BOMA Greater Charlotte

HVAC BASICS, CODES, AND FUNDAMENTALS

FEBRUARY 8, 2023

- Who – team intro
- Why – Intent of Basics / Fundamentals
- Overview of codes
- Reliability and Redundancy
- O&Ms
- Preventative Maintenance Considerations

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TEAM INTRO

Matt Brewster

Donovan Moose

Caleb Heddle

WHY – INTENT / FUNDAMENTALS

WILL

- Review Basics
- Review the "How"
  - Heat
  - Water
  - Air
  - Etc.

WILL NOT

- Review Intricate Controls Schemes
- Review Complex Building Systems

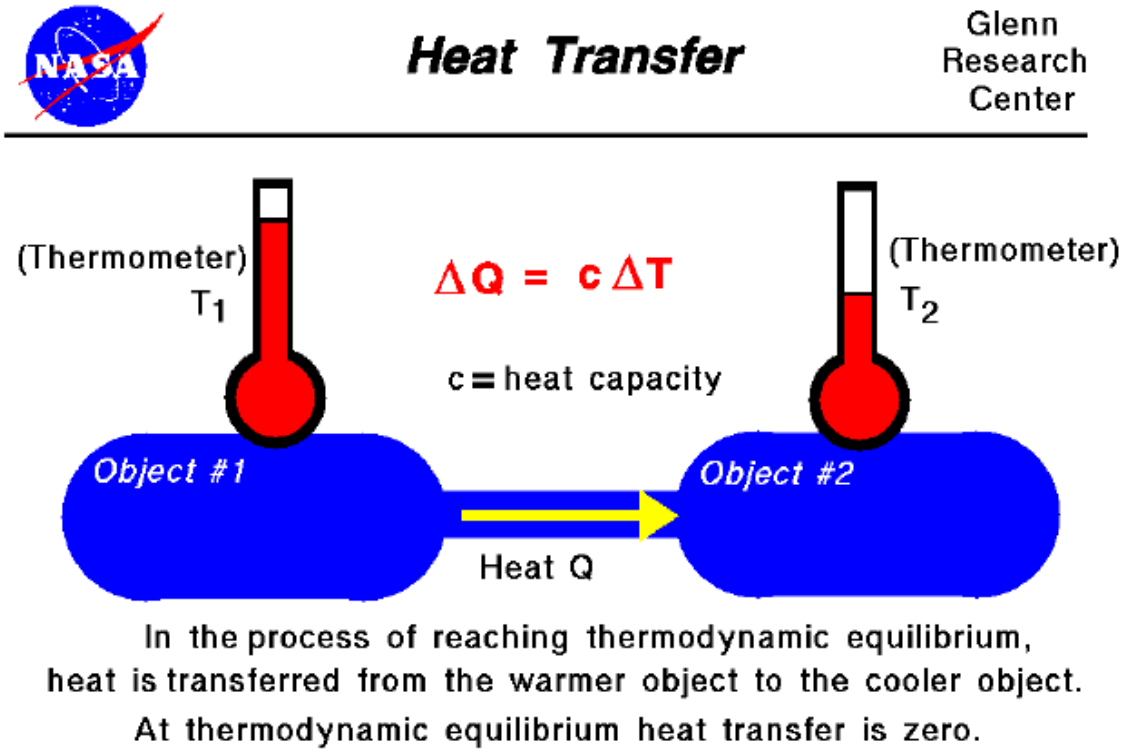
HVAC BASICS

Building Systems Fundamentals to:

- Move Air
- Move Water
- Move Heat
- Move Moisture (different from water)

Equipment:

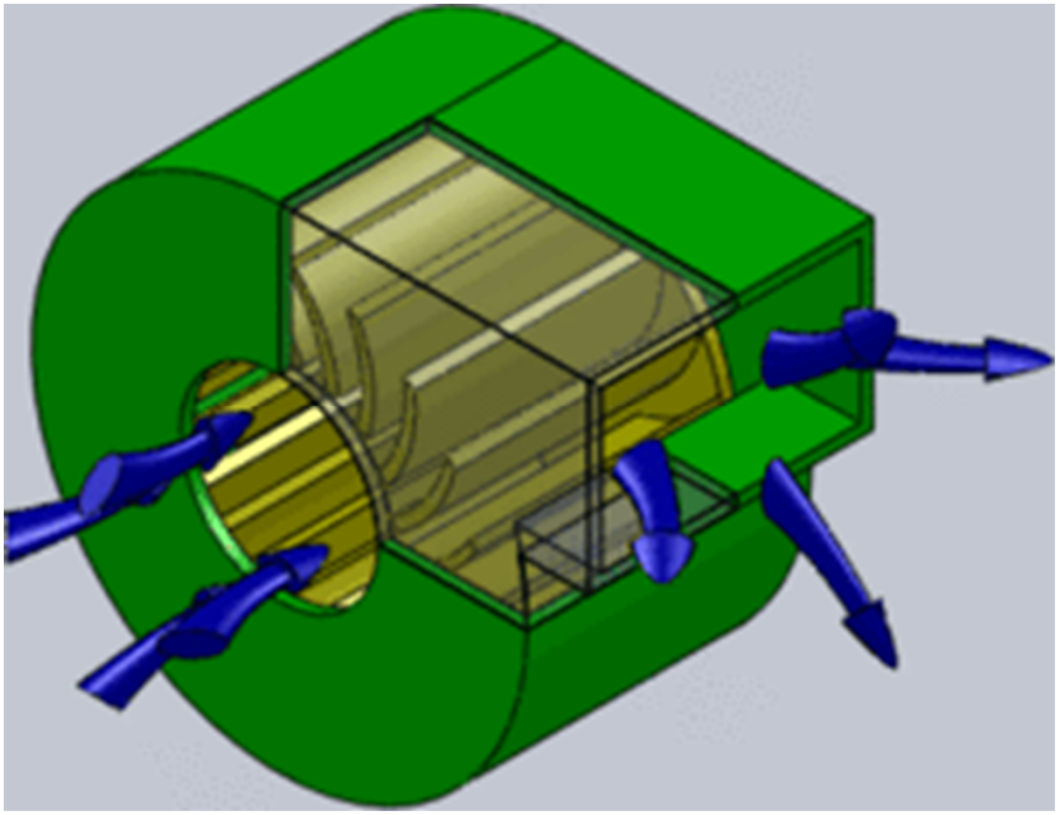
- Air Handling Units / Fans
- Chillers
- Pumps
- Boilers
- Steam Generators



