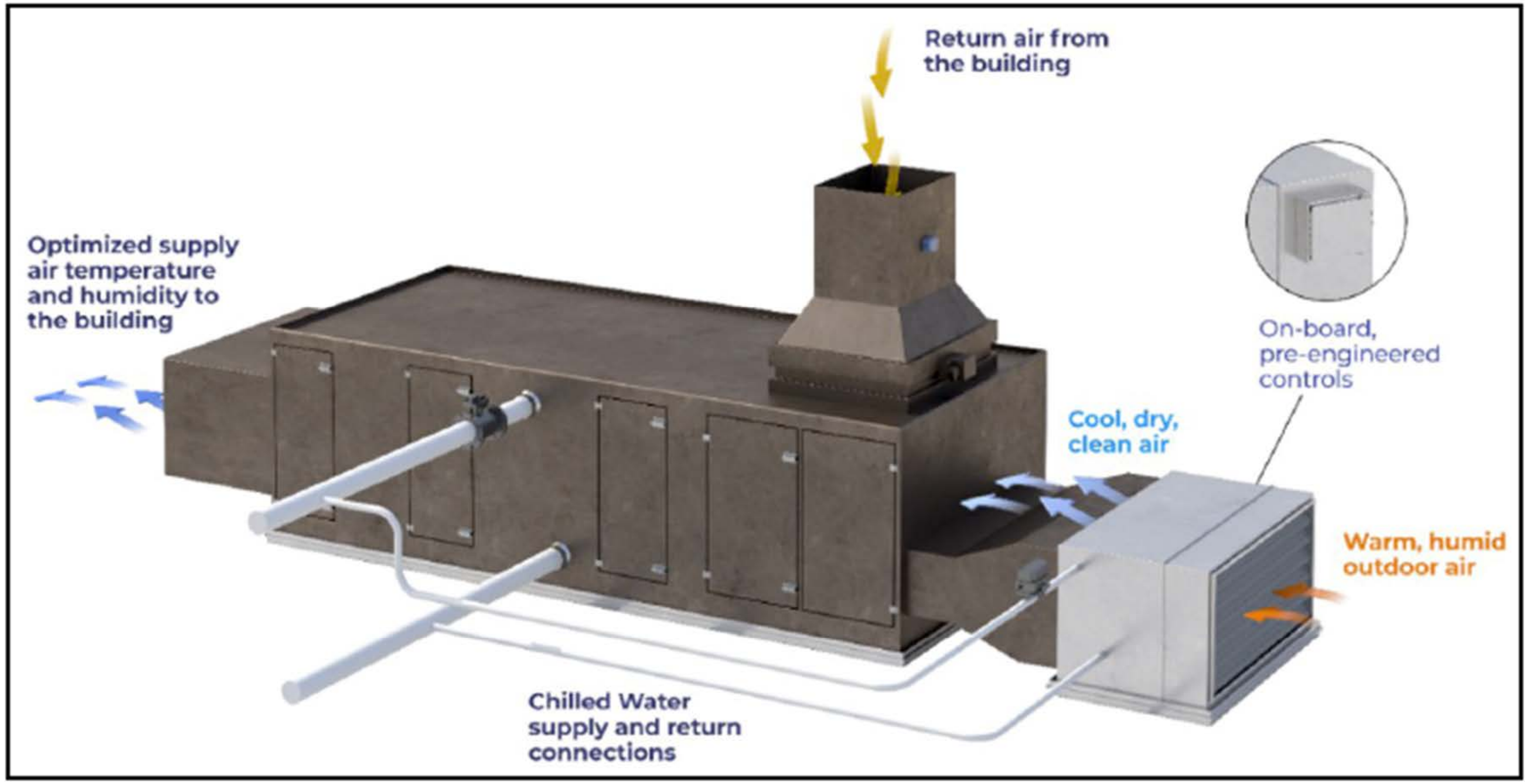


Image courtesy Altaire Systems, LLC (www.altairesystems.com).

Figure 5-3. Example outdoor air pretreatment device that decouples latent and sensible cooling loads.

Federal Government Technology Innovation Programs: GSA/DoE
U.S. General Services Green Proving Ground Program (GPG)
in Partnership with U.S. Department of Energy

The Green Proving Ground program leverages GSA's real estate portfolio to evaluate innovative building technologies. The program aims to drive down operational costs in federal buildings and help lead market transformation through the deployment of new technologies.

2021 – Award Winners
Academy Energy Group & Altaire Systems
HVAC DEHUMIDIFICATION

Federal Government Technology Innovation Programs: GSA/DoE
U.S. General Services Green Proving Ground Program (GPG)
in Partnership with U.S. Department of Energy

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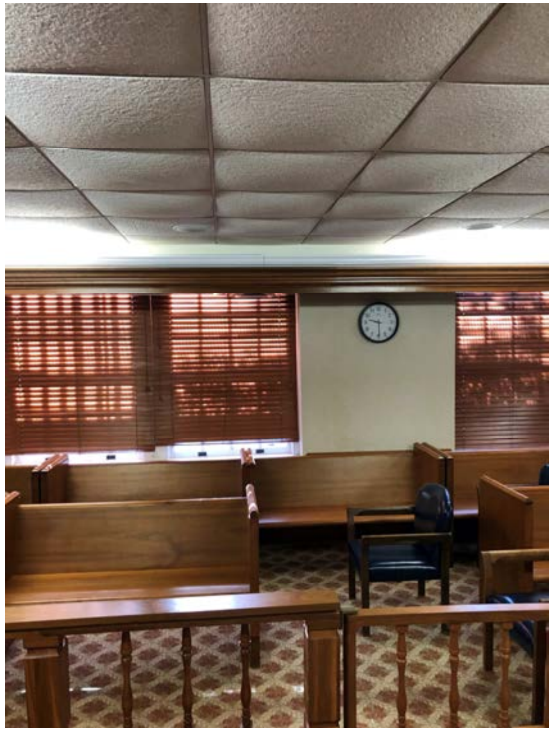
GSA | GPG Green Proving Ground Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Ward R. Burke United State Courthouse
Humidity Damaging Building – See Ceiling System Bowing
ENERGY WASTE: The Boiler Operates Year-round to Battle the Humidity



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Federal Government Technology Innovation Programs: (DoE)
U.S. Department of Energy’s
High Impact Technology (HIT) Catalyst Program

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High Impact Technology Catalyst

Buildings

U.S. DEPARTMENT OF ENERGY

The High Impact Technology (HIT) Catalyst is designed to help identify, prioritize and deploy cost-effective, innovative, energy-efficient technology solutions.

