Best Practices for Building Ventilation Improvements and Efficiency

November 19, 2019

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Antitrust Policy

This webinar will be held in strict compliance with the TAPPI Antitrust Policy.

Specifically, discussing prices or pricing policy and discussing any restraint of competition of any kind will not be tolerated.

Introduction

PTOC (Papermaking Technology and Operations Committee)

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Today’s Speaker

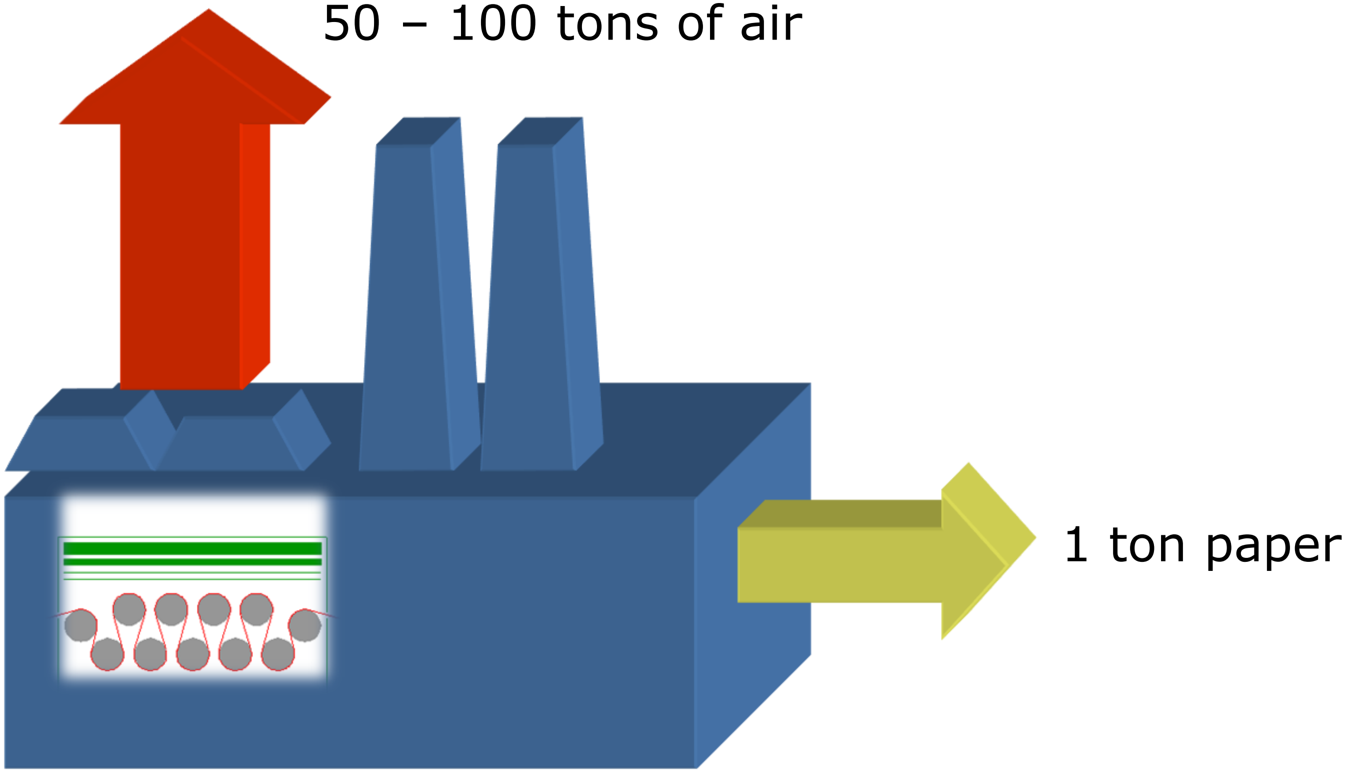
Based at Headquarters in Montreal, Quebec, Lawrence Yane’s is Sales Manager for Enerquin Air. Lawrence has Bachelor of Mechanical Engineering (1994) and Master of Science (1997) degrees from McGill University in Montreal and has spent his entire professional career in Technical Sales and Product Development. He works closely with clients on paper and tissue air systems issues, focusing on drying efficiency and optimisation which are key factors for maximum production and profitability. Lawrence is also an active member of TAPPI’s Yankee Dryer Safety and Reliability Committee.

Agenda

- The importance of building ventilation
- Evaluating existing PM machine room performance
- Greenfield projects
- Considerations for tissue mills
- Case studies
- Heat recovery

ENERQUIN AIR

A Few Years Ago...

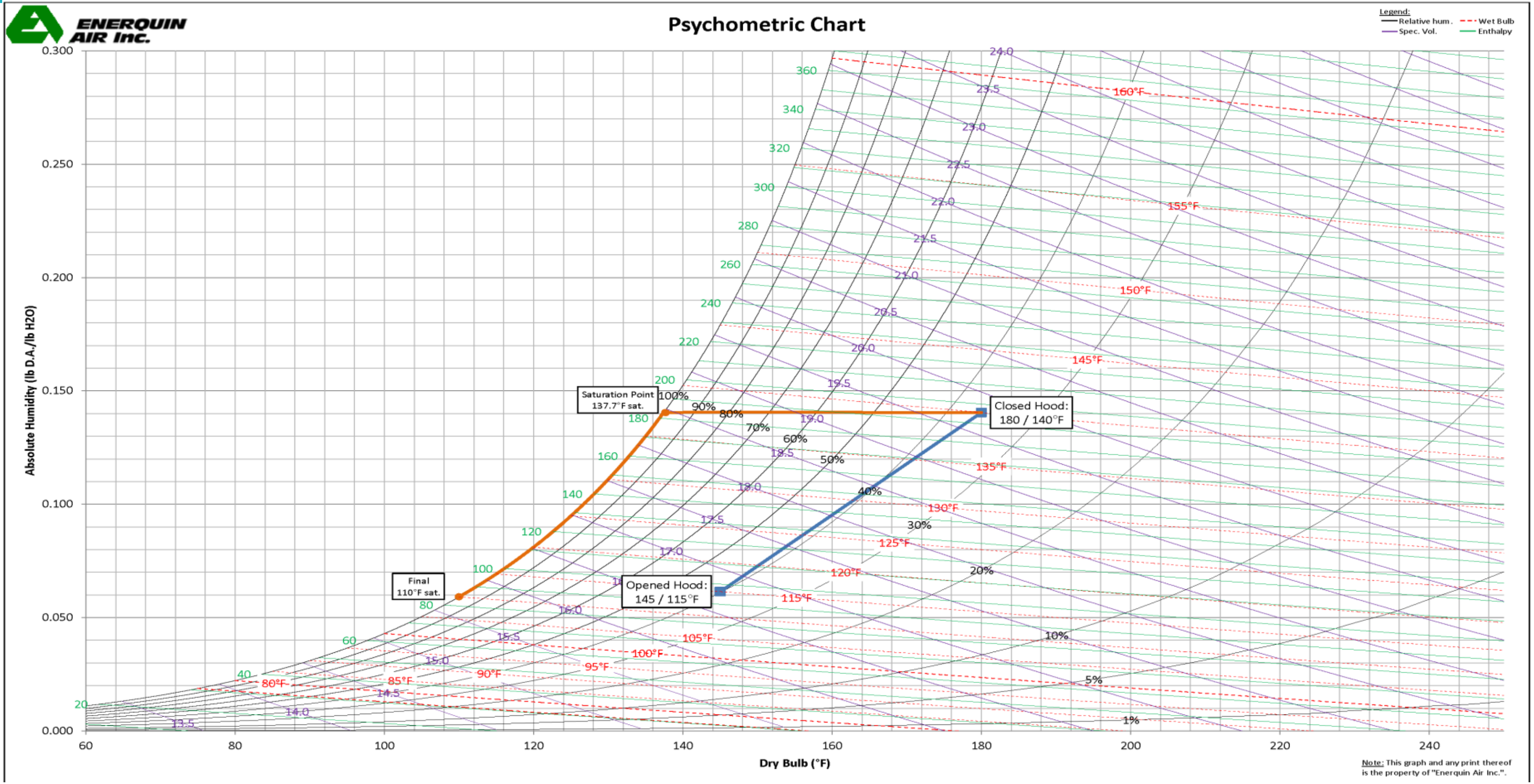

50 – 100 tons of air
1 ton paper

Poor building ventilation design or poorly-operated systems:

- Significant negative impact on paper mills profitability
- Rapid building deterioration

Well-designed building ventilation systems:

- Provide adequate PM room conditions
- Ensure comfortable working conditions throughout the entire machine room
- Combined with heat recovery units provides free or low cost heating
- Positive impact on paper mills profitability and sustainability


ENERQUIN AIR Inc.
Psychometric Chart
Legend:
Relative hum.
Wet Bulb
Spec. Vol.
Enthalpy
Absolute Humidity (lb D.A./lb H2O)
Dry Bulb (°F)
Saturation Point
137.7°F sat.
Closed Hood:
180 / 140°F
Opened Hood:
145 / 115°F
Final
110°F sat.
Note: This graph and any print thereof is the property of "Enerquin Air Inc.".

Negative Building Balance

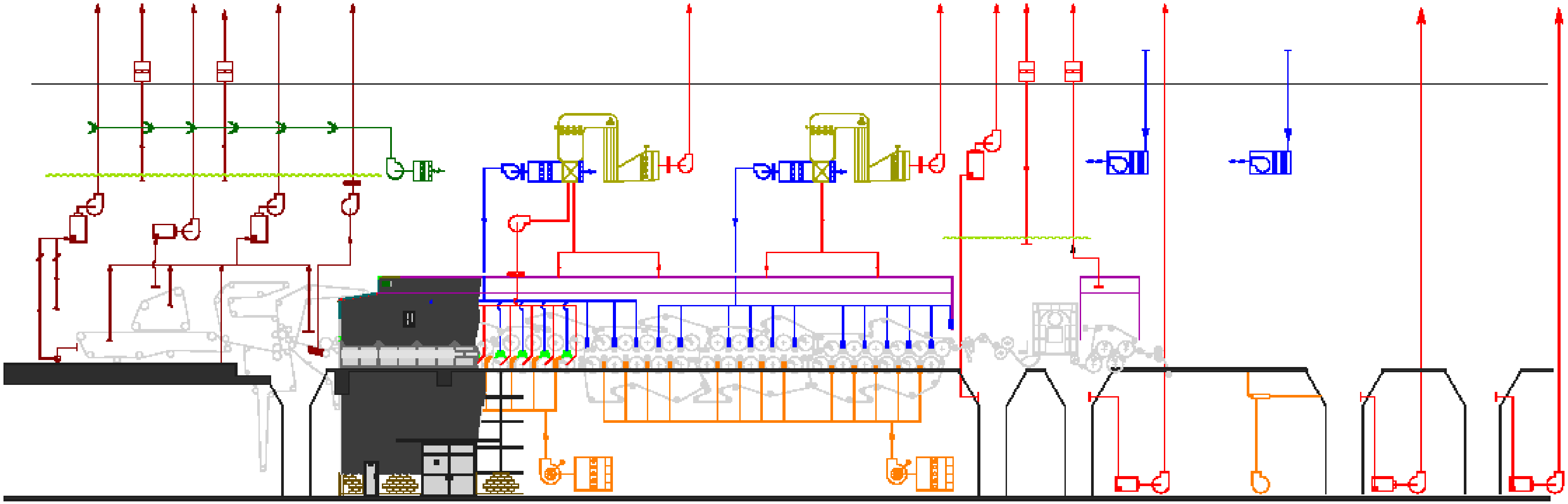
Step 1: Establish the required Wet-End ventilation
→ Former Exhaust: exhaust as much as possible at the source
→ False Ceiling Exhaust System

Step 2: Assess the need for roof exhausters to provide desired room air change rate during summer time.