HVAC BASICS

Fans:

- Move Air
- Located Stand-Alone, or Within AHUs
- Require Power
- Key Units – Static Pressure (“ w.c.), Volume (CFM), Power (HP)



AIR HANDLING UNIT TYPES

Custom Units – High Acuity, Expensive, Complex

Modular Units – High Acuity, Economical, Less Complex

DX Units – Low Acuity, Economical, Simple/Basic (Typically)

Package Systems – Low Acuity, Very Economical, Simple/Basic

Split Systems – Supplemental for Process Loading, Economical

VRF – Supplemental for Process Loading, Complex, Expensive, Efficient

CRAC – For Large Process Loading, Typically Data Center, Complex, Expensive

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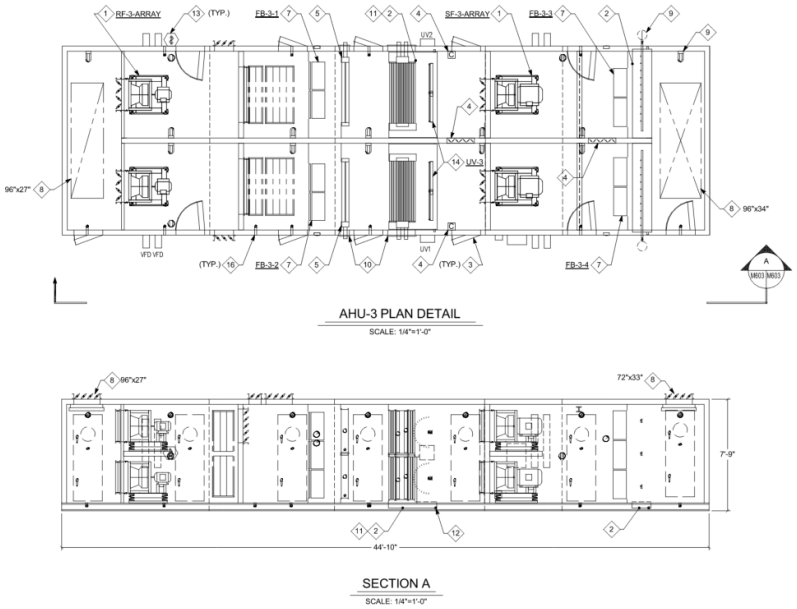
AIR HANDLING UNIT TYPES