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Federal Government Technology Innovation Programs: (DoE)
U.S. Department of Energy's
High Impact Technology (HIT) Catalyst Program

U.S. Navy – Naval Support Activity (NSA) Orlando, FL
National Renewable Energy Laboratory (NREL) – Instrumentation & M&V
For Seven (7) Air Pre-Treatment Units

Latent Cooling vs. Sensible Cooling

- ***Latent Cooling.*** **Removal of water** from the air by means of condensing water vapor from the air through cooling that results in a reduction in dewpoint temperature of the airstream.

- ***Sensible Cooling.*** **Removal of heat** from an airstream that does not result in a change in water vapor content and that results in a decrease in the measured DBT of the air with no change to dewpoint temperature.

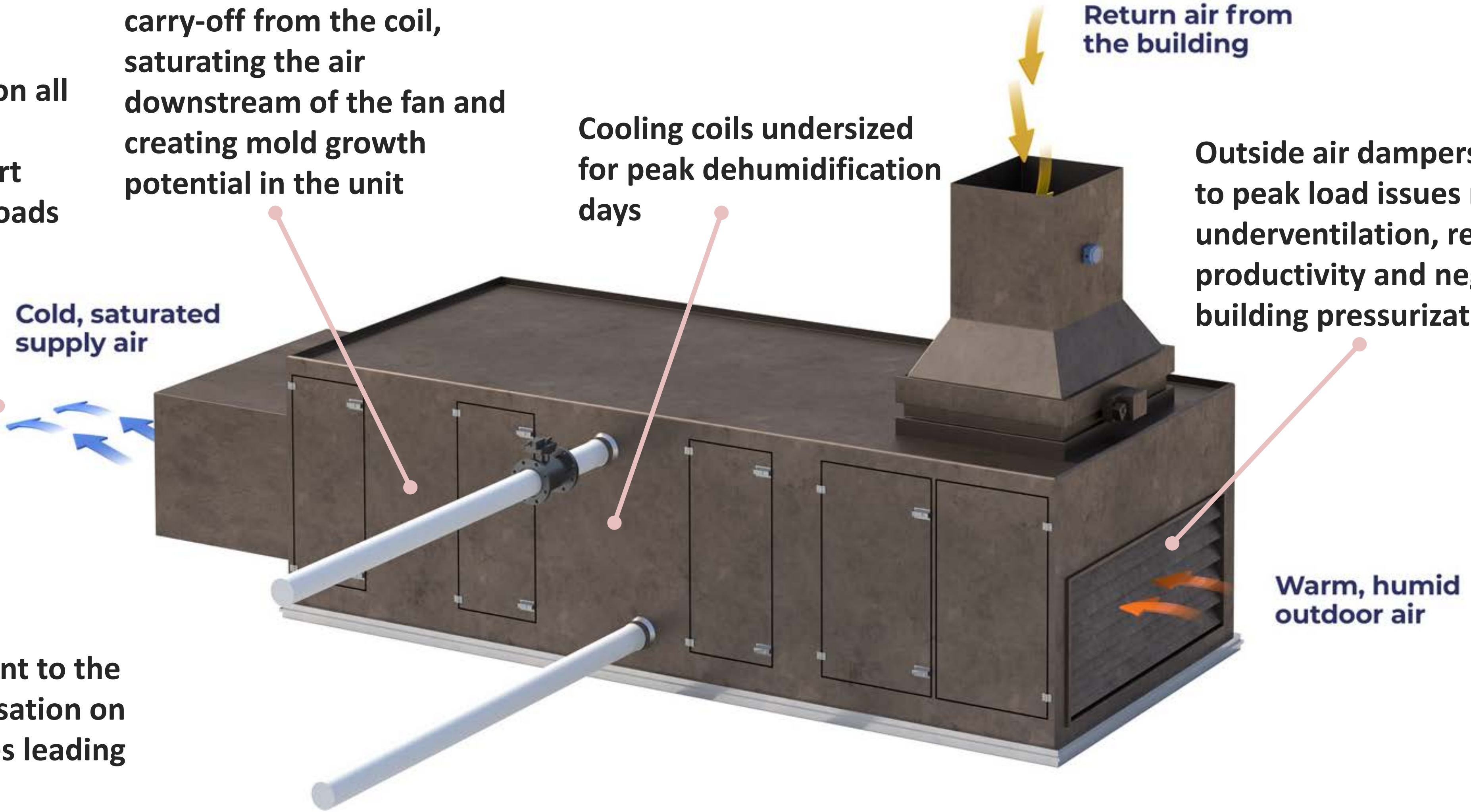
The Humidity Problem

Spaces are overcooled on all but peak summer days resulting in poor comfort control or high reheat loads and high energy costs

High air velocities lead to carry-off from the coil, saturating the air downstream of the fan and creating mold growth potential in the unit

Cooling coils undersized for peak dehumidification days

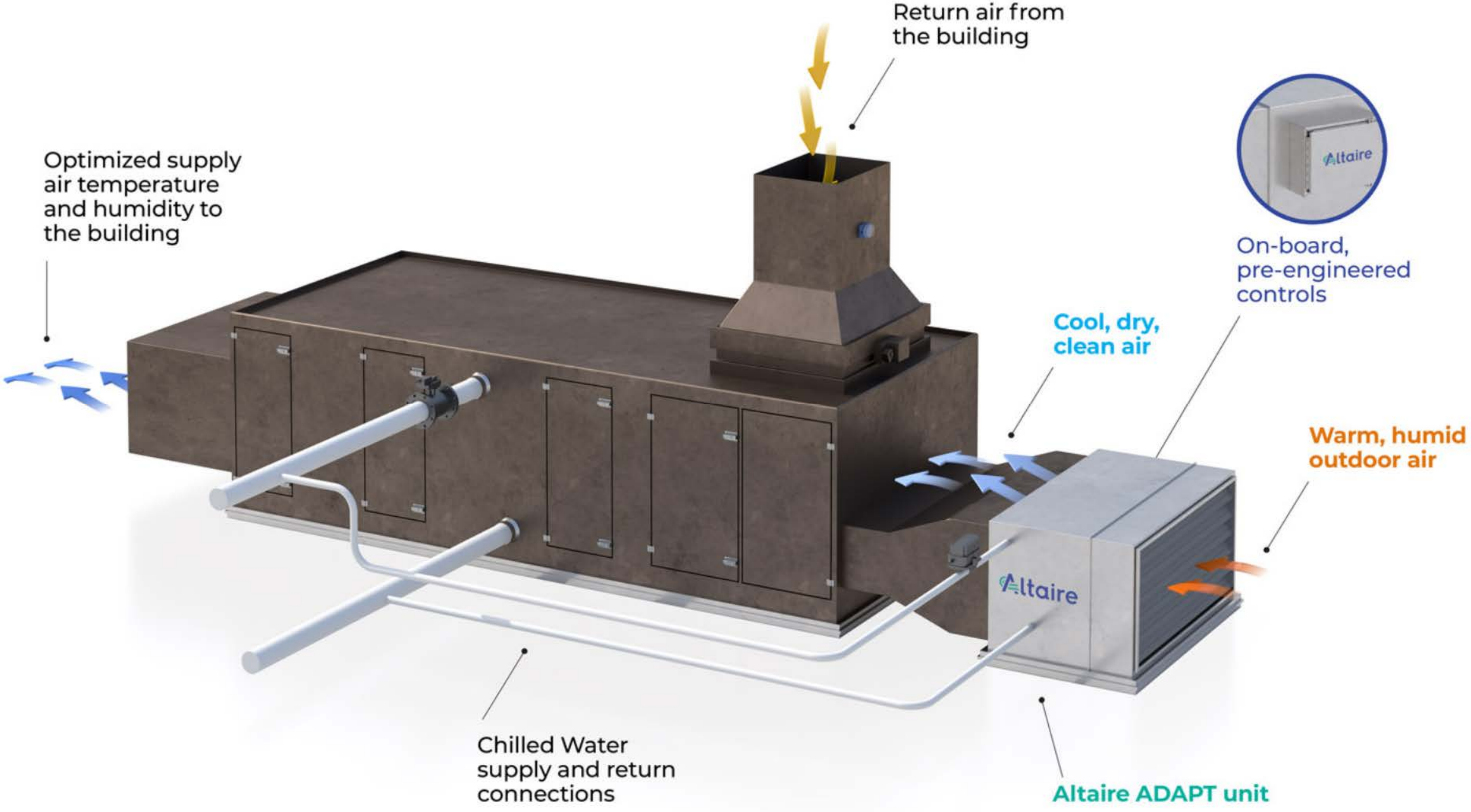
Outside air dampers closed due to peak load issues resulting in underventilation, reduced productivity and negative building pressurization



