BCxA Building Commissioning Association

From Fumes to Function:
A Commissioning Success Story

Hardik Miyani, PE, CEM, CRE, CPHC, LEED Green Associate

Energy and Decarbonization Project Manager, Baumann Consulting

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Course Description

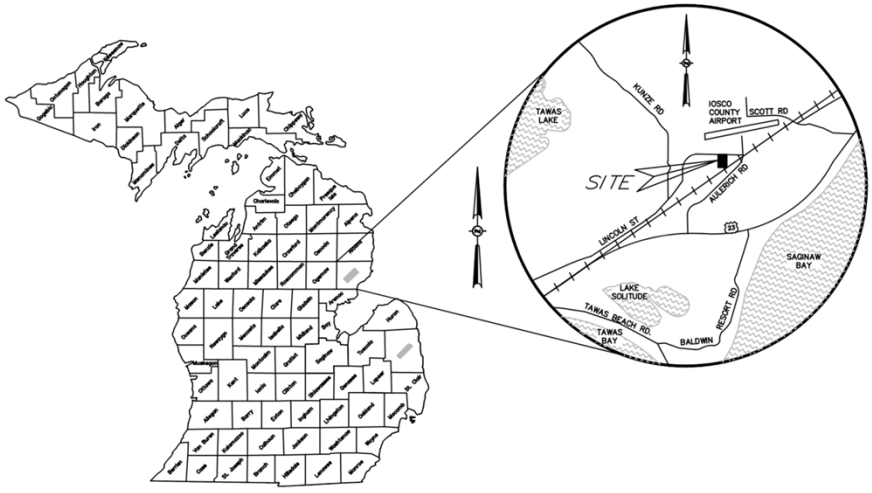
Proper building pressurization is essential to protect occupants, maintain air quality, and ensure energy efficiency. This case study details how commissioning resolved an industrial facility's issue of CO and NO_2 from a vehicle garage infiltrating office areas. Using Integrated System Testing (IST), all mechanical, electrical and control systems were evaluated under seasonal conditions. Commissioning activities included smoke and pressurization testing, sensor calibration, and sequence validation. Staff were trained, and an SOP was developed for long-term compliance. The presentation demonstrates commissioning as a proactive, data-driven process that enhances safety, efficiency, and reliability in industrial facilities.