Custom Units – High Acuity, Expensive, Complex



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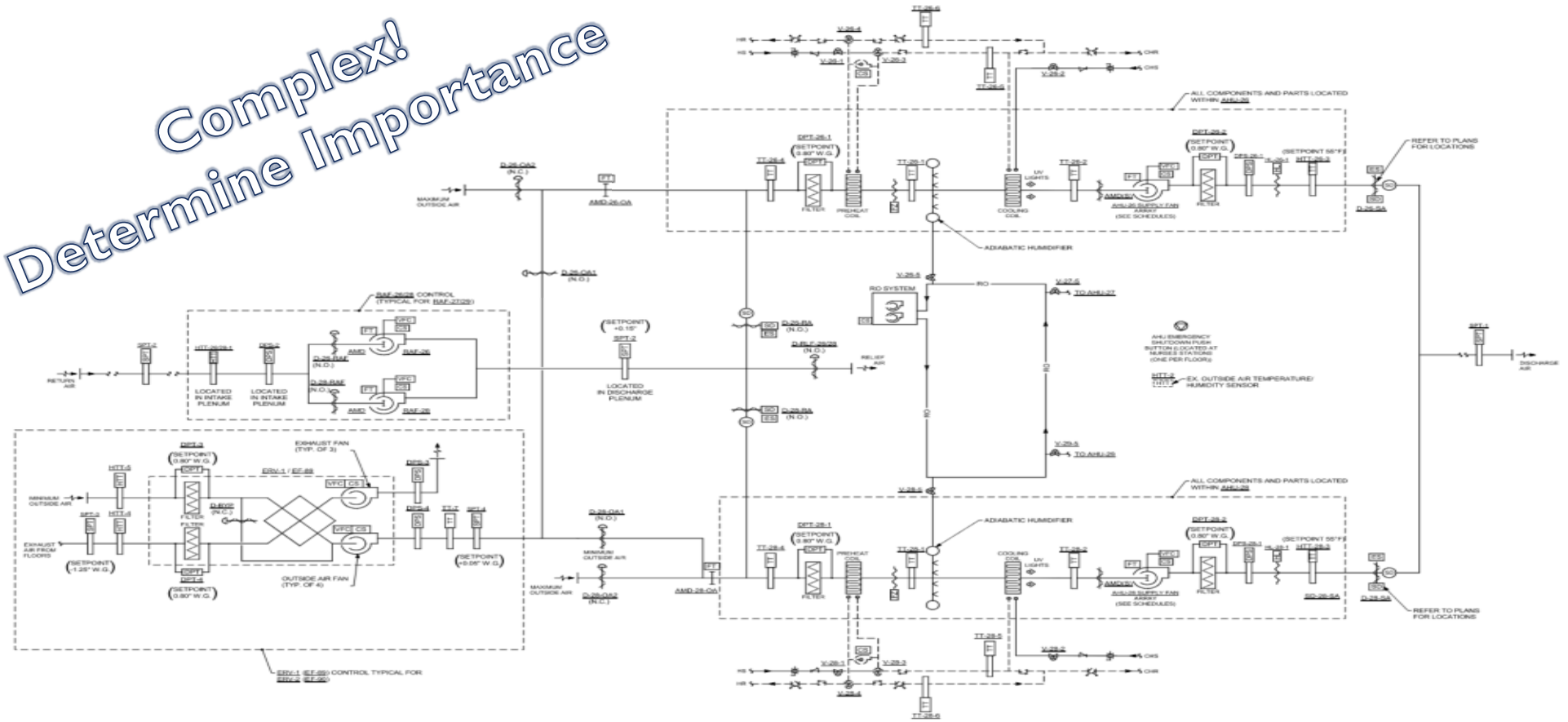
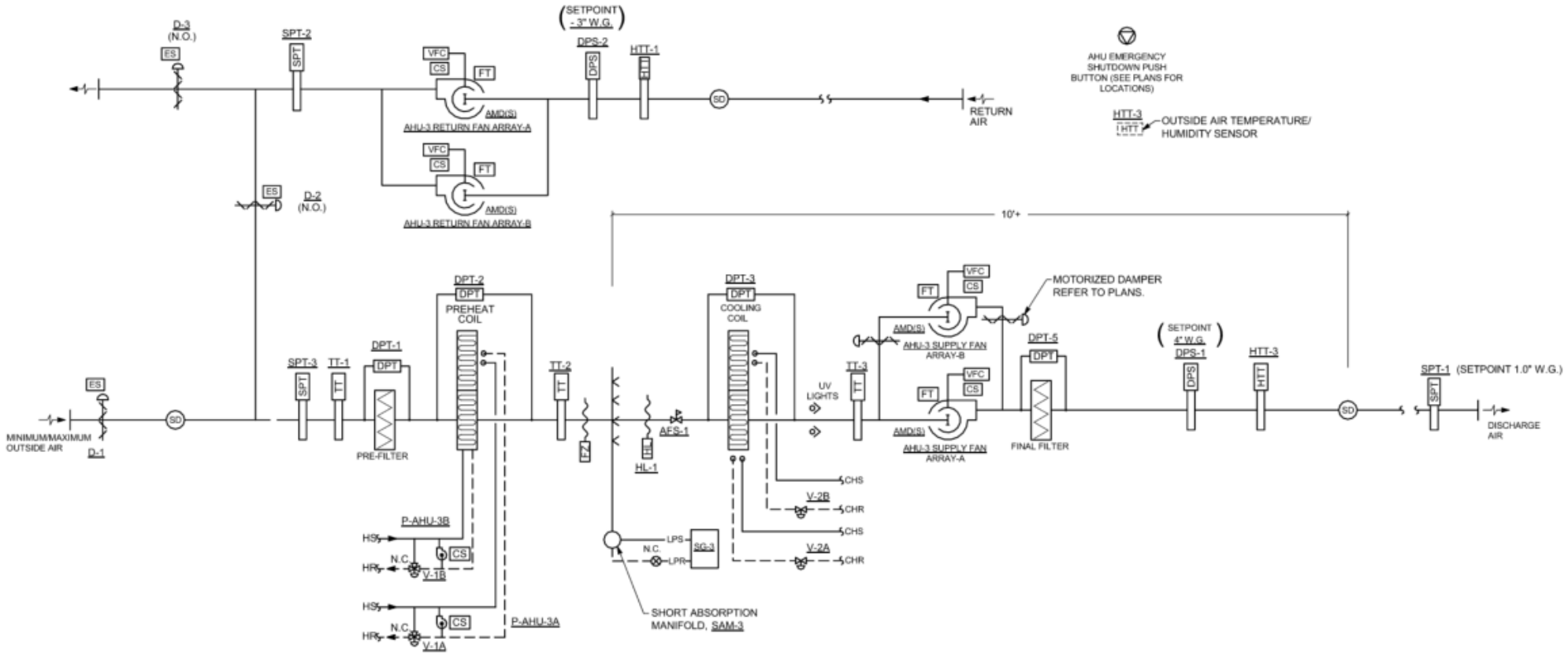