Cold saturated air is sent to the space creating condensation on air distribution surfaces leading to mold growth

Legacy Market Solutions

Advanced Dehumidification Airstream Pretreat Technology (**ADAPT**™)



Psychrometric Analysis

Altaire
HEALTH, COMFORT, QUALITY

PSYCHROMETRIC CHART
BAROMETRIC PRESSURE 29.921 inches of Mercury

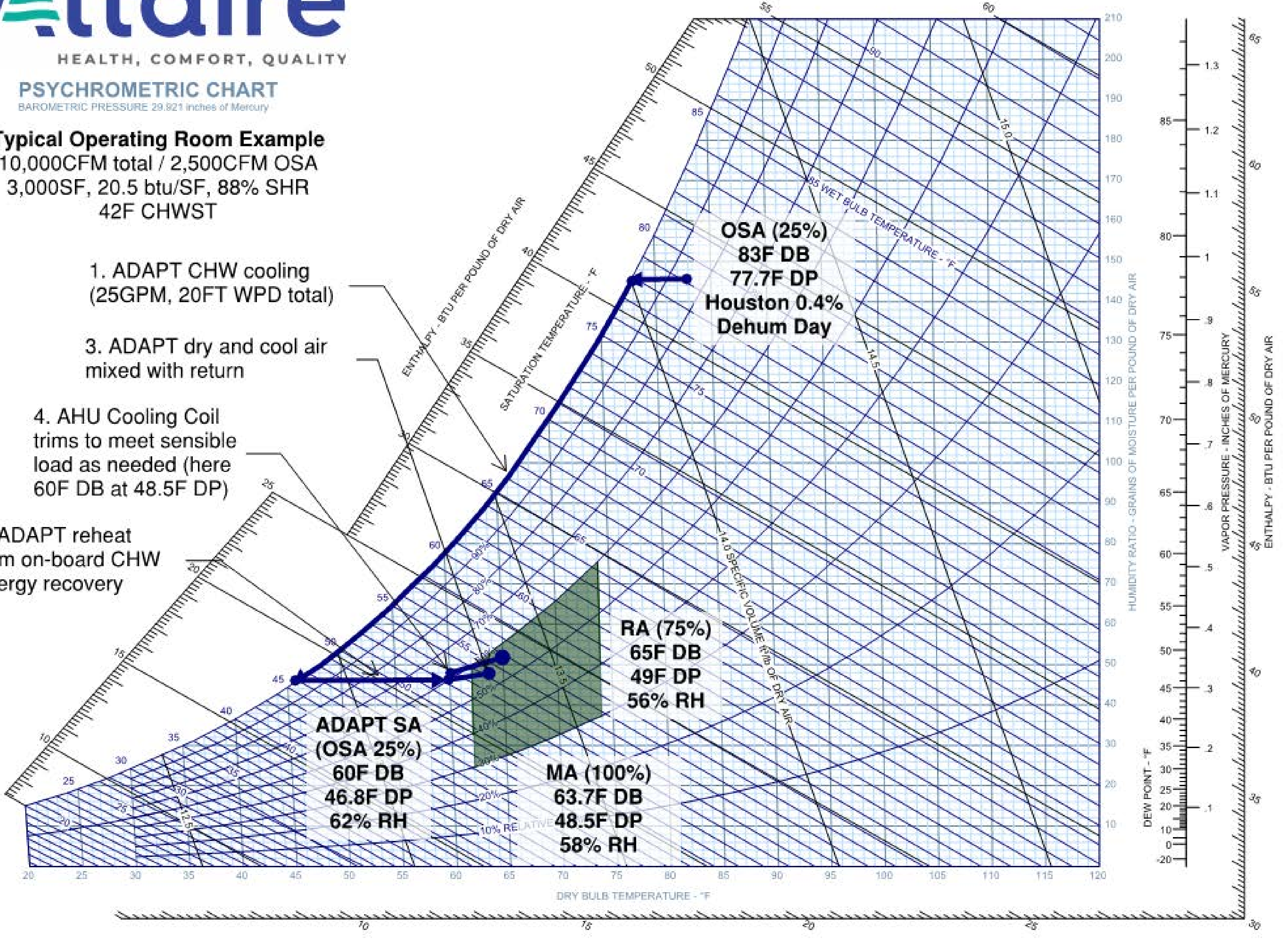
Typical Operating Room Example
10,000CFM total / 2,500CFM OSA
3,000SF, 20.5 btu/SF, 88% SHR
42F CHWST