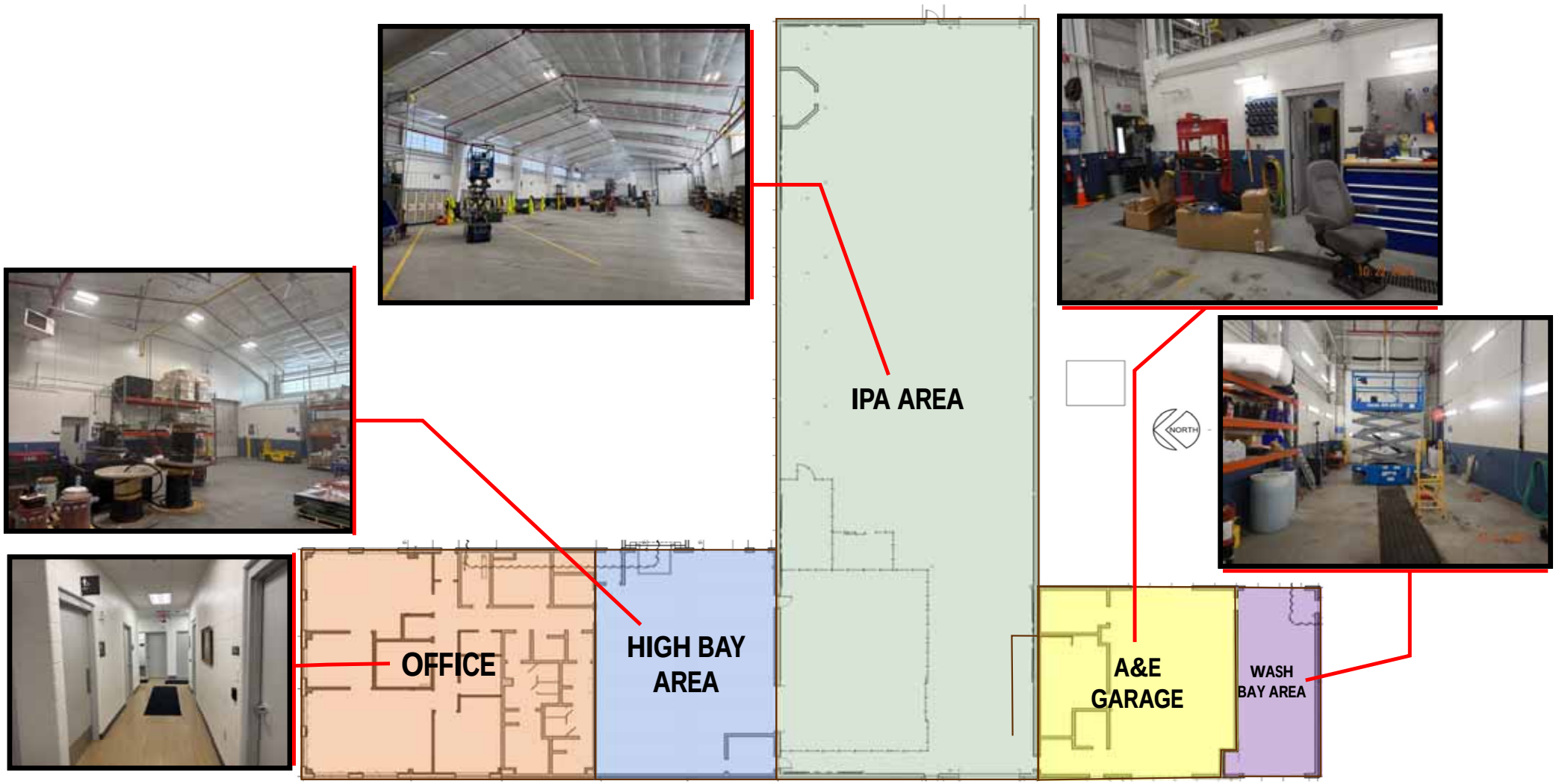
Learning Objectives

- Describe the impact of improper building pressurization on indoor air quality and occupant safety.
- Apply commissioning techniques, such as integrated system testing and smoke tests, to diagnose and resolve pressurization issues.
- Analyze the effectiveness of CO/NO_2 sensor testing and the sequence of operation in maintaining safe facility environments.
- Develop Standard Operating Procedures (SOPs) and staff training programs to sustain proper pressurization control.

Introduction

- Location: Tawas, MI
- Facility Type: Fleet Vehicle Industrial Facility
- Size: 22,000 ft² | 2,044 m²