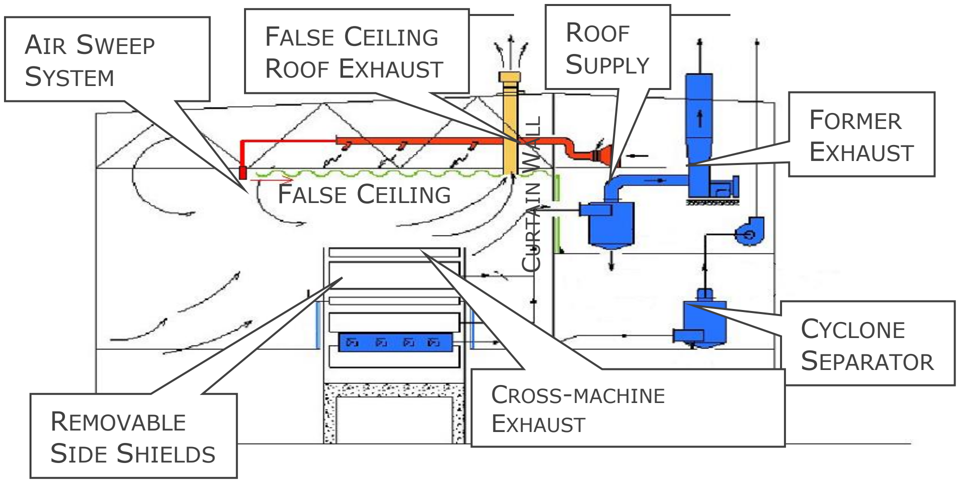
Step 3: Determine required fresh air supply mass to obtain desirable machine room air balance

Step 4: Identify heat recovery potentials to provide free or low cost heating (PM exhaust, turbo blower, flue gas stack, etc).

Air Balance Measurements



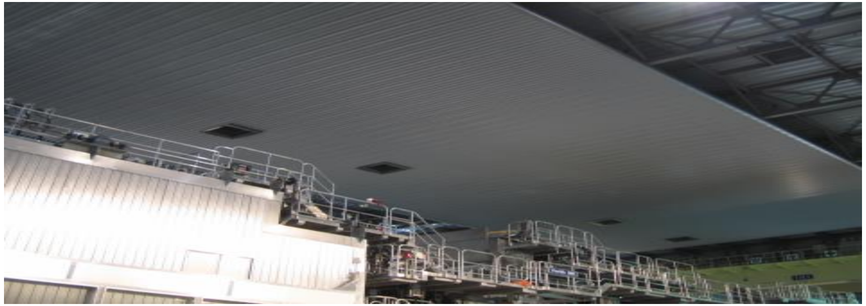
Former Exhaust



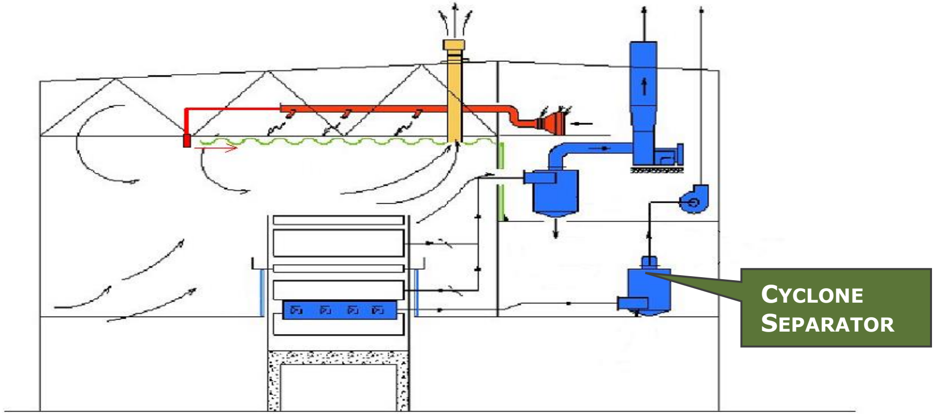
Overall Wet End Ventilation

WET END & PRESS SECTION AIR SYSTEMS
A comprehensive approach to control mist and ensure machine cleanliness

False Ceiling system protects building structure and avoid dripping



Wet End Ventilation



Overall Wet End Ventilation

TYPICAL VERTICAL SEPARATORS

TYPICAL HORIZONTAL SEPARATOR

Exhaust capacity: 200 to 600 CFM per inch of wire width. Depends on:

- BW
- Machine speed
- Former
- Stock temperature
- Type of former → Typical average capacity VS type of former:
    - Fourdrinier : 350 CFM / in. trim
    - Twin wire : 425 to 550 CFM / in. trim

Exhaust Fan

- Centrifugal Backward Incline (BI) wheel or radial blade wheel
- Axial wheel type <u>not recommended</u>

Water/Fiber removal device:

- Baffle type
- In-line type (spin eliminator)
- Cyclonic Type (inlet perpendicular to outlet)
  - Vertical or Horizontal

Cross-machine exhaust ducts

Former Exhaust Cross-Machine Pick-up

Former Exhaust Drive Side Pick-up

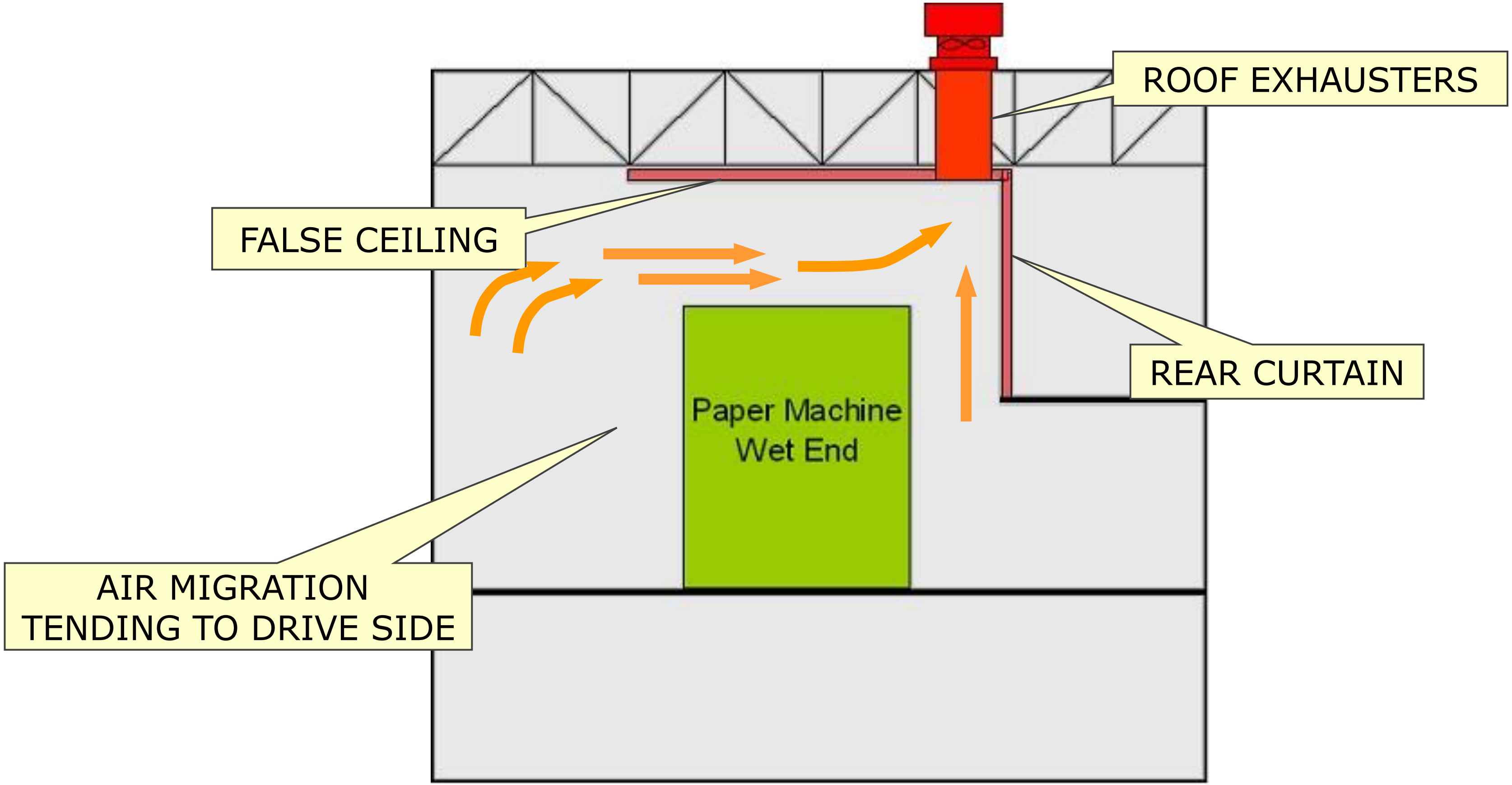
Cyclone Separator

Cyclone Separator

Wet End False Ceiling

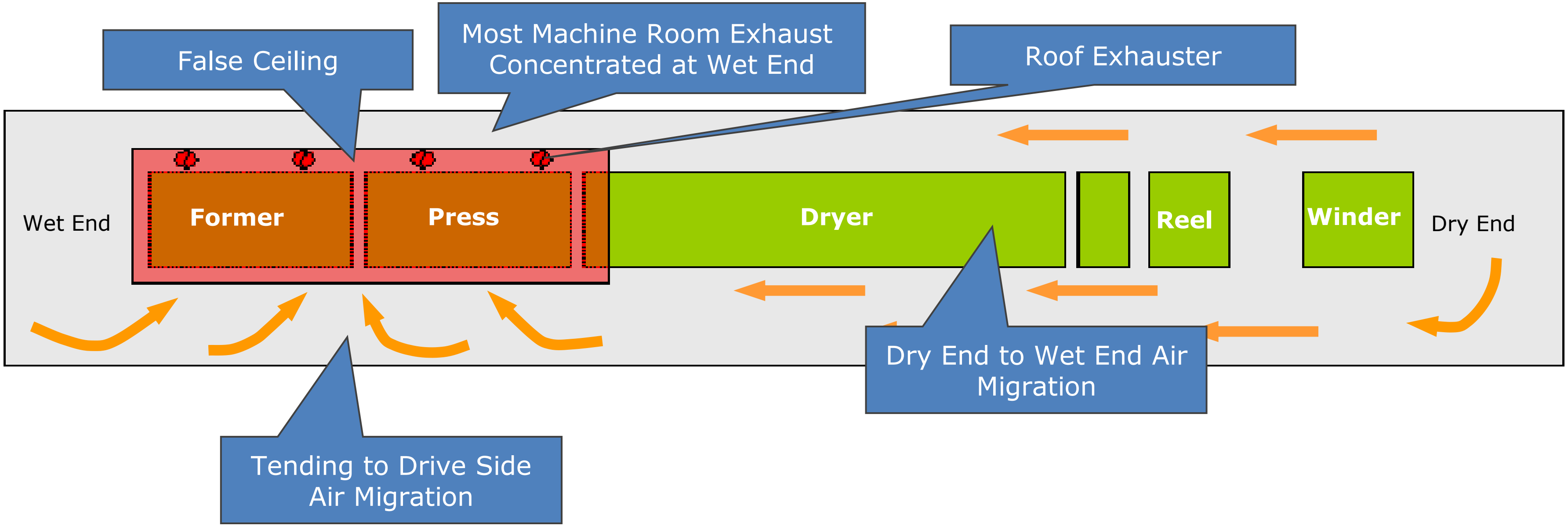
- **Roof Exhausters**
  - Extract air from underneath the false ceiling at the backside
- **WE Roof Supply**
  - Hot air supplied between building roof and false ceiling
  - This area must be kept under positive pressure
  - Air temperature > Stock temperature