Module 3 – Session 1.1

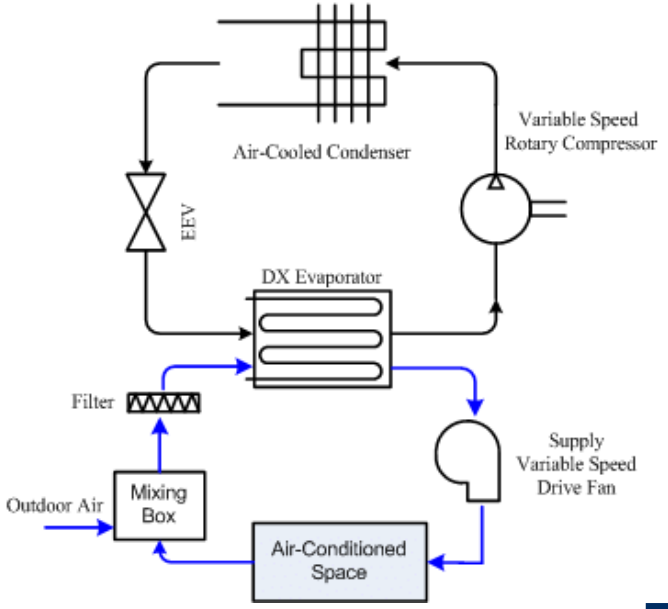
AIR HANDLING UNIT TYPES

Modular Units – High Acuity, Economical, Less Complex


D-3
(N.O.)
ES
SPT-2
SPT
VFC
CS
FT
AMD(S)
AHU-3 RETURN FAN ARRAY-A
(SETPOINT
- 3" W.G.
DPS-2
DPS
HTT-1
HTT
SD
RETURN
AIR
AHU EMERGENCY
SHUTDOWN PUSH
BUTTON (SEE PLANS FOR
LOCATIONS)
HTT-3
OUTSIDE AIR TEMPERATURE/
HUMIDITY SENSOR
ES
D-2
(N.O.)
AHU-3 RETURN FAN ARRAY-B
10'+
DPT-2
DPT
PREHEAT
COIL
DPT-3
COOLING
COIL
MOTORIZED DAMPER
REFER TO PLANS.
SETPOINT
4" W.G.
DPS-1
HTT-3
SPT-1 (SETPOINT 1.0" W.G.)
SPT-3
TT-1
DPT-1
TT-2
UV
LIGHTS
TT-3
DPT-5
AMD(S)
AHU-3 SUPPLY FAN
ARRAY-B
AHU-3 SUPPLY FAN
ARRAY-A
FINAL FILTER
DISCHARGE
AIR
MINIMUM/MAXIMUM
OUTSIDE AIR
D-1
PRE-FILTER
AFS-1
HL-1
FZ
CHS
CHR
V-2B
V-2A
LPS
N.C.
LPR
SG-3
P-AHU-3B
HS
HR
V-1B
P-AHU-3A
V-1A
SHORT ABSORPTION
MANIFOLD, SAM-3

AIR HANDLING UNIT TYPES

DX / Packaged Units – Low Acuity, Economical, Simple/Basic (Typically)



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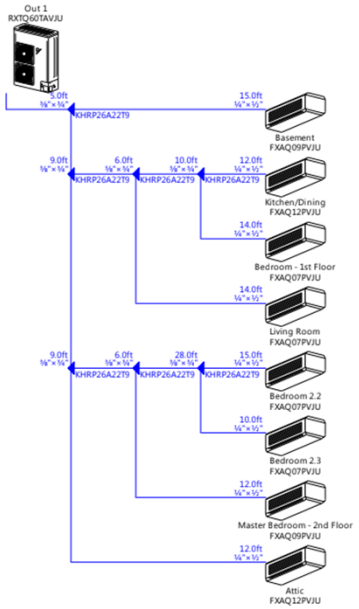
AIR HANDLING UNIT TYPES

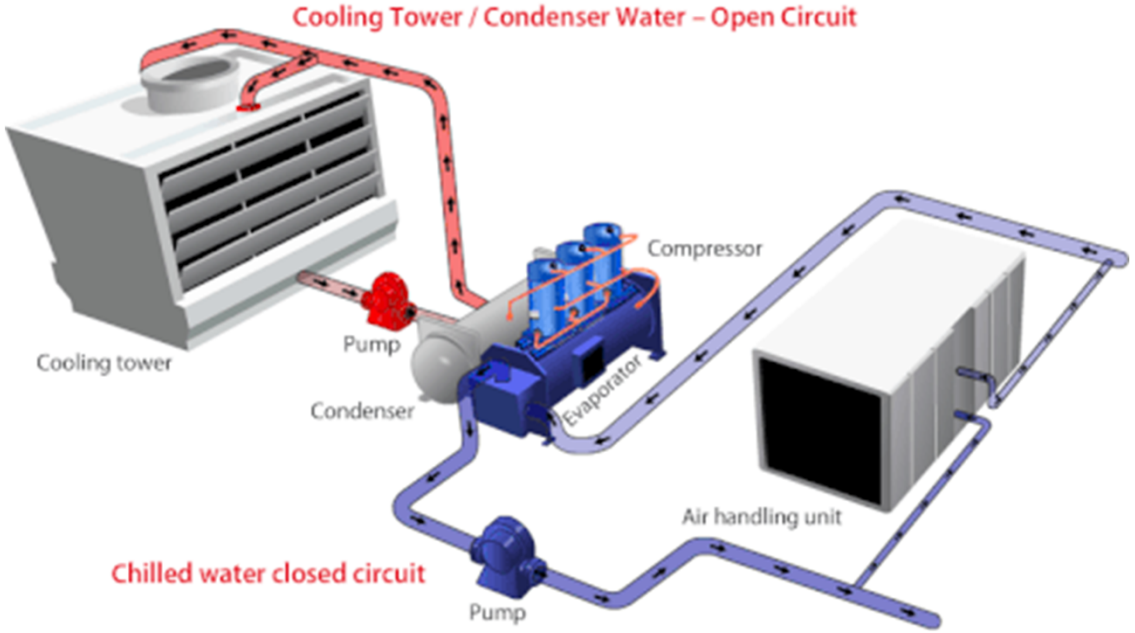
VRF – Supplemental for Process Loading, Complex, Expensive, Efficient



HVAC BASICS

Chilled Water:

- Generate Chilled Water
- Located (Typically) in Plants
- Require Power
- Key Units – Pressure (feet of head, PSI), Volume (GPM), Power (HP), Voltage (V), Temperatures (EWT, LWT, °F)



CHILLER TYPES – AIR COOLED

- Heat Rejection to Air
- Located Outside
  - Atmosphere considerations
- Good for Low Acuity Applications
- Reduced First Cost
- Low Efficiency

CHILLER TYPES – WATER COOLED

Heat Rejection to Water (Cooling Tower)

Located Inside

- Central Utility Plant Considerations
- Refrigerant Purge System

Good for High Acuity Applications

Increased First Cost

High Efficiency (Even with Tower Fans)