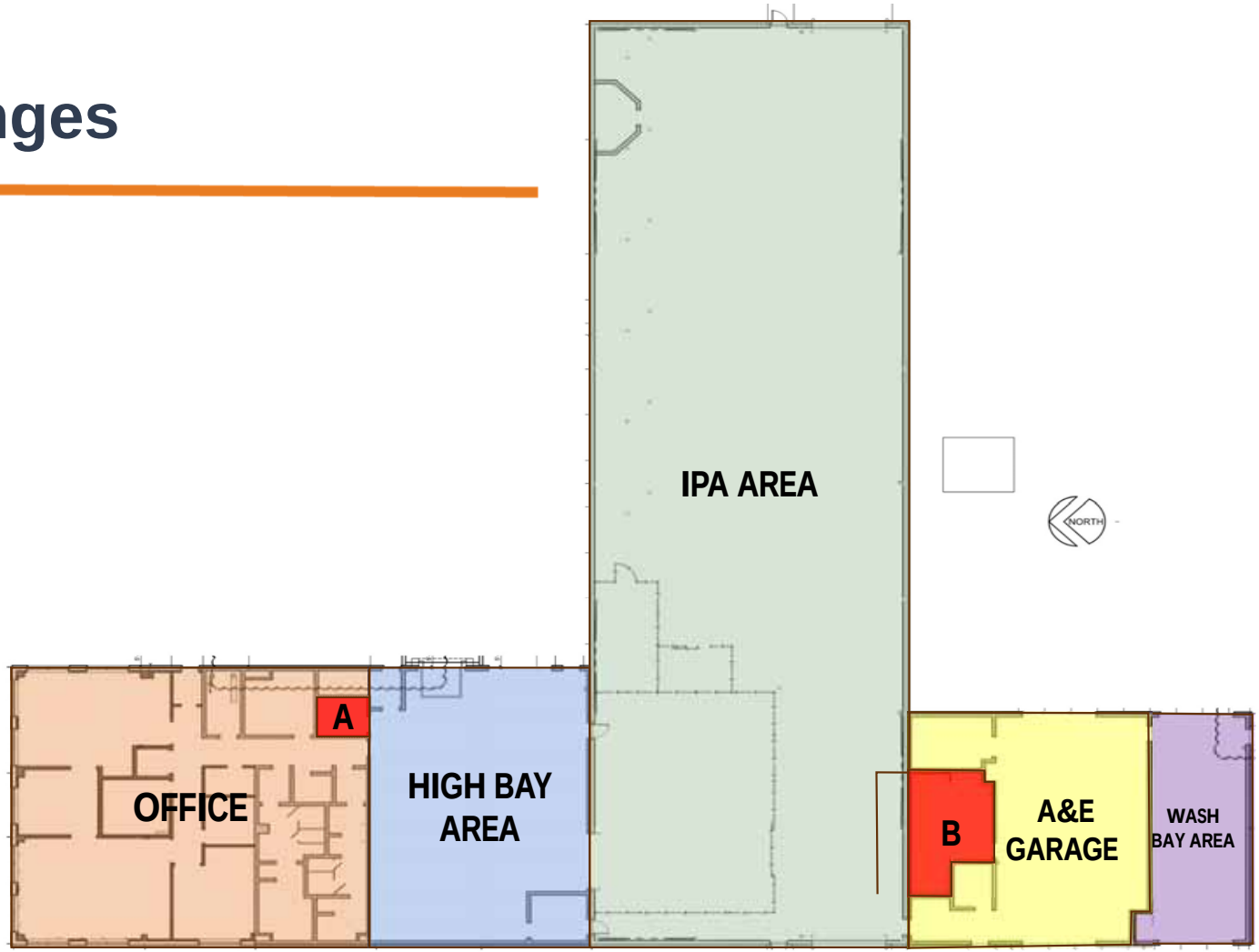



IPA AREA
OFFICE
HIGH BAY AREA
A&E GARAGE
WASH BAY AREA
NORTH

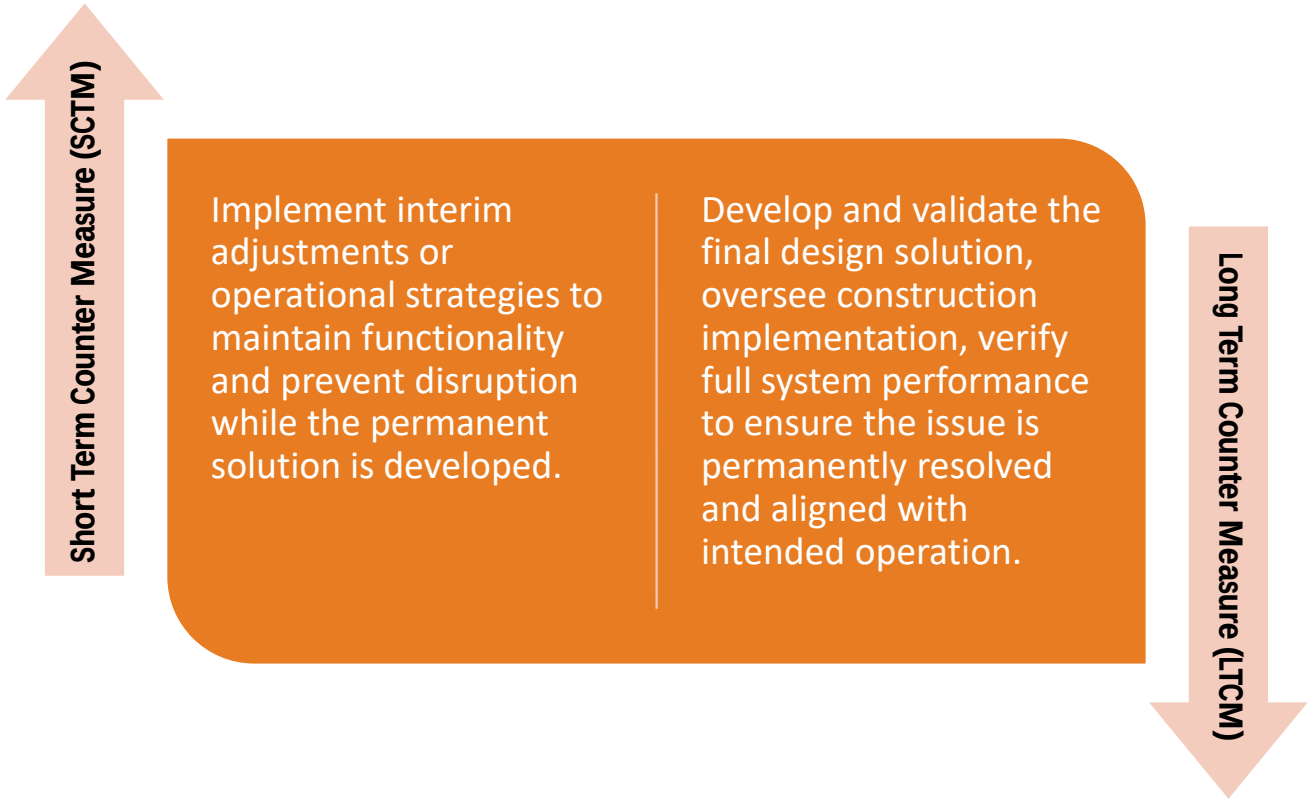
Challenges

- Signs of vehicle smoke exhaust found in the office.
- Multiple staff members fainting on site, leading to serious health and safety concerns on site.