1. ADAPT CHW cooling (25GPM, 20FT WPD total)

3. ADAPT dry and cool air mixed with return

4. AHU Cooling Coil trims to meet sensible load as needed (here 60F DB at 48.5F DP)

2. ADAPT reheat from on-board CHW energy recovery



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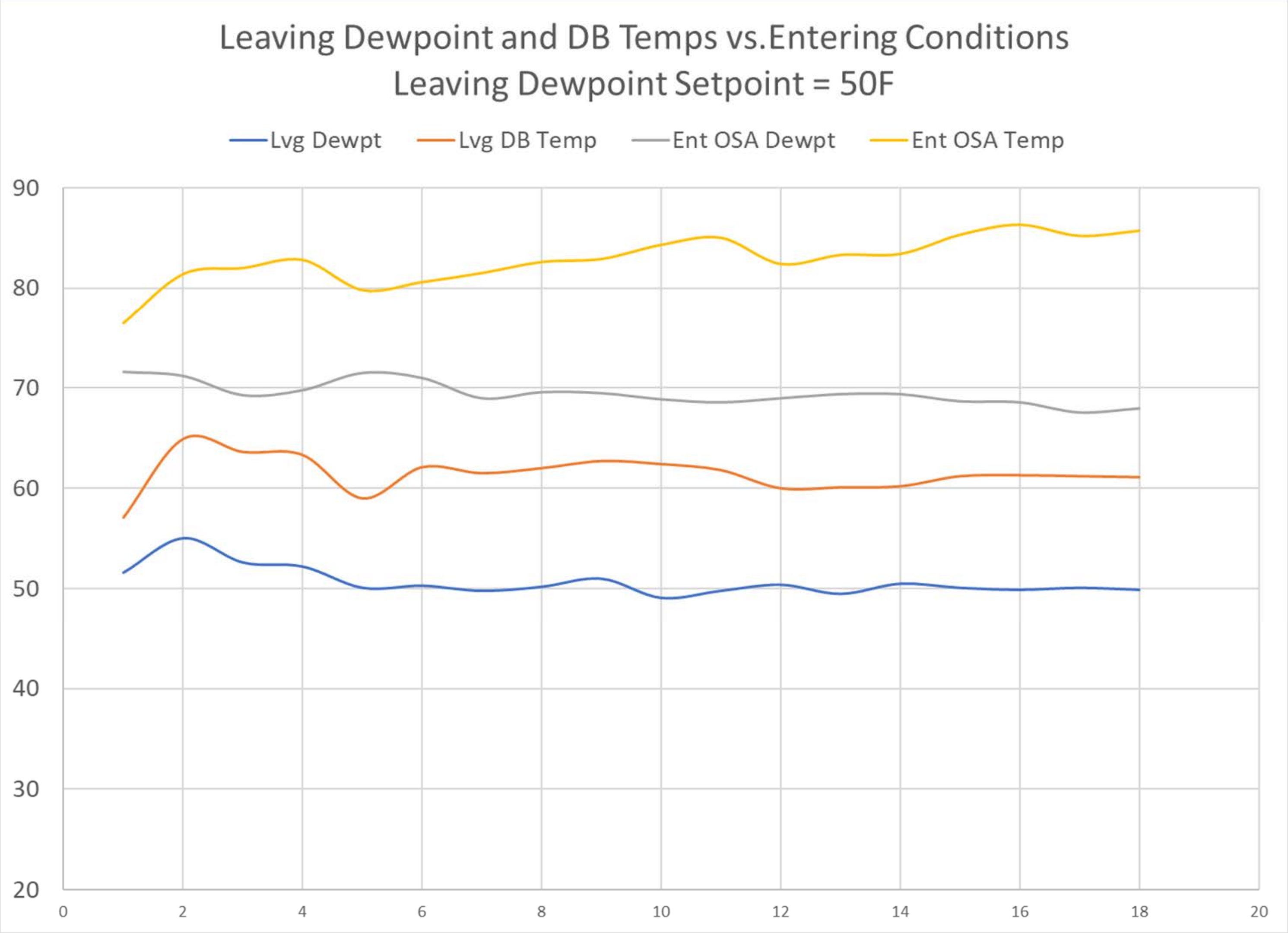
U.S. Navy – Naval Support Activity (NSA) Orlando, FL
Data from the Field



ADAPT Integrated Heat Recovery

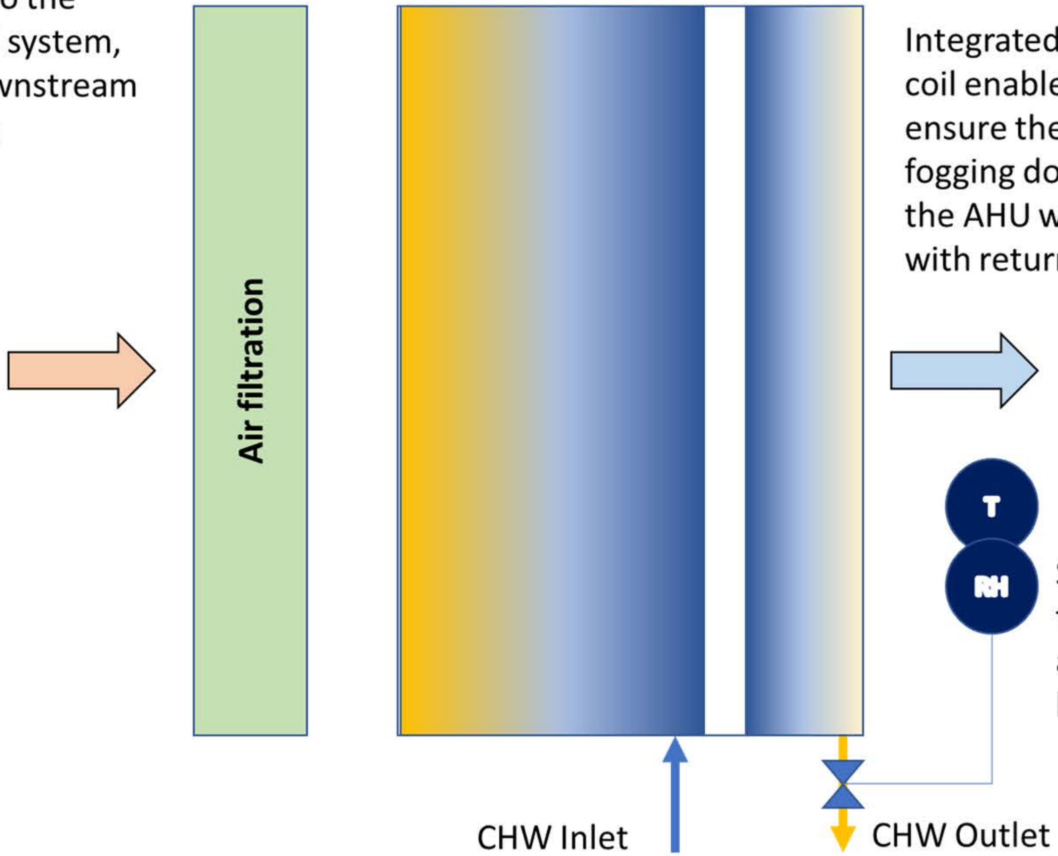
ADAPT Coil Layout

Outside air is filtered, delivering cleaner outdoor air to the existing AHU system, reducing downstream filter loading