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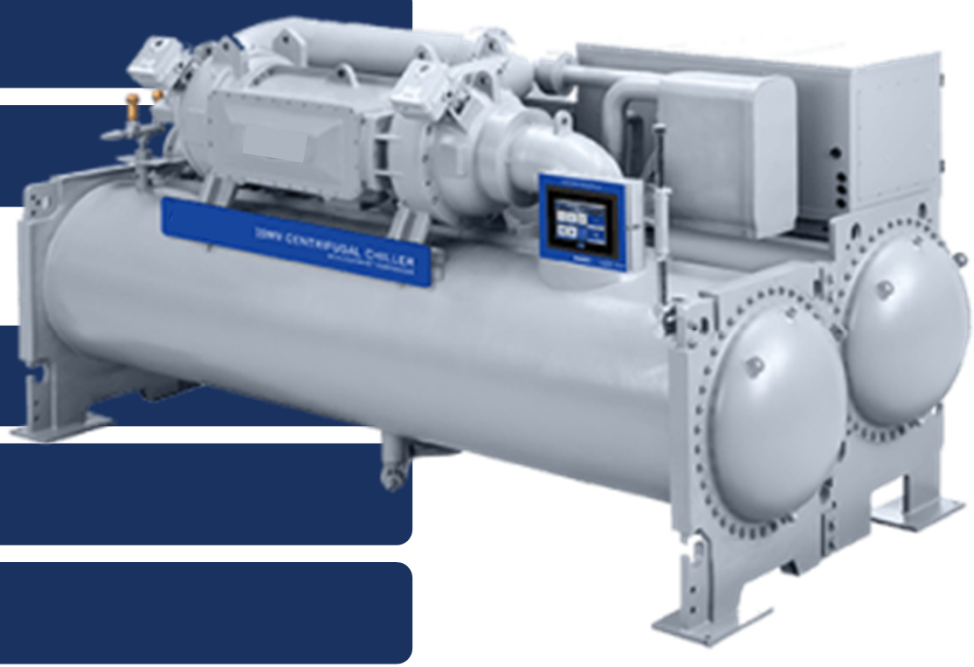
CHILLER TYPES – WATER COOLED

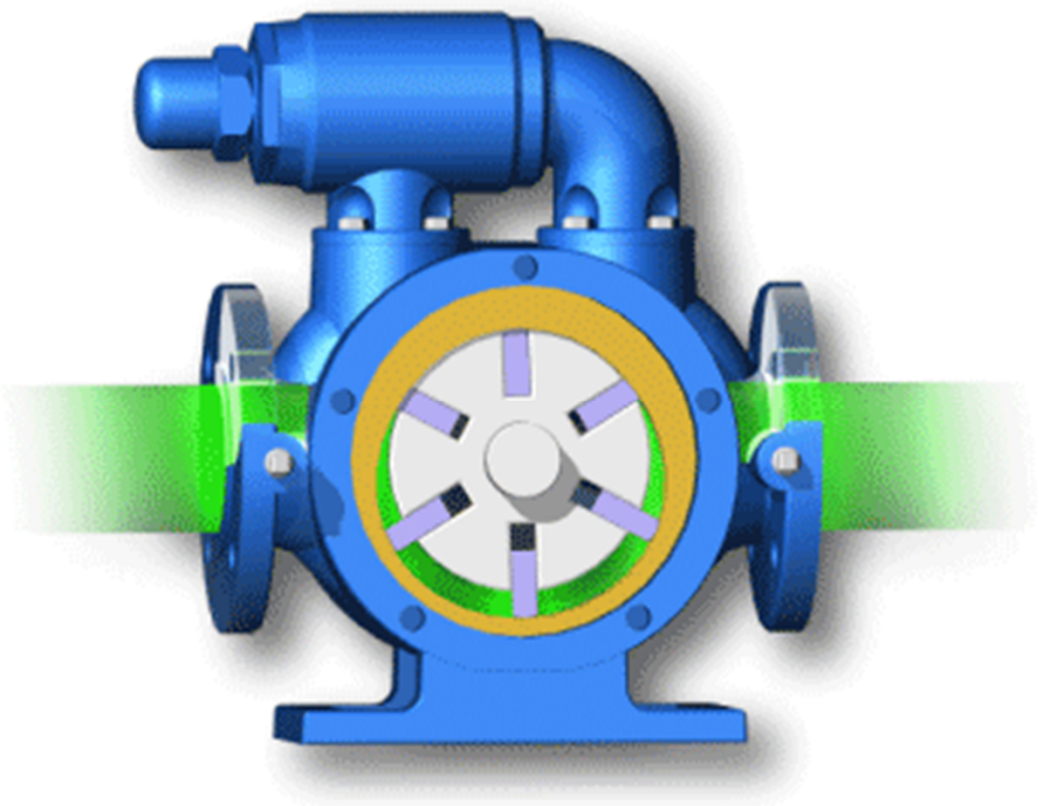
- Heat Rejection to Water (Cooling Tower)
- Located Inside
  - Central Utility Plant Considerations
  - Refrigerant Purge System
- Good for High Acuity Applications
- Increased First Cost
- High Efficiency (Even with Tower Fans)



HVAC BASICS

Pumps:

- Move Water
- Located (Typically) in Plants
- Require Power
- Key Units – Pressure (feet of head), Volume (GPM), Power (HP)