Wet End False Ceiling



Wet End False Ceiling

PM Room Ventilation Strategy



$$\boldsymbol{Air\ Balance} = \frac{\boldsymbol{Air\ Mass\ Supply}\ (\#\ \boldsymbol{D.A./min})}{\boldsymbol{Air\ Mass\ Exhaust}\ (\#\boldsymbol{D.A./min})}$$

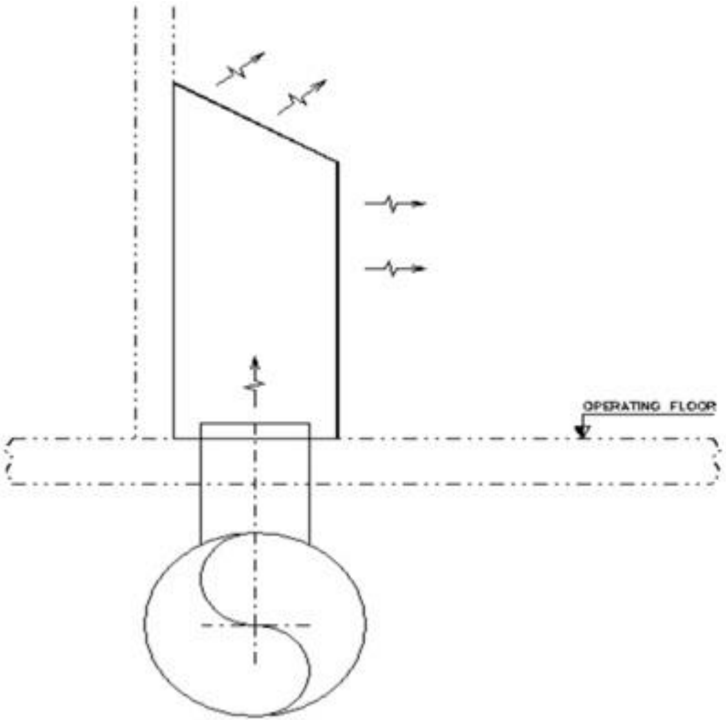
Target Air Balance
Summer: 65% to 75%
Winter: 90% to 100%

Recommended Air Change Rate (a/c)
Summer: 8 to 10
Winter: 6 to 8
Wet End: 35 to 55
→ greater than overall building A/C rate to promote DE to WE air flow
→ slightly lower in winter
→ varies according to machine room layout, production, type of former, etc.

Enerquin Air Make-up Air Flow Distribution Concept

- **Provide proper fresh air distribution to promote desirable air movement:**
  - Air migration from the DE to the WE of the machine room.
  - Air migration from lower elevation to upper elevation
  - Air migration from tending side to backside of the P.M.

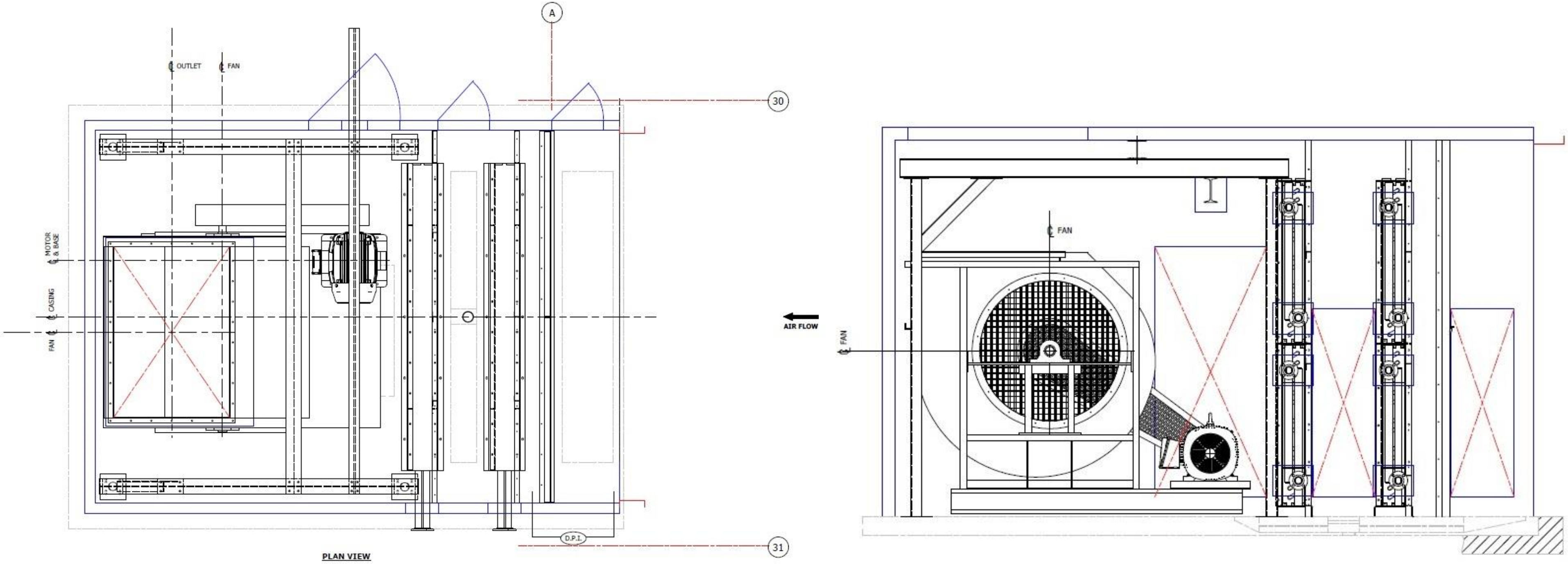
- **The fresh air distribution should generally be distributed as follows:**
  - 40% on the operating floor at tending side aisle
  - 15% on the back side of the operating floor
  - 25% on the basement floor
  - 10% in specific working areas such as winder areas, etc.
  - 10% on the extreme W.E. wall



Building ventilation supply plenum

- Typically used on tending side, operating floor level
- Normally recessed between building columns
- Equipped with distribution grilles or fabricated from perforated metal for even distribution

Air Make-up Unit Configuration



Air Make-Up Unit

Air Make-Up Unit

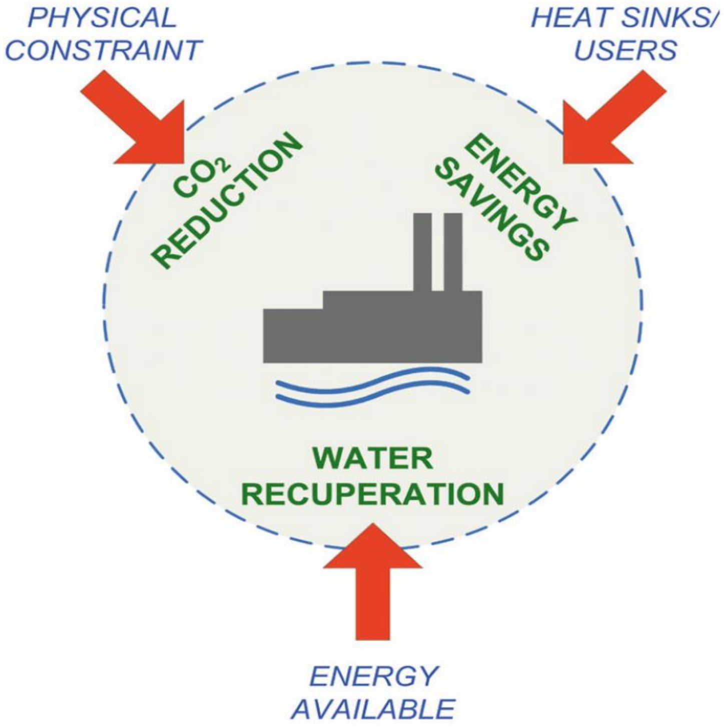
Objectives

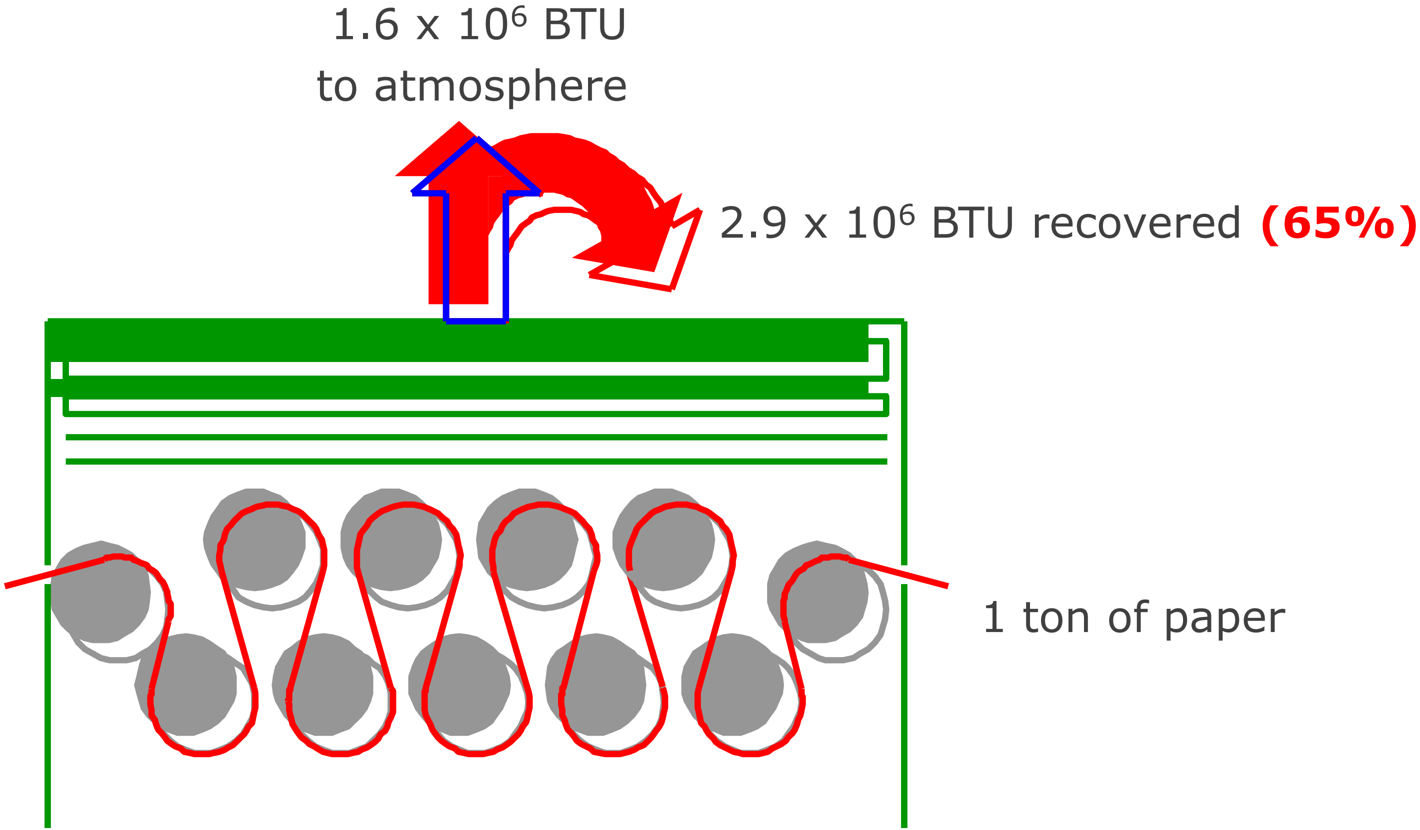
- Complete analysis of the building ventilation condition;
- Identify economically-viable potential sources of heat recovery;
- Build a maintenance punch list to re-establish ventilation system capacity;
- Overall paper machine building air balance for winter and summer modes;
- Determine PM building air changes per hour;
- Determine PM Wet End air changes per hour.
- Evaluate the general condition of all the air system equipment;
- Determine efficiency and performance of each air system and fan;

Procedure:

- Measure all air flow supplied to the building with corresponding temperatures (dry bulb & wet bulb);
- Measure all air flow exhausted to the atmosphere, including process exhaust systems, with corresponding temperatures (dry & wet bulb);
- Measure floor temperature at different locations and elevations throughout the building;
- Identify sources of air infiltration into the building (wall openings and open doors, etc.)