TOP VIEW

Cooling & Dehumidifying Coil Section

Desaturation / Reheat Coil Section



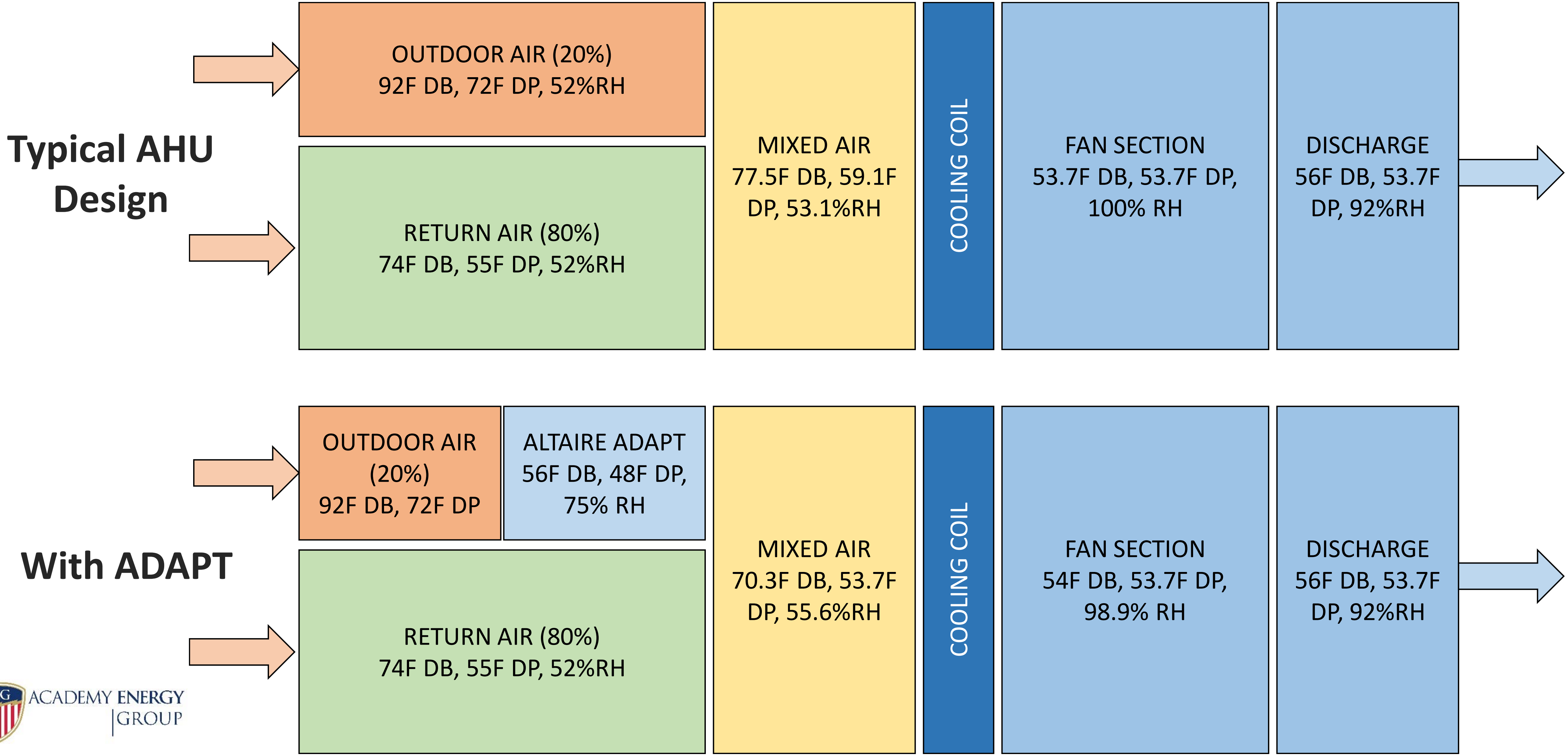
Integrated desaturation coil enables control to ensure there is no fogging downstream in the AHU when mixing with return air

Single valve is used to control both temp and humidity of the leaving air

ADAPT designed with low pressure drop based on unit size, coil selection, and configuration to allow the unit to be bolted onto most existing AHUs without limiting airflow

Application Performance Examples: Peak Sensible Load Day

Example Peak Sensible Day Requiring 56F Supply Air Temp to Meet Space Loads (SHR=0.91)



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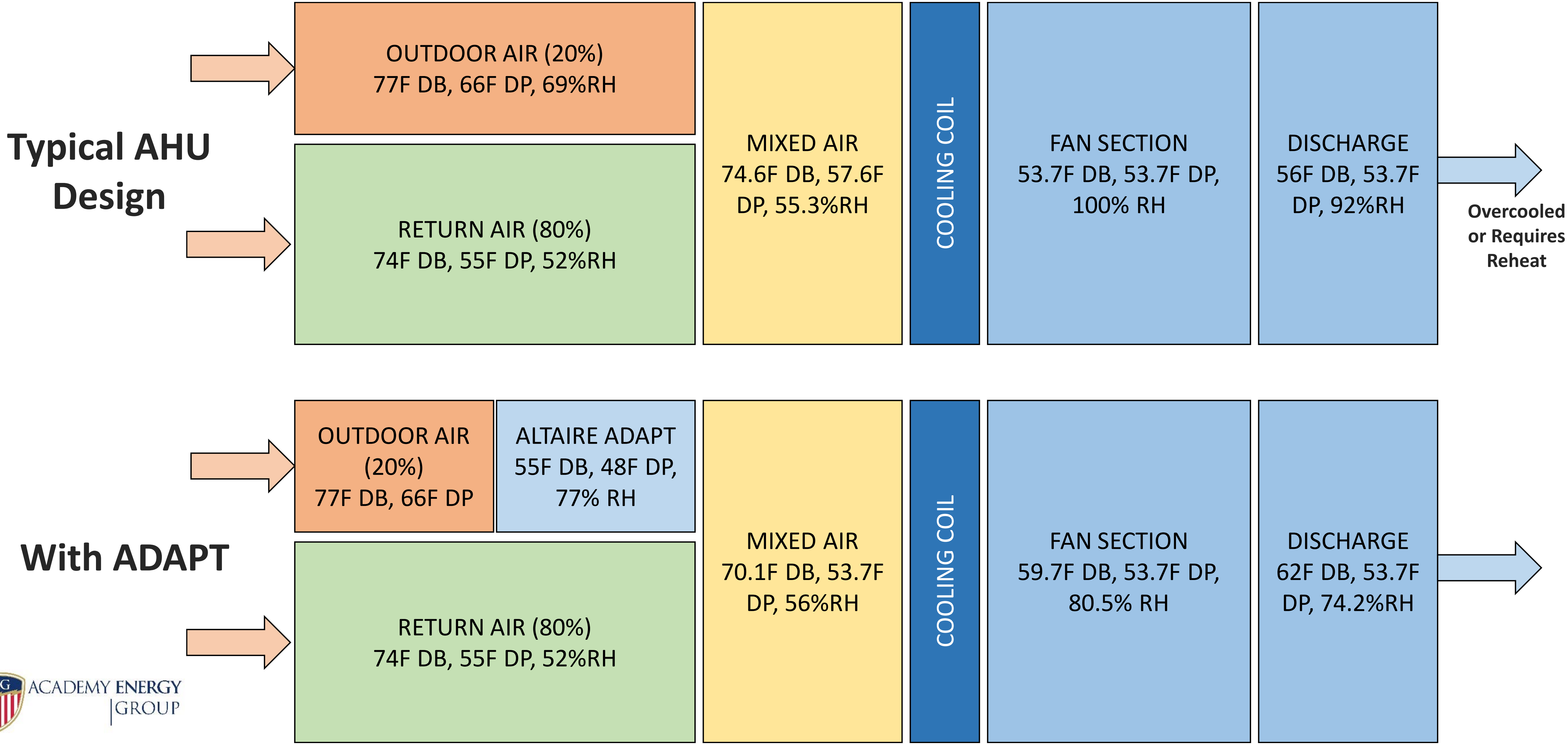
Application Performance Examples: Part Load Day