PUMPING SYSTEMS

Different Strategies Based on Facility Needs

- Variable Primary
- Primary Secondary

System Considerations

- Chilled Water System
- Condenser Water System

Energy Efficiency Considerations

Controllability

- Variable Frequency Drives (VFDs)
- Differential Pressure (DP) Transmitters

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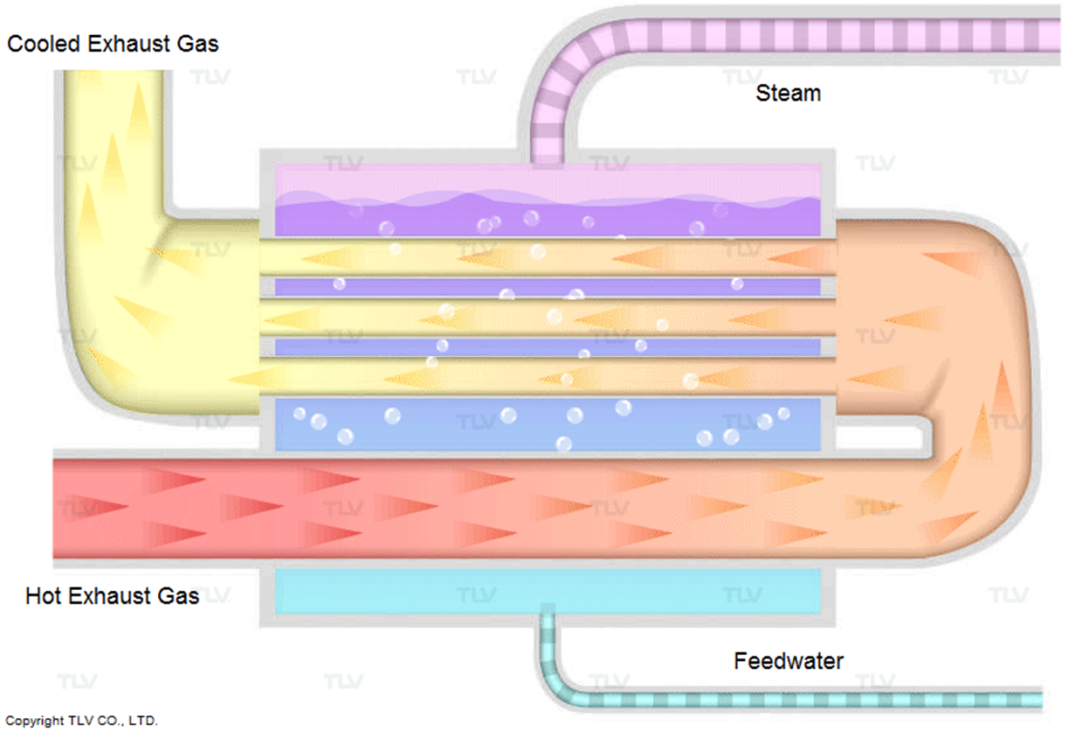
HVAC BASICS

Boilers:

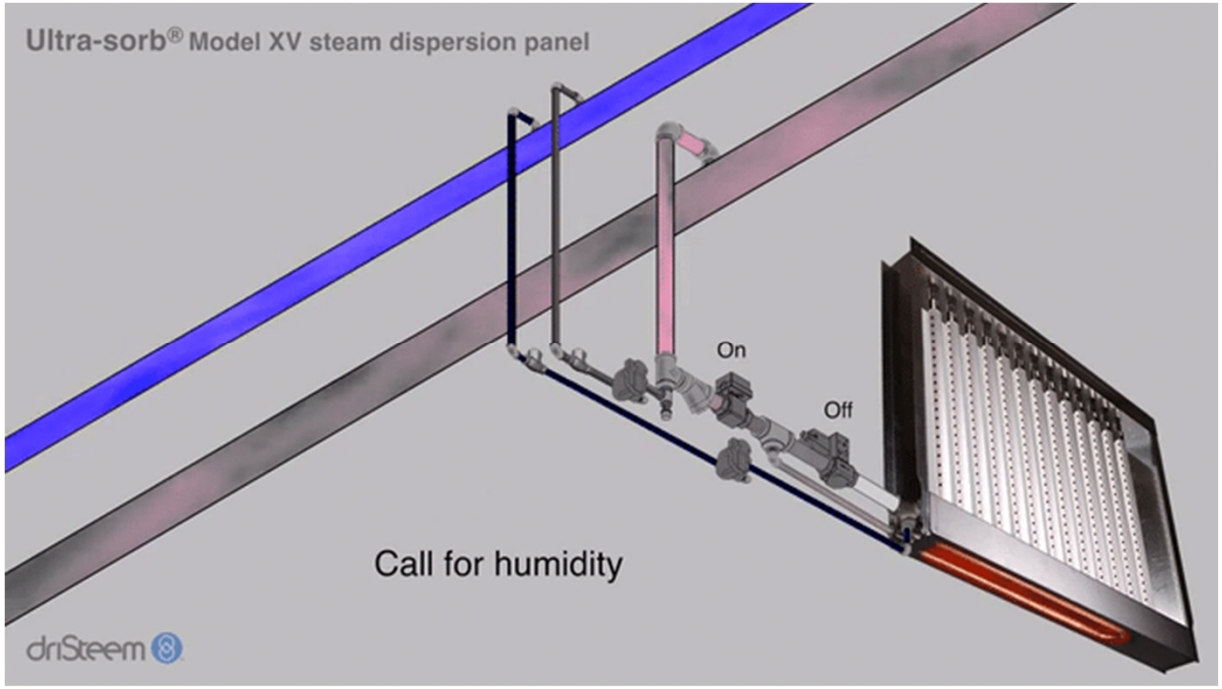
- Generate Hot Water / Steam
- Located (Typically) in Plants
- Require Fuel (or Power)
- Key Units – Pressure (feet of head, PSI), Volume (GPM, Lb/Hr), Temperatures (EWT, LWT, °F)



HVAC BASICS

Humidification:

- Increase Moisture in Air
- Located (Typically) in AHUs
- Require Steam
- Key Units – Pressure (PSI), Volume (Lb/Hr)



OVERVIEW OF CODES

Federal Guidelines Institute (FGI – Outpatient Facilities) – 2018

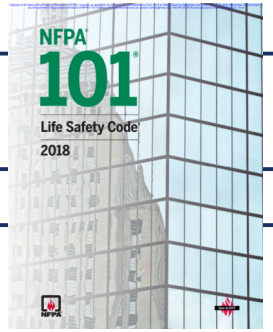
- ASHRAE 170 – 2021 (no longer 2017)