Each heat recovery application is unique and requires a specific analysis to identify and qualify the available heat sources, heat sinks and the best way to maximize the energy transfer while minimizing the capital investment. Further benefits include CO_2 reductions and recovered water.

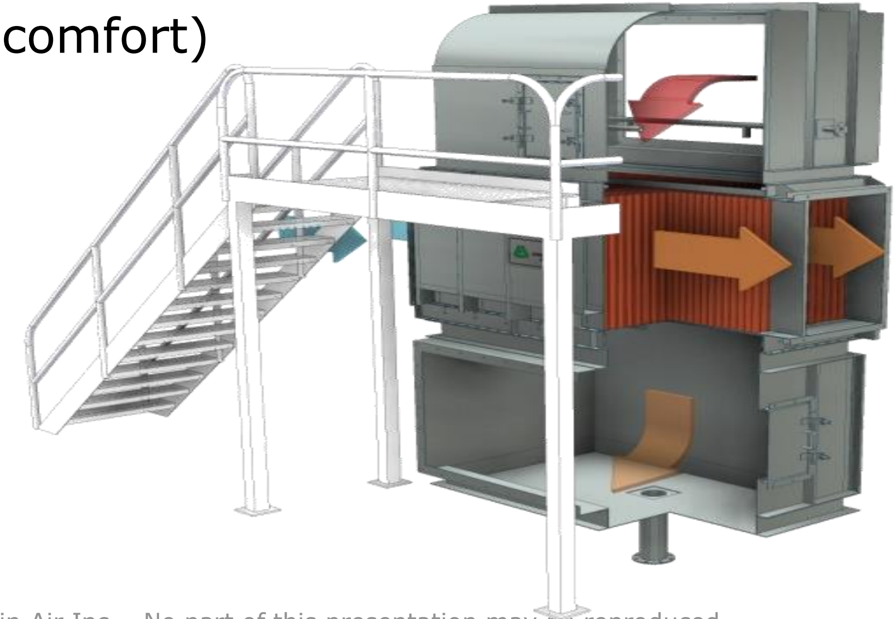



1.6 x 10^6 BTU
to atmosphere
2.9 x 10^6 BTU recovered (65%)
1 ton of paper

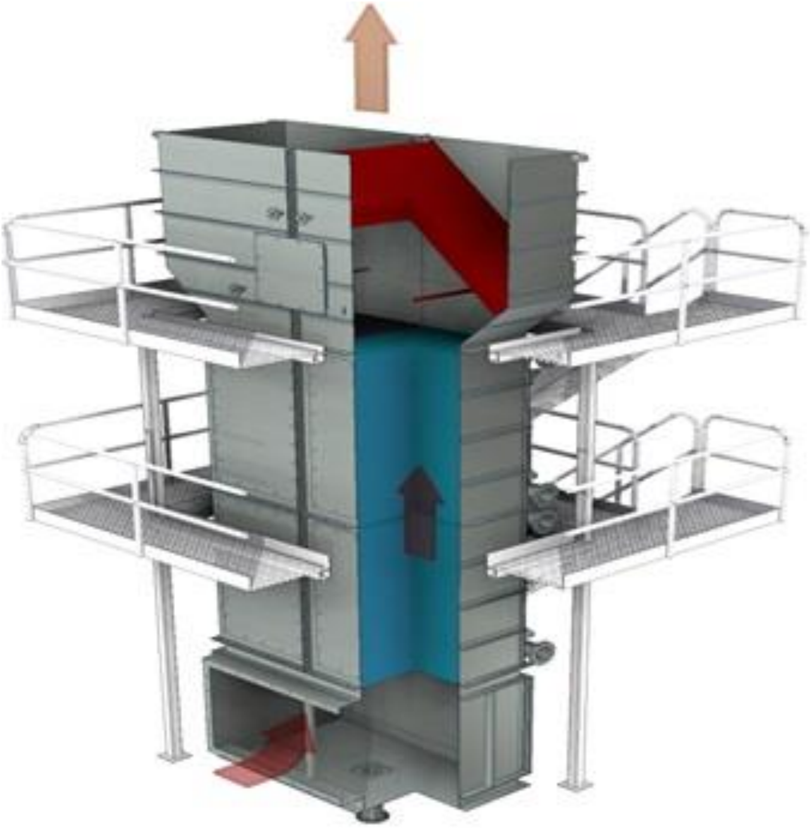
Recovers sensible heat (Dry HRU)

Pre-heating of **building ventilation air**:

- Running only during winter
- Temperature rise limited (Personnel comfort)



Indirect Air to Glycol

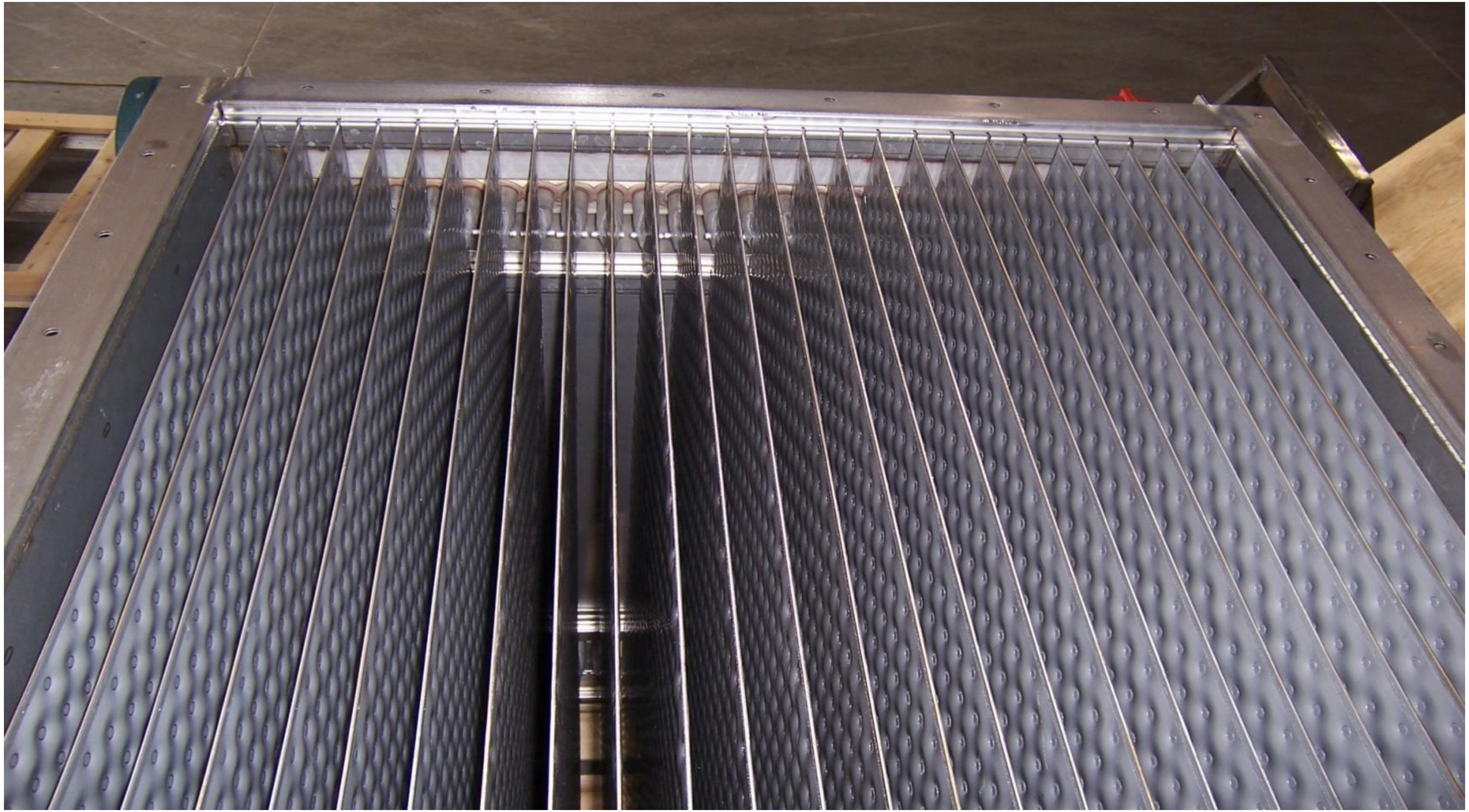


- Indirect type, no contact with contaminated air stream
- Applications:
  - Process & fresh water
  - Glycol solution & Thermo-fluids
- Wide gap plate design; minimize fouling
- *100 psig operating pressure*
- Cleaning showers reduces maintenance requirement

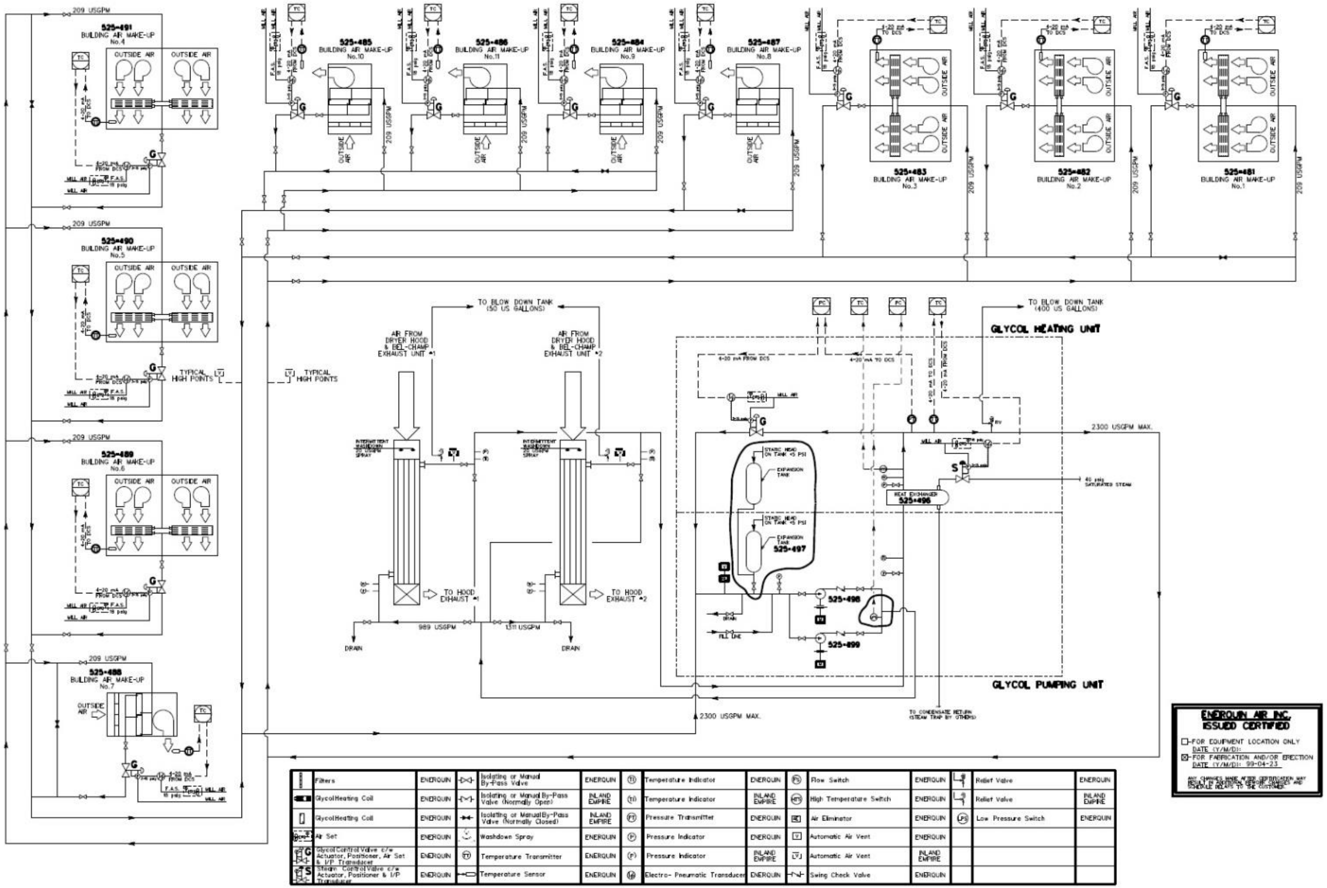
Design Considerations:

- Used for Wet Exchange only
- Maximum glycol/thermal oil temperature
- Typically U = 70 to 100 btu/hr-ft2-°Fr
- Try to maintain exhaust velocity ≥ 2000 fpm
- Try to keep plate spacing ≥ 1¼ in.
- Use counterflow arrangement
    - Ideally liquid flows up
    - Exhaust air goes down
- Provide cleaning spray nozzles on top
- Provide hinged access panel for maintenance
- Maximize plate length to optimize cost
- Requires water eliminator section after plates

Glycol Plates



P&ID Glycol Heat Recovery System



Glycol Pumping Station

The amount/type of dust produced depends on

- Product type
- Machine speed

The problem with dust buildup

- Finished product quality
- Fire hazard
- Maintenance/cleaning

Enerquin Air Machine Room Ventilation Concept

- Proper distribution of make-up air between operating floor, mezzanine and basement promoting desirable air migration.
- Pressurize basement
- Pressurize mezzanine (where mechanical systems are) to prevent dust from migrating there
- Pressurize false ceiling

Air Movement:

Supply and building exhaust airflows designed and balanced such that there will be no cross flow along the length of machine

- ❖Wet humid air will not travel to dry end and vice versa
- ❖Minimize paper dust dispersion from the dry end area (even with dust collection system, dust will be present)

Makeup air flow distribution:

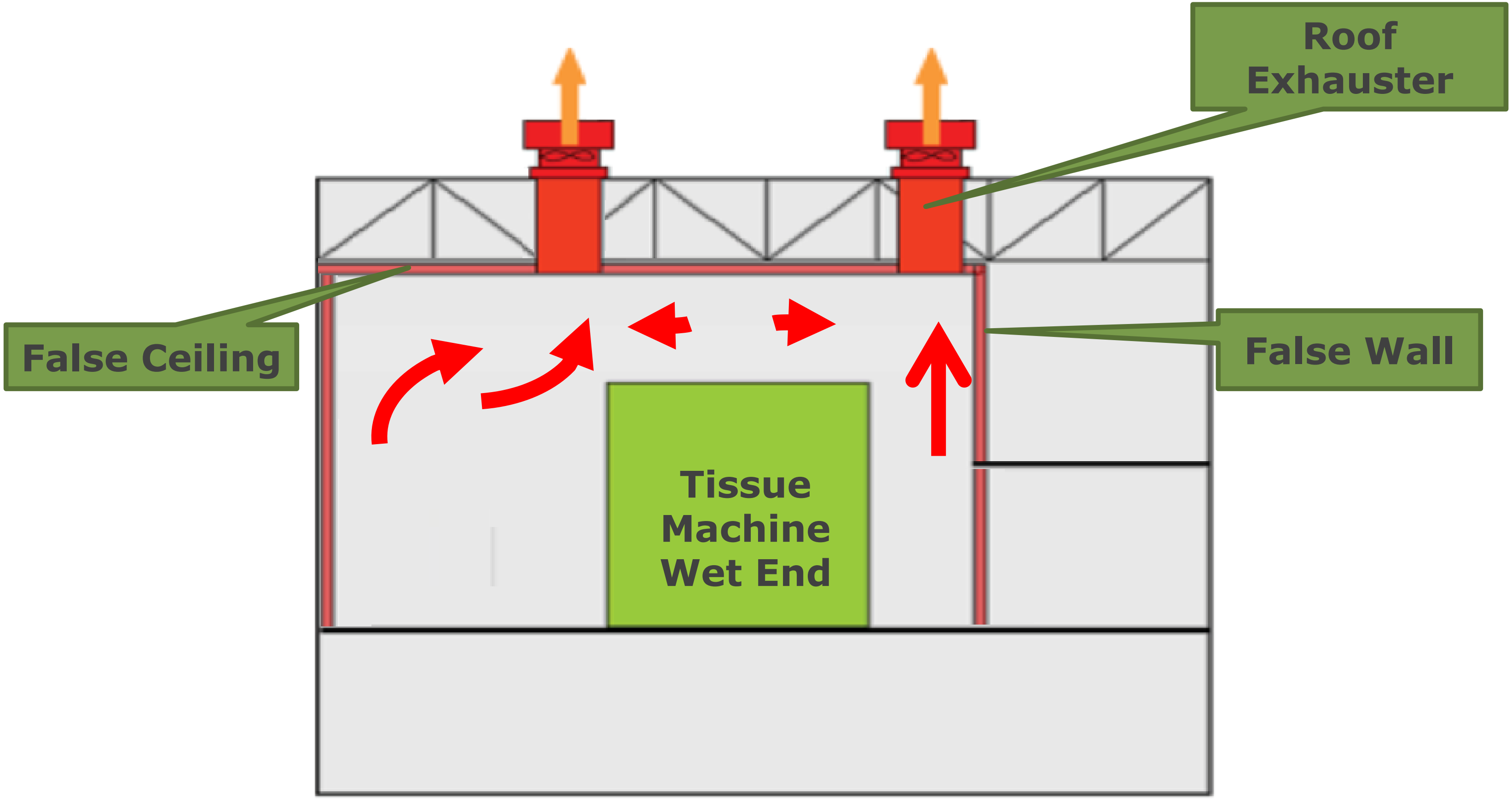
- **Basement**
  - ~15% to 20% of total supply
  - Ductwork

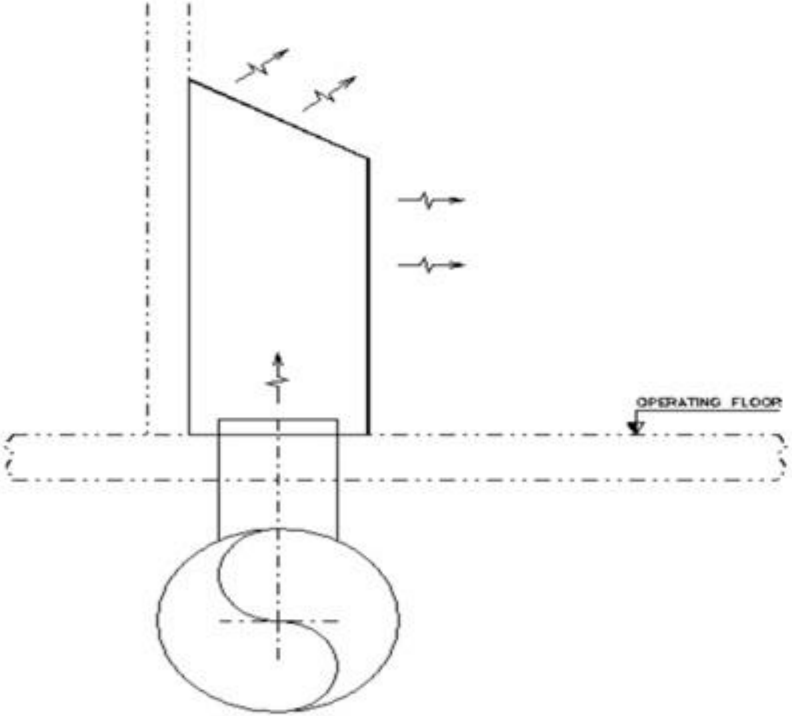
- **Operating Floor**
  - ~60% to 65% of total supply
  - Wall plenum at floor level around perimeter of machine room

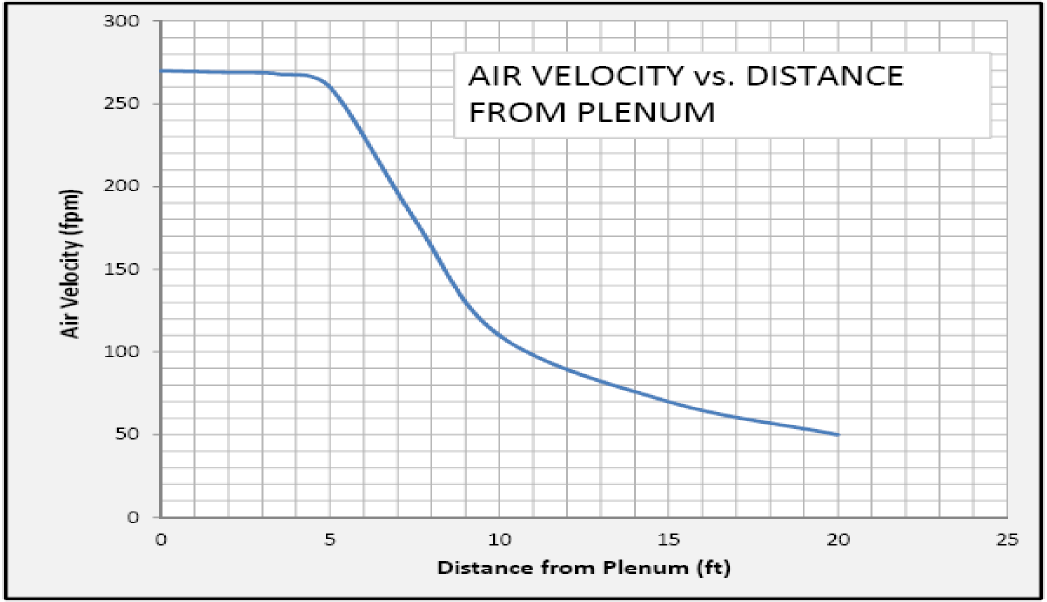
- **Mezzanine**
  - ~20% of total supply
  - Ductwork

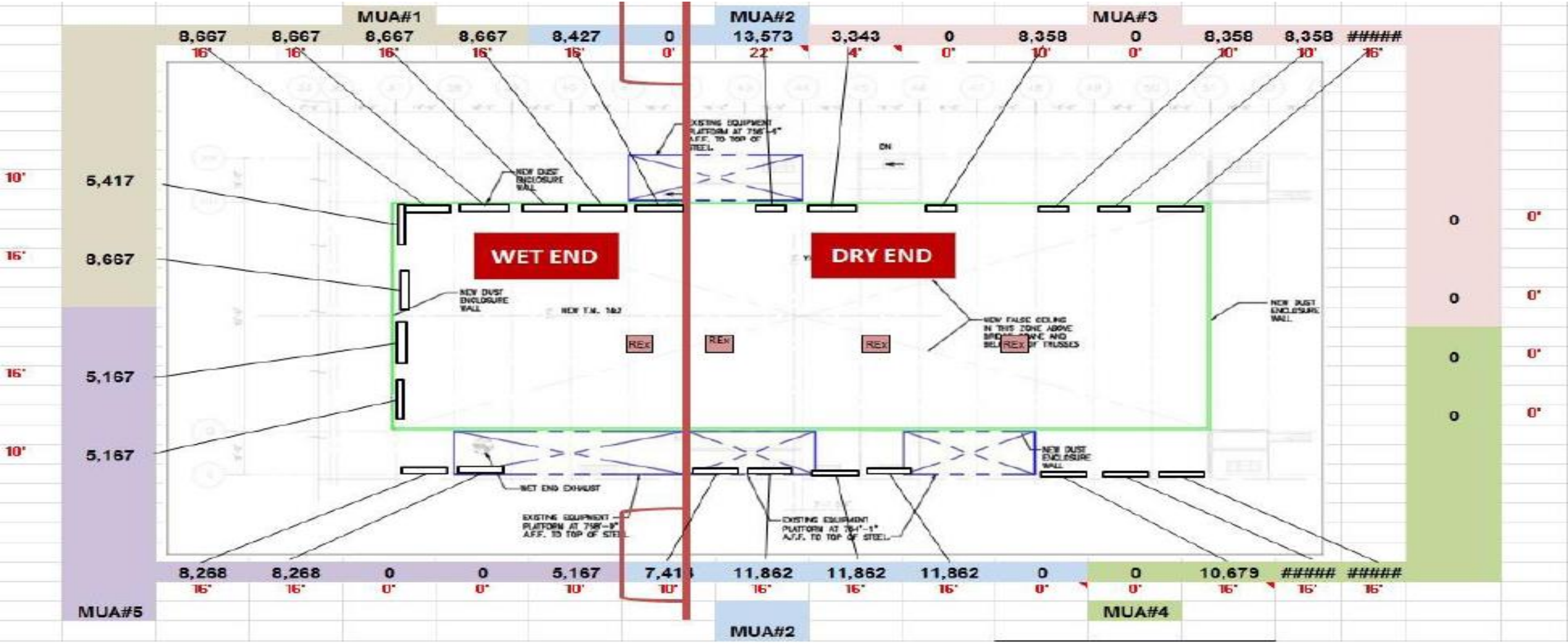
False Ceiling: From wet end to the dry end of TM room