Example Part Load Day Requiring 62F Supply Air Temp to Meet Space Loads (SHR = 0.88)



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NREL Modeled Energy Savings
Sample Typical Office Building – Atlanta, GA

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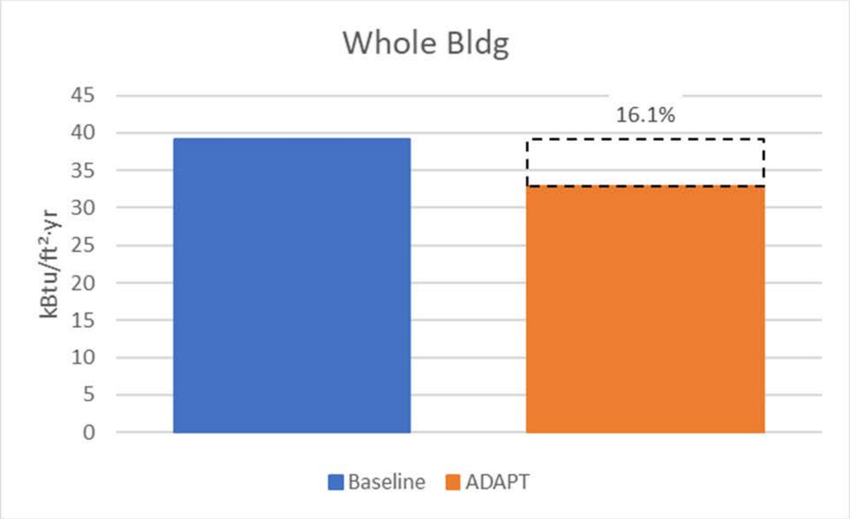