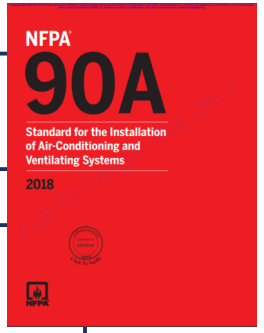
NFPA

- NFPA-101
- NFPA-90A
- NFPA-80
- NFPA-70 (NEC)

North Carolina Building/Mechanical/Plumbing/Fire Code

ASHRAE – 90.1, 62.1, 55, 15





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RELIABILITY AND REDUNDANCY

- What does Code say?
- What is Risk Aversion?
- What are Users' Needs?
- Energy Consumption

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RELIABILITY AND REDUNDANCY

- What Does Code Say - Healthcare

6.1 Utilities

6.1.1 Ventilation Upon Loss of Electrical Power. The space ventilation and pressure relationship requirements of Tables 7.1, 8.1, and 9.1 shall be maintained for the following spaces, even in the event of loss of normal electrical power.

a. All rooms
b. Protective environment (PE) rooms (inpatient only)
c. Operating rooms (ORs), including delivery rooms (Cesarean) (inpatient and outpatient only)

Exception to 6.1.1: When an essential power system is not provided or required, operation of space ventilation and pressure relationships is not required.

Informative Note: For further information, see NFPA 99 (2021) in Informative Appendix E.

6.1.2 Heating and Cooling Sources

6.1.2.1 Provide heat sources and essential accessories in number and arrangement sufficient to accommodate the facility needs (reserve capacity), even when any one of the heat sources or essential accessories is not operating due to a breakdown or routine maintenance. The capacity of the remaining source or sources shall be sufficient to provide for domestic hot water, sterilization, and dietary purposes and to provide heating for operating, delivery, birthing, labor, recovery, emergency, intensive care, nursery, and resident care areas and inpatient/resident rooms. Fuel sufficient to support the owner's facility operation plan upon loss of fuel service shall be provided on site.

Exception to 6.1.2.1: Reserve capacity is not required if the ASHRAE 99% heating dry-bulb temperature for the facility is greater than or equal to 25°F (–4°C).

6.1.2.2 Inpatient and Residential Health Care Spaces. For central cooling systems greater than 400 tons (1407 kW) peak cooling load, the number and arrangement of cooling sources and essential accessories shall be sufficient to support the owner's facility operation plan upon a breakdown or routine maintenance of any one of the cooling sources.

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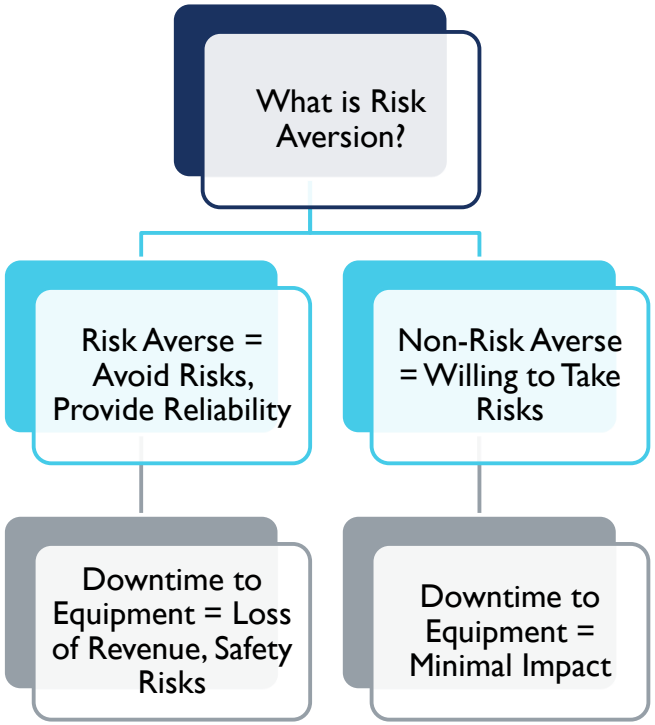
RELIABILITY AND REDUNDANCY



Where do you think your users land?

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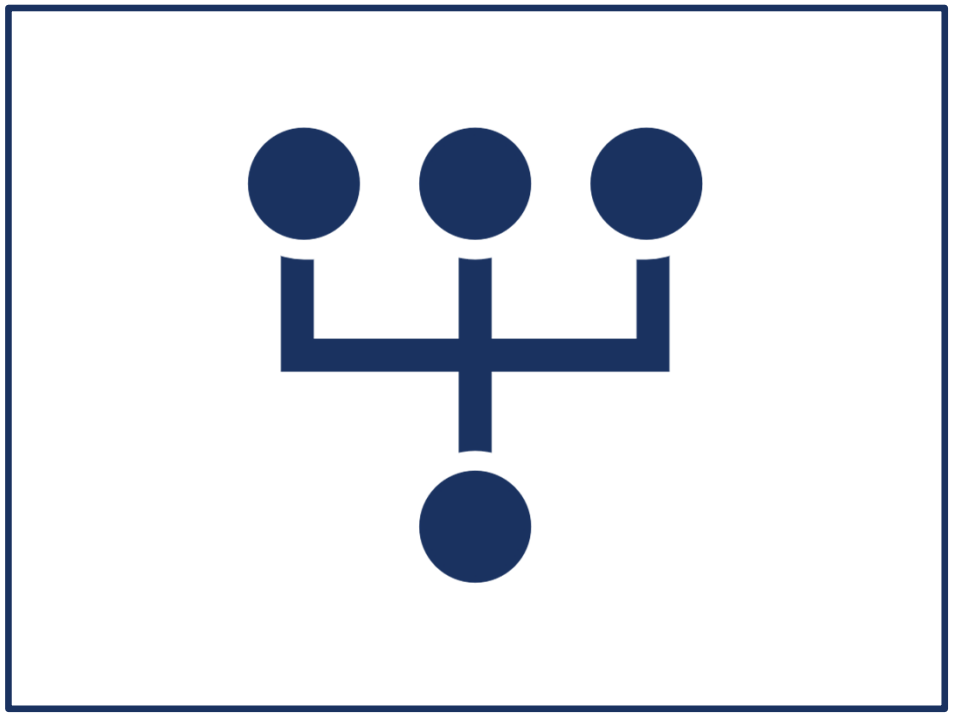
RELIABILITY AND REDUNDANCY



- What are Users' Needs?
  - Executive?
  - Clinical?
  - Operations
  - Maintenance
  - Others?