False Wall: From operating floor to ceiling on complete perimeter of building


Roof
Exhauster
False Ceiling
False Wall
Tissue
Machine
Wet End


OPERATING FLOOR


AIR VELOCITY vs. DISTANCE FROM PLENUM
Air Velocity (fpm)
300
250
200
150
100
50
0
0
5
10
15
20
25
Distance from Plenum (ft)


MUA#1
MUA#2
MUA#3
MUA#4
MUA#5
8,667
16'
8,427
0
0'
13,573
22'
3,343
4'
8,358
10'
#####
5,417
5,167
8,268
7,41
11,862
10,679
WET END
DRY END
REx
NEW DUST ENCLOSURE WALL
WET END EXHAUST
EXISTING EQUIPMENT PLATFORM
NEW FALSE CEILING

Best Practices for Keeping Machine Rooms Clean

- Strategic location of dust removal equipment + maintain equipment
- Strategic location of building exhaust fans + maintian equipment
- Pressurize certain regions in machine room to prevent dust from migrating there
- Balance Dry End and Wet End pressure to reduce dust migration within the building

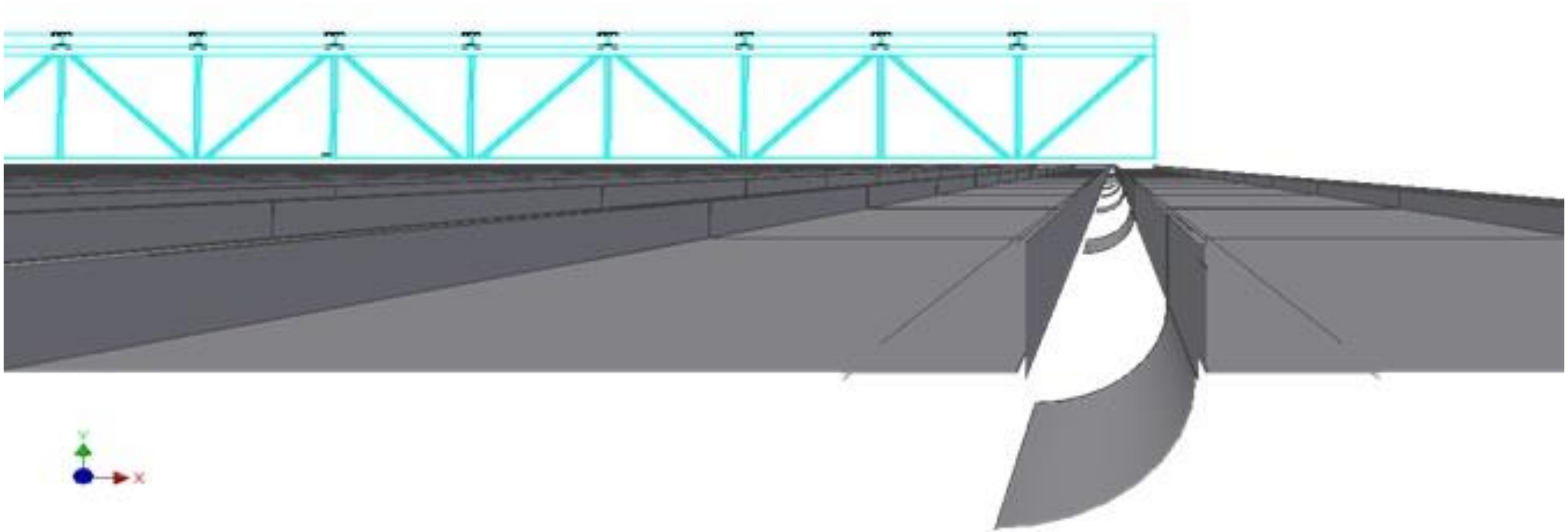
Case Studies

Case Study #1: Tissue Machine Room Upgrade

Problem:
- Preliminary degradation of machine room roof trusses at Wet End
- Fires

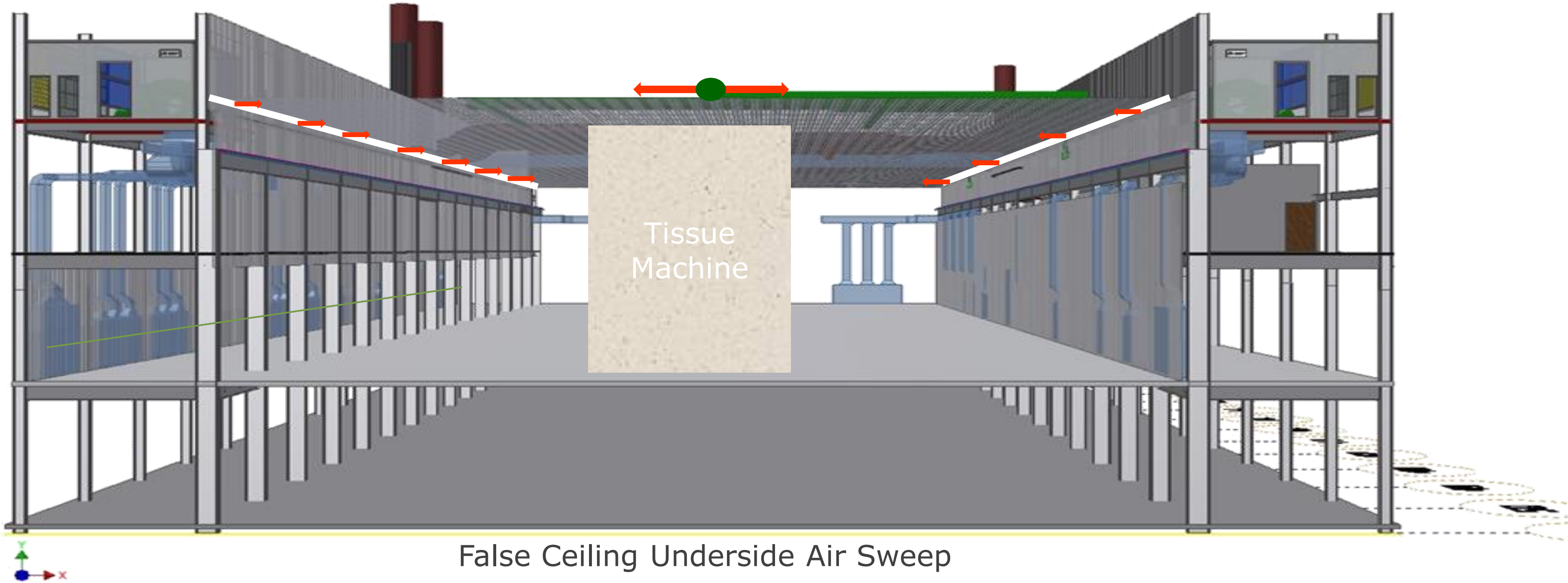
Solution:
- Installation of false ceiling c/w:
    - Roof supply system
    - Air sweep deflectors

Case Study #1: Tissue Machine Room Upgrade



Air Sweep Deflectors

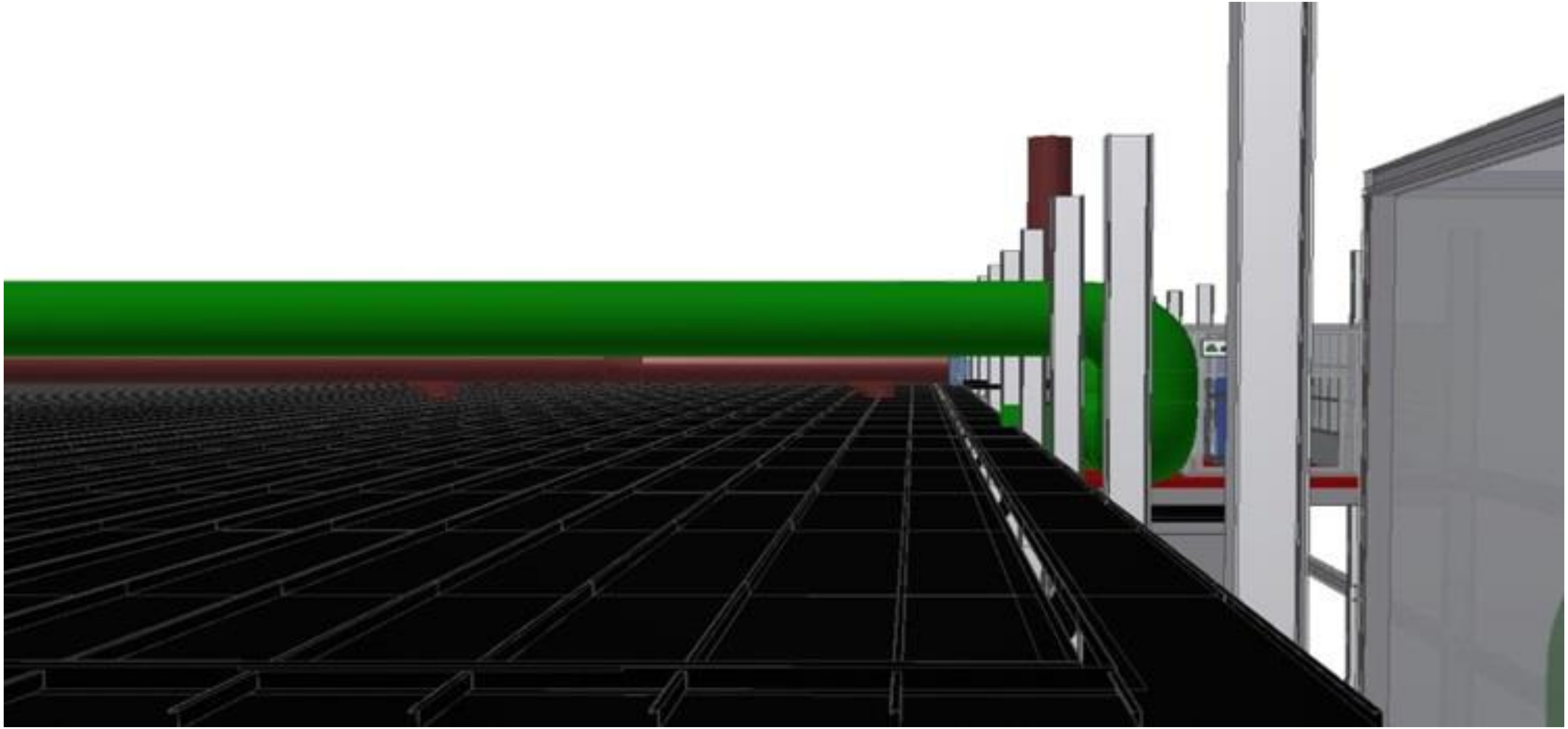
Case Study #1: Tissue Machine Room Upgrade