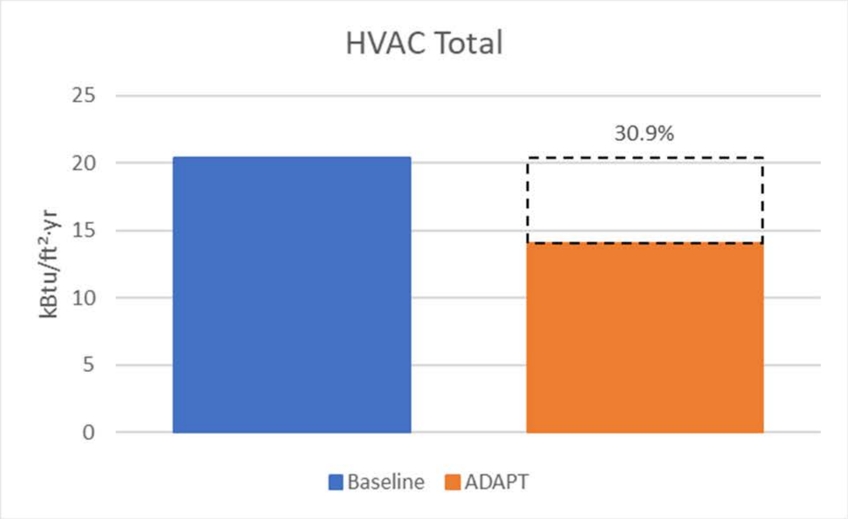

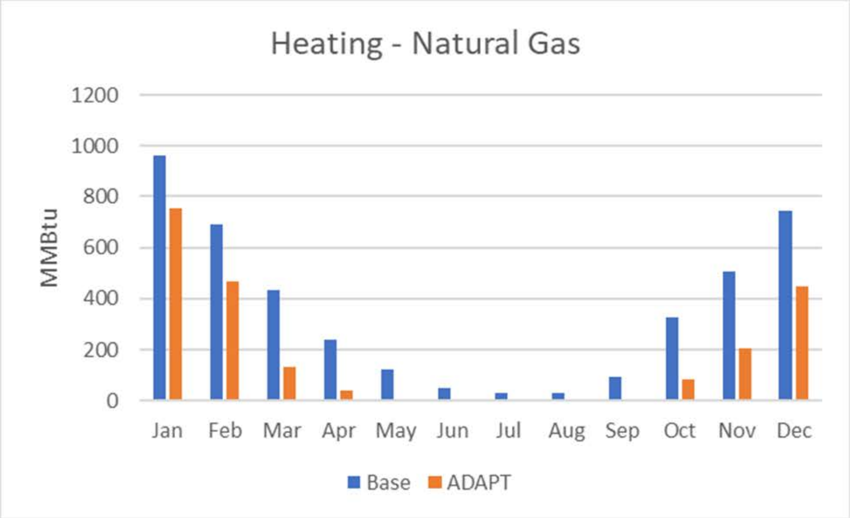

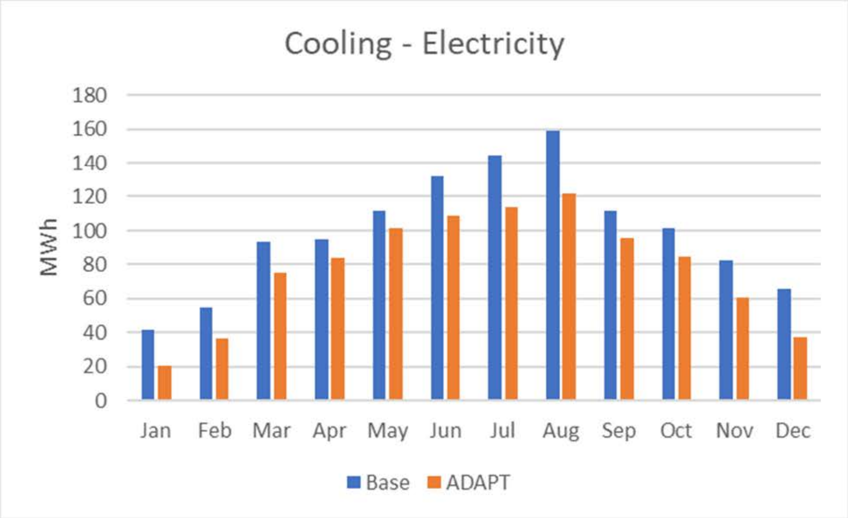

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ECM Calculations and M&V

- Altaire has developed a detailed 8760 ECM calculator based on the existing conditions and application of ADAPT

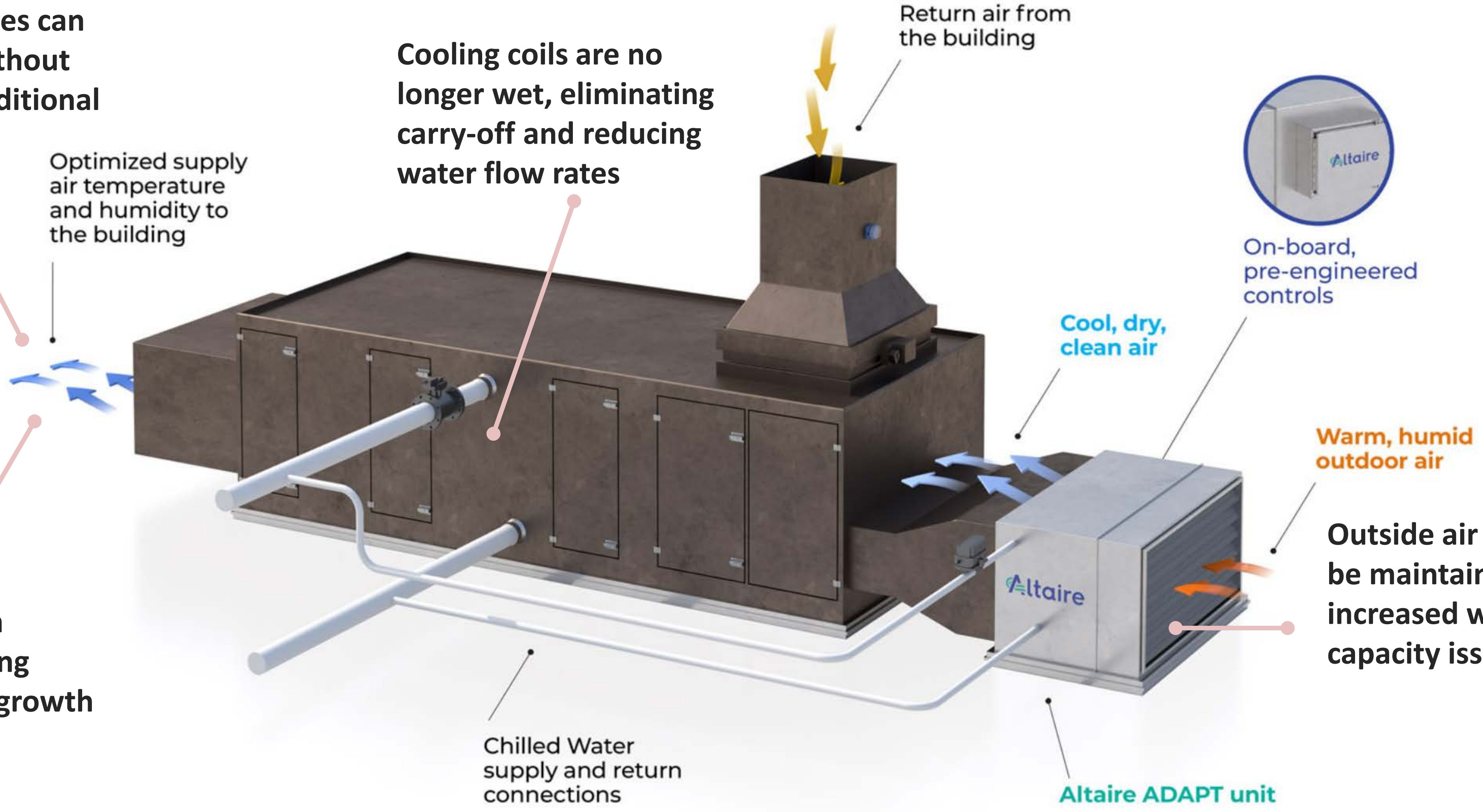
- Field Measurement and Verification
  - CHW tons
  - CHW Plant kWh
  - Reheat: HHW, steam, electricity
  - AHU Fan kWh

- Adjusted baseline may be needed for buildings with OSA flows below design / new ASHRAE requirements.

Advanced Dehumidification Airstream Pretreat Technology (**ADAPT**™)

Space temperatures can be maintained without overcooling or additional reheat energy

Cooling coils are no longer wet, eliminating carry-off and reducing water flow rates