RELIABILITY AND REDUNDANCY

Energy Consumption v. Intended Use

Must Consider the "Costs" of Each

Cannot Sacrifice Use/Intent for Energy (in some cases)

Typically Means More Robust Systems, Not Necessarily Most Efficient

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OPERATIONS AND MAINTENANCE

What is required?

What is best practice?

Why important.

OPERATIONS AND MAINTENANCE

What is Required?

- Refer to ASHRAE 62.1 – Chapter 8
- Develop a Plan

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OPERATIONS AND MAINTENANCE – WHAT IS REQUIRED?

Table 8-1 Minimum Maintenance Activity and Frequency for Ventilation System Equipment and Associated Components

Inspection/Maintenance Task	Frequency [a]
a. Investigate system for water int	
b. Verify that the space provided f cooling tower water systems, ar	
c. Open cooling tower water syste to limit the growth of microbiol	
d. Verify that the space provided f	
e. Check pressure drop and sched necessary to ensure proper oper	
f. Check ultraviolet lamp. Clean c	
g. Visually inspect dehumidificati growth. Measure relative humic	
h. Maintain floor drains and trap p of contaminants from the floor	
i. Check ventilation and IAQ relat or replace as needed to ensure p	
j. Check P-traps in floor drains lo proper operation.	
k. Check fan belt tension. Check f evidence of improper alignmen	
l. Check variable-frequency drive	
m. Check for proper operation of cooling or heating coil for damage or evidence of leaks. Clean, restore, or replace as required.	Semiannually
n. Visually inspect outdoor air intake louvers, bird screens, mist eliminators, and adjacent areas for cleanliness and integrity; clean as needed; remove all visible debris or visible biological material observed and repair physical damage to louvers, s air entry.	Semiannually
o. Visually inspect natu Remove all visible d if such damage impa apparatus shall be pl	
p. Verify the operation	
q. Check air filter fit ar	
r. Check control box f	
s. Check motor contact	
t. Check fan blades an	
u. Check integrity of al equipment.	
v. Assess field service	
w. Check drain pans, dr wetting. Repair and	
x. Check for evidence	
y. Inspect unit for evid as necessary.	
z. Check for proper damper operation. Clean, lubricate, repair, replace, or adjust as needed to ensure proper operation.	Annually
aa. Visually inspect areas of moisture accumulation for biological growth. If present, clean or disinfect as needed.	Annually

a. Minimum frequencies may be increased or decreased if indicated in the O&M manual.

Table 8-1 Minimum Maintenance Activity and Frequency for Ventilation System Equipment and Associated Components *(Continued)*

Inspection/Maintenance Task	Frequency [a]
ab. Check condensate pump. Clean or replace as needed.	Annually
ac. Visually inspect exposed ductwork and external piping for insulation and vapor barrier for integrity. Correct as needed.	Annually
ad. Verify the accuracy of permanently mounted sensors whose primary function is outdoor air delivery monitoring, outdoor air delivery verification, or dynamic minimum outdoor air control, such as flow stations at an air handler and those used for demand control ventilation, including CO_2 sensors. A sensor failing to meet the accuracy specified in the O&M manual shall be recalibrated or replaced. Performance verification shall include output comparison to a measurement reference standard consistent with those specified for similar devices in ASHRAE Standard 41.2 or ASHRAE Standard 111.	5 years
ae. Verify the total quantity of outdoor air delivered by air handlers set to minimum outdoor air mode. If measured minimum airflow rates are less than the design minimum rate documented in the O&M manual, ± a 10% balancing tolerance, (1) confirm the measured rate does not conform with the provisions of this standard and (2) adjust or modify the air-handler components to correct the airflow deficiency. Ventilation systems shall be balanced in accordance with ASHRAE Standard 111 or its equivalent, at least to the extent necessary to verify conformance with the total outdoor airflow and space supply airflow requirements of this standard. **Exception:** Units under 2000 cfm (1000 L/s) of supply air are exempt from this requirement.	5 years

a. Minimum frequencies may be increased or decreased if indicated in the O&M manual.

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OPERATIONS AND MAINTENANCE

What is Best Practice?

- Preventative Maintenance
- Code is Minimum Requirements
- What's best for facility
- Walk your building
- Check all equipment

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OPERATIONS AND MAINTENANCE – WHY IMPORTANT

- Hypothetical Example:
  - A custom air handling unit (AHU) serving an Ambulatory Surgery Center (ASC) requires monthly PMs to ensure its longevity. It is 5 years old, and has all the "bells and whistles". It was determined that replacing its filters was cumbersome and time consuming, and the filters seemed to be performing well, even though they haven't been replaced in 24 months.
  - After continuous run time, particulate began to bypass filters and load up the freeze-stat, a crucial piece of hardware meant to protect the unit from freezing, and the cooling coil of the unit ultimately ruptured, causing significant damage.

OPERATIONS AND MAINTENANCE – WHY IMPORTANT

Replace Filters (Every 6 Months):

Material:	$3,668
Labor:	$480
24 Month Cost:	**$16,592**

React to Damaged Coil:

Filter Material:	$3,668
Filter Labor:	$480
Coil Material:	$14,678
Coil Labor:	$6,520
Ancillary Damage:	$25,000?
Operation Downtime:	$60,000?
24 Month Cost:	**$25,366 + $85,000**

Was it worth it?

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