False Ceiling Underside Air Sweep

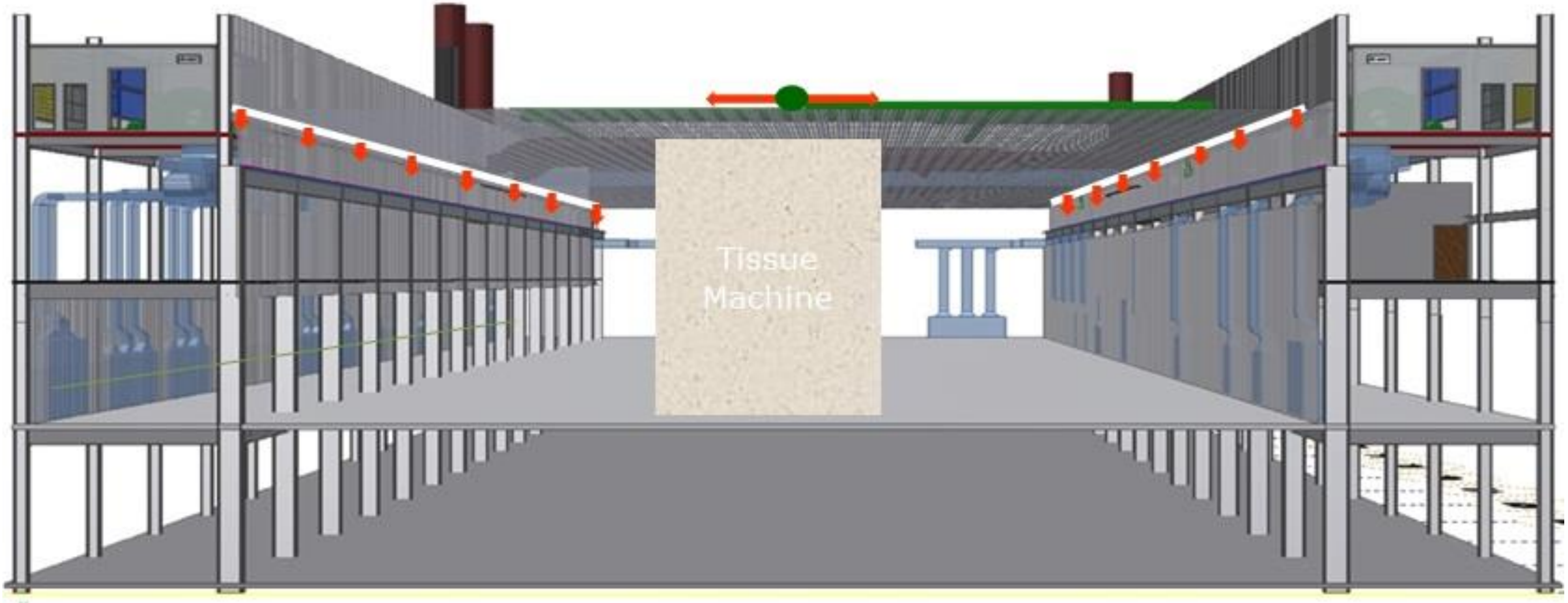
Case Study #1: Tissue Machine Room Upgrade

Case Study #1: Tissue Machine Room Upgrade



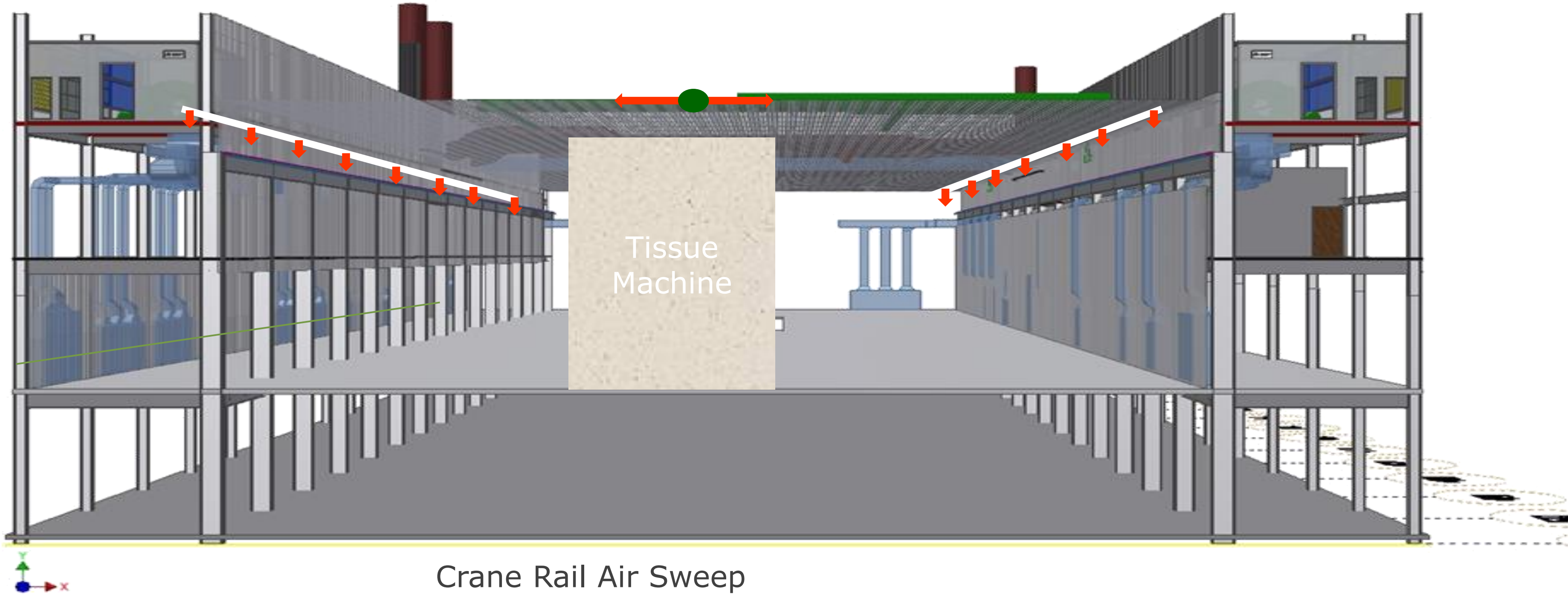
False Ceiling Peripheral Slots

Case Study #1: Tissue Machine Room Upgrade



False Ceiling Peripheral Slots

Case Study #1: Tissue Machine Room Upgrade

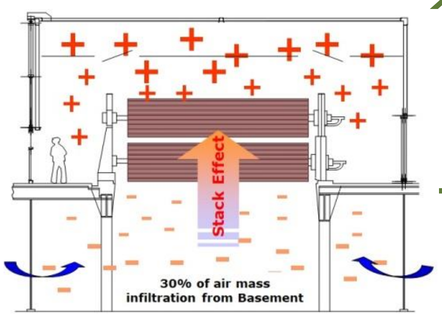


Crane Rail Air Sweep

Problem/Background:

- Linerboard machine with closed hood
- Mill located in Southeast USA
- Extremely high operating floor temperatures/humidity reported (20 degrees greater than ambient)

Case Study #2: Hot Machine Room Down South



Definition

Ratio of supplied air mass vs. exhausted air mass

Recommended Air Balance

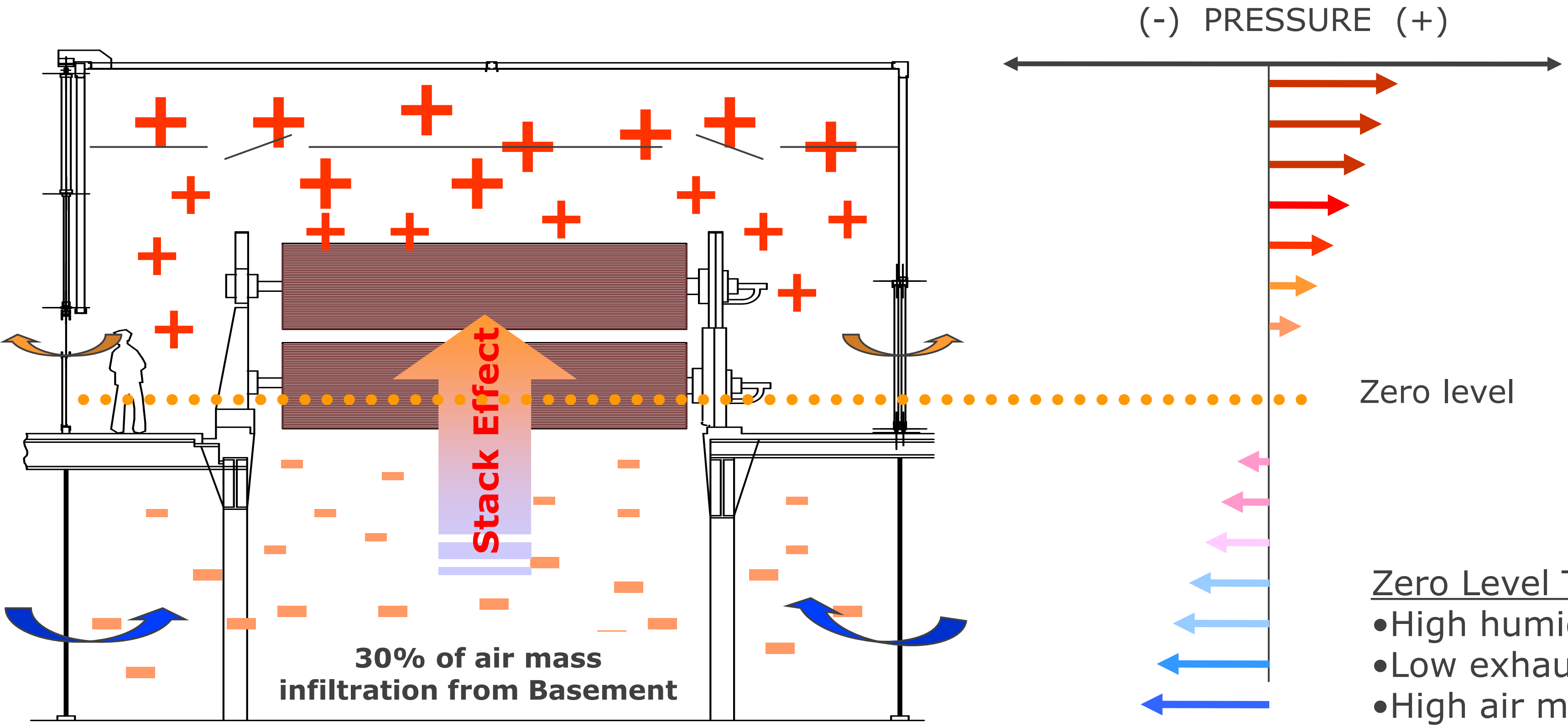
- Closed Hoods 65% to 75%
- Open Hoods 30% to 35%

Proper Air Balance

Zero level at 7 ft above operating floor

- ✓ Efficient operation
- ✓ Reduce air exhaust requirements
- ✓ Reduce energy usage
- ✓ Contain water vapors without spilling or condensation
- ✓ Reduce uncontrolled air currents which have adverse effect on runnability