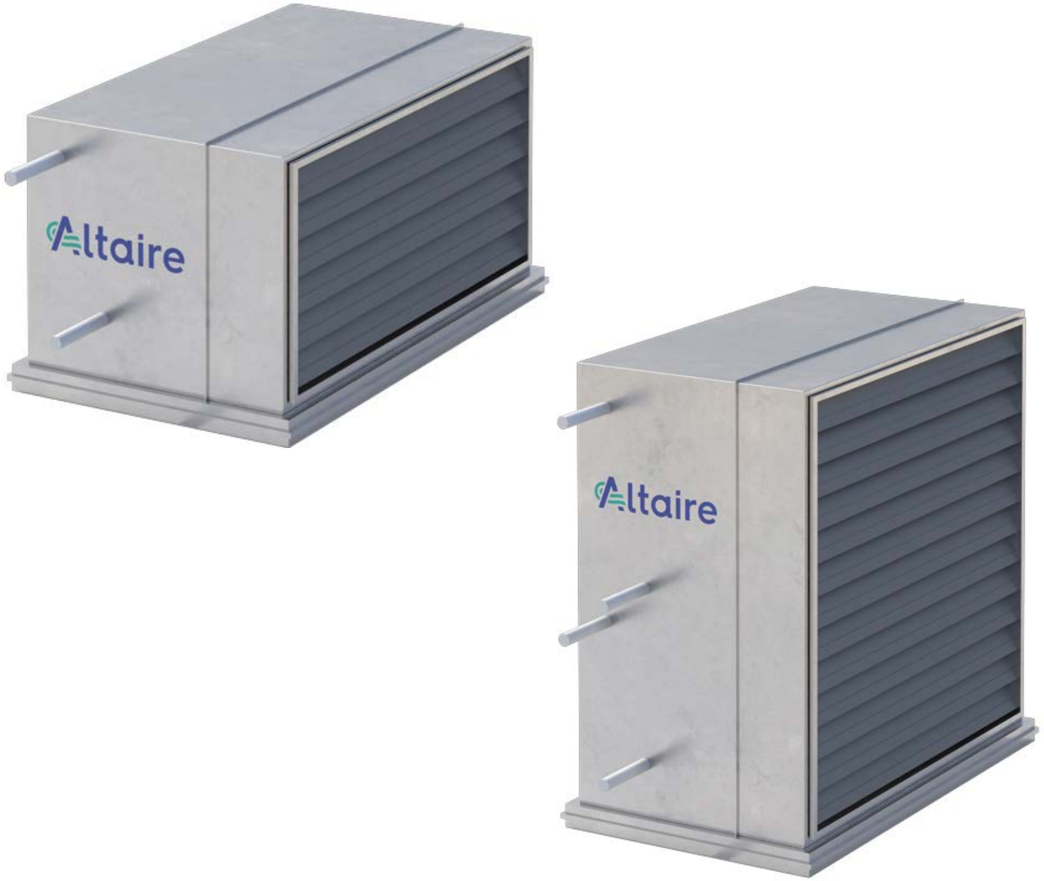
Supply air is far from saturation, eliminating conditions for mold growth

Outside air flow rates can be maintained or increased without capacity issues

ADAPT Products (patent no. US11,441,797)

Advanced Dehumidification Airstream Pretreat Technology

- Handles 100% of dehumidification loads, protecting downstream systems from moisture
- Available in 2500, 5000, & 10,000 cfm capacities
- Constructed to last 20+ in marine environments using marine grade aluminum and 316 stainless steel
- Dehumidification capacity for the most extreme conditions, adding resiliency and flexibility
- Energy efficient design with integrated heat recovery delivers lower peak chilled water flows and loads
- ASHRAE 90.1 compliant, can eliminate exhaust heat recovery
- Options for boost fan, preheat, and bypass
- MERV 8 pre-filter and MERV 14 final filter - low pressure drop
- Shipped as one unit but can be broken down for site-assembly
- Units can be stacked to meet additional capacity requirements

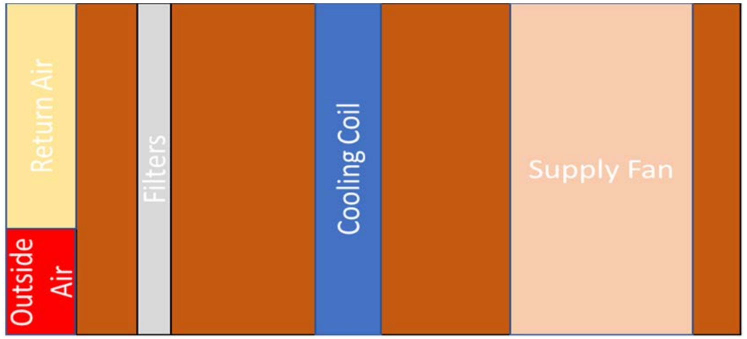


ADAPT New Construction & Retrofit Design Considerations

- Reduced downstream AHU size and cost
  - Decoupling latent cooling fundamentally changes the incoming design conditions
  - Higher face velocities -> less coil area
  - No dehumidification -> less rows on the coils
  - Dry coils -> higher delta T
  - Smaller AHU -> easier install
- ADAPT unit has high delta T (17F+)
  - Lower pump energy
  - Smaller distribution pipe sizes
  - More efficient chillers
- Integrated CHW reheat eliminates need for downstream reheat (ASHRAE 90.1 compliant)
- Decoupling latent and sensible control allows the supply air temp from the AHU to be reset, reducing cooling energy / improving space comfort
- Integrated CHW reheat can reduce peak cooling loads, enabling higher outside air flow rates without energy penalty

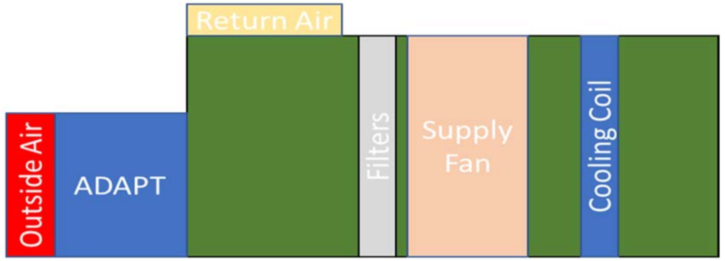
Comparative Replacement Options:
25,000 CFM AHU with 5,000 CFM Outside Air

Replacement AHU (Typical Solution)



- **8.5ft x 8.5ft: 50% larger with significantly larger coil, cannot fit through a doorway for installation**
- **$250,000 AHU cost**
- **Major site disruption to install indoors**
- **Annual Operating Cost[1]: $26,200/yr**

Replacement AHU + ADAPT



- **6.5ft x 6.5ft: 50% smaller with significantly smaller coil, sections can fit through a standard door**
- **$150,000 AHU cost + $125,000 ADAPT**
- **No site disruption for indoor installation**
- **Annual Operating Cost[1]: $12,400/yr**

(1) Annual operating cost assumes 15kW BPH, $0.12/kWh electricity cost, 60 hours per week operation; includes airside economizer.

ADAPT DOAS

Dedicated Outside Air System

- Adds fan to the ADAPT system to enable standalone operations
- Available in 2500, 5000 and 10,000 cfm capacities
- Delivers dry, neutral ventilation air without additional reheat energy or systems
- Energy efficient design with integrated heat recovery delivers lower peak chilled water flows and loads
- Integrated MERV 8 pre-filter with MERV 14 final filter
- Shipped as one unit but can be broken down for site-assembled applications
- Units can be stacked for additional capacity requirements

ADAPT Dedicated Outside Air System (DOAS) 10,000 CFM

ACADEMY ENERGY GROUP

U.S. Department of Veterans Affairs - North

New York State Certified
Service-Disabled Veteran-Owned Business

ACADEMY ENERGY GROUP

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Thank you for participating!