Case Study #2: Hot Machine Room Down South



Hood Pressurized

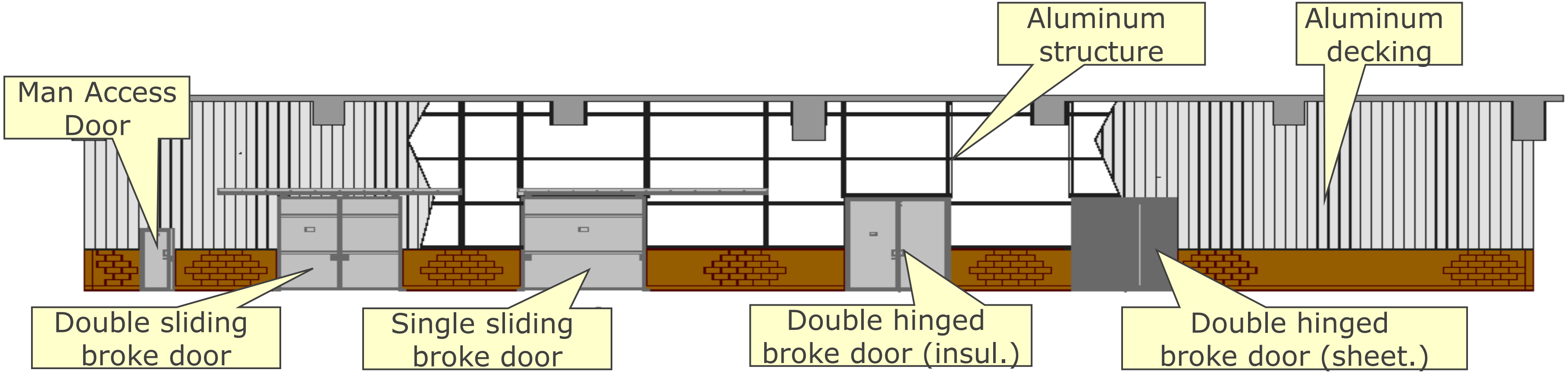
Zero Level Too Low:
- High humidity level
- Low exhaust
- High air make-up

Designed to work in conjunction with closed hood

- Minimize colder air infiltration
- Increase efficiency of the dryer section
- Ensure proper closed hood operation

Accessibility:
Broke removable door options
- Double or single sliding
- Double hinged
- Roll-Up door

Man access doors



Case Study #2: Hot Machine Room Down South

Basement Enclosure Challenges

Results:

- 10F temperature drop on operating floor
- Typically, the goal is to be 5F greater than ambient, but this machine room had 2 machines.

Case Study #3: PM Upgrade Project

Problems:

- Machine room was under a negative balance
- Additional exhaust from upgrade project increased building negative
- Limited space available outside building for requisite make-up units

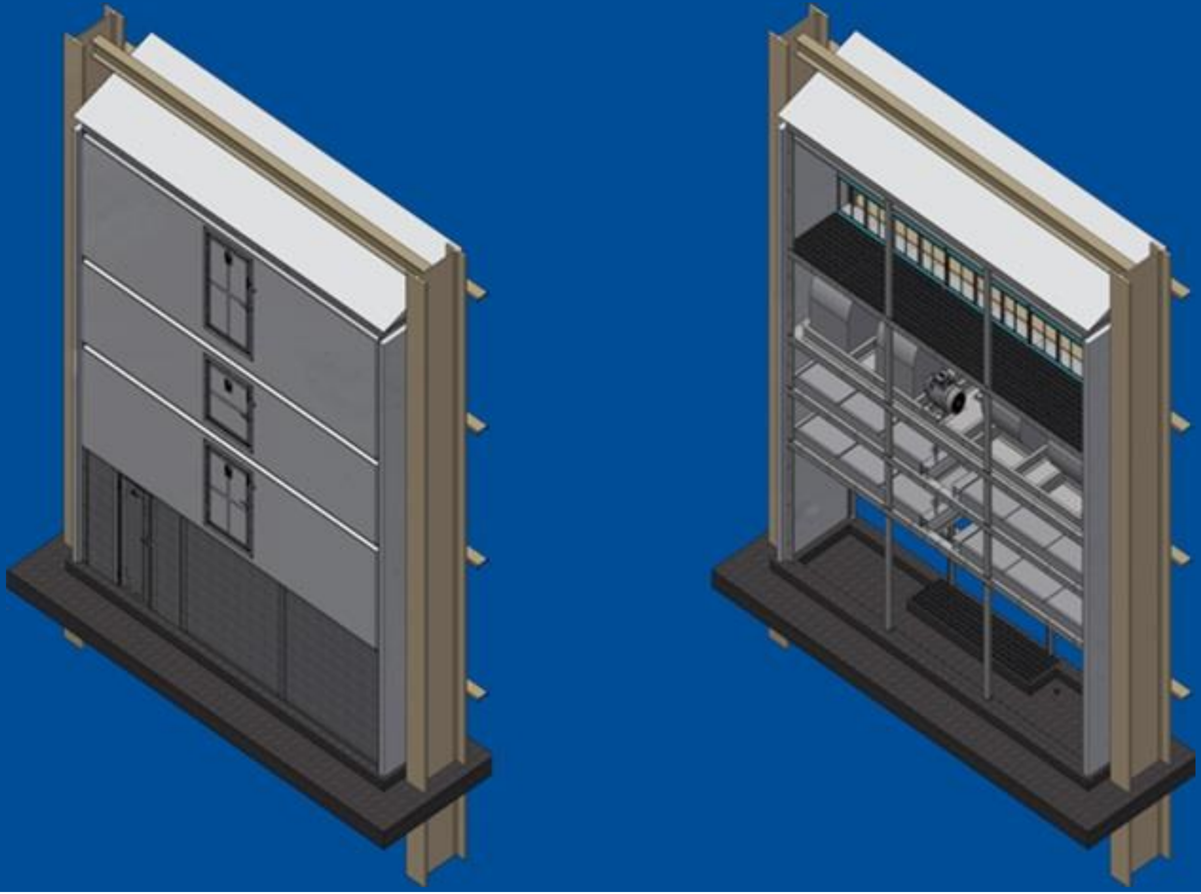
Solution:

- Installation of customized vertical make-up units (with no ductwork) between building columns

Results:

- Raised building balance to industry-standard levels

Case Study #3: PM Upgrade Project



Conventional Outdoor Air Make-up Unit

Case Study #4: Former Exhaust

Problem/Background:

- Mist around the forming area
- Condensation on building structure
- Fiber accumulation on machine
- Safety and maintenance issues
- Reduced machine Efficiency
- Dripping
- Deterioration
- Fogging during cold months

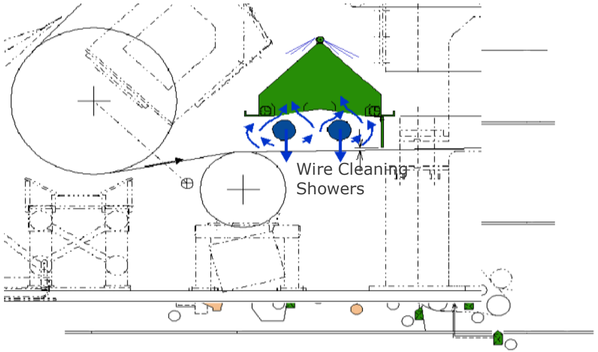
Solution and Approach

- Exhaust mist efficiently (capture at source)

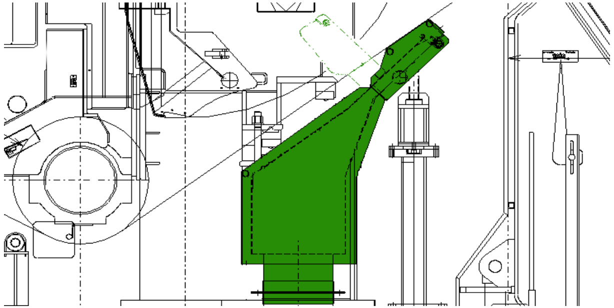
→ Vapor not captured at the source requires 2x capacity to exhaust at false ceiling level

Case Study #4: Former Exhaust

Inside wire loop

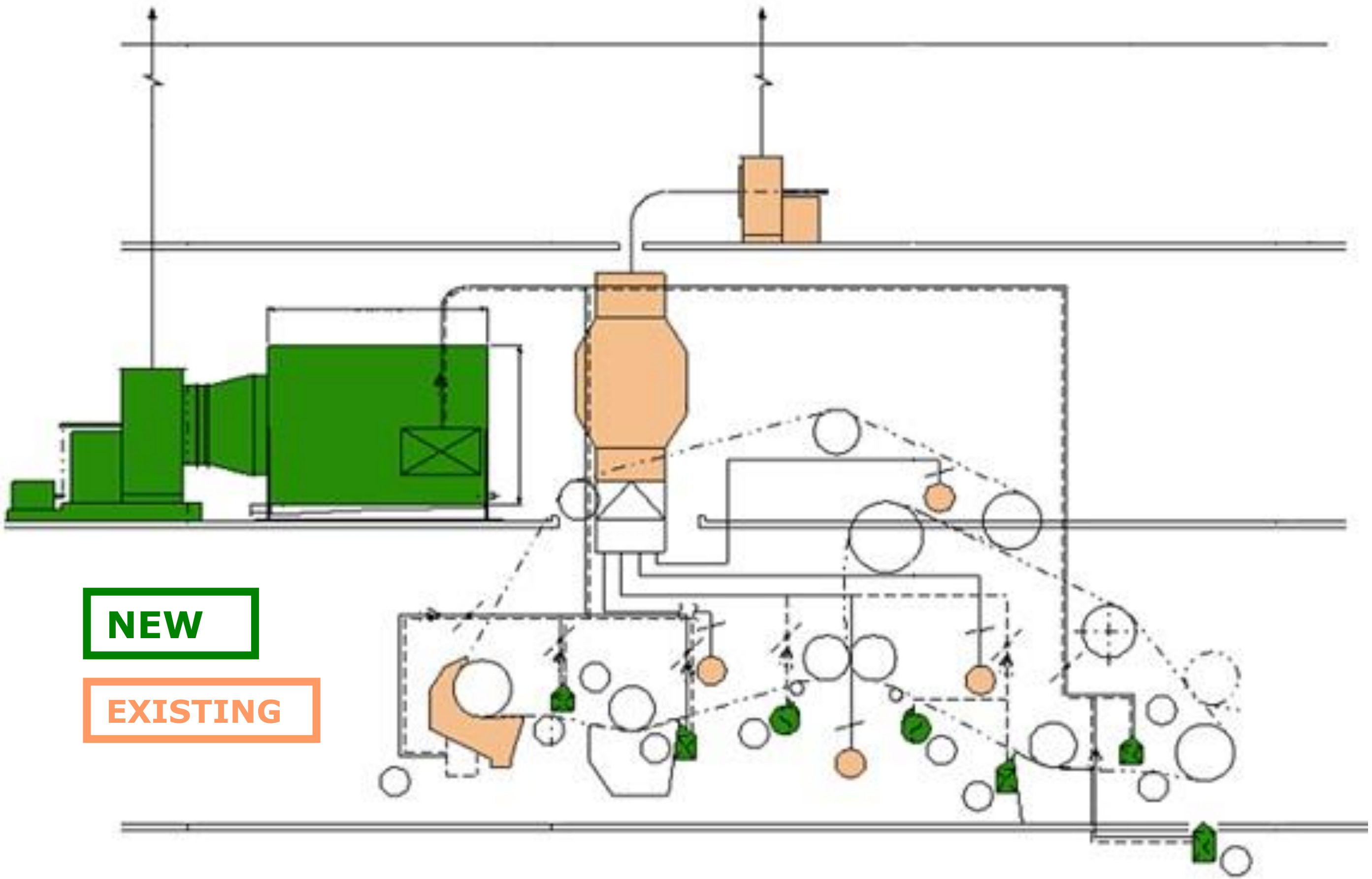


Outside wire loop



Typical Cross-Machine Duct

Case Study #4: Former Exhaust



Performance Results

	Before	After
Humidity (lb. H_2O/lb. Dry Air)	0.025	0.0085
Mass Flow Out of PM (lb. H_2O/lhr.)	18.17	7.83

→ 50% reduction in water mass flow dispersed in machine room

Case Study #4: Former Exhaust

SYSTEM OFF

SYSTEM ON

Thank you for your attention!

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