Challenges

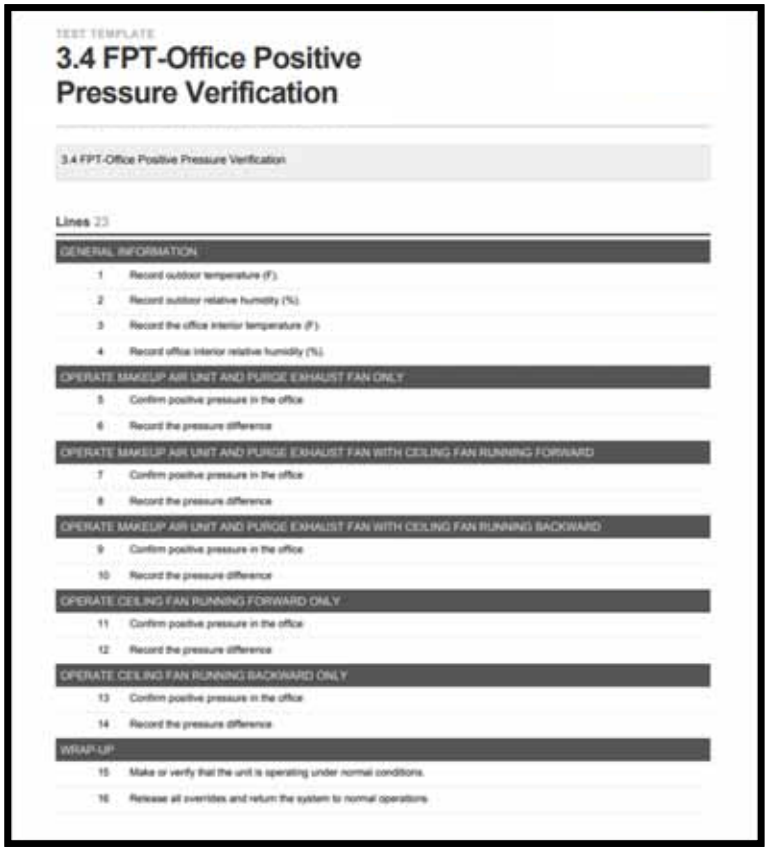

IPA AREA
NORTH
A
OFFICE
HIGH BAY AREA
B
A&E GARAGE
WASH BAY AREA

Solution


Short Term Counter Measure (SCTM)
Implement interim adjustments or operational strategies to maintain functionality and prevent disruption while the permanent solution is developed.
Develop and validate the final design solution, oversee construction implementation, verify full system performance to ensure the issue is permanently resolved and aligned with intended operation.
Long Term Counter Measure (LTCM)

Design Phase

- Design review
  - Design codes missing
  - Incomplete SOO of existing equipment's
  - Missing equipment's
  - Incorrect location of equipment's
- Developed SOO for building pressurization test



TEST TEMPLATE

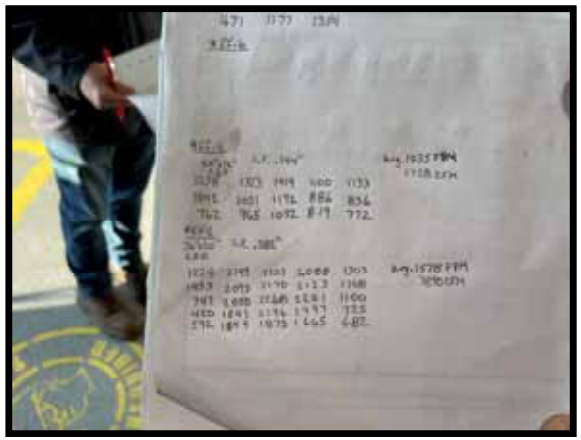
3.4 FPT-Office Positive Pressure Verification

3.4 FPT-Office Positive Pressure Verification

Lines 23

GENERAL INFORMATION	
1	Record outdoor temperature (F).
2	Record outdoor relative humidity (%).
3	Record the office interior temperature (F).
4	Record office interior relative humidity (%).
OPERATE MAKEUP AIR UNIT AND PURGE EXHAUST FAN ONLY	
5	Confirm positive pressure in the office
6	Record the pressure difference
OPERATE MAKEUP AIR UNIT AND PURGE EXHAUST FAN WITH CEILING FAN RUNNING FORWARD	
7	Confirm positive pressure in the office
8	Record the pressure difference
OPERATE MAKEUP AIR UNIT AND PURGE EXHAUST FAN WITH CEILING FAN RUNNING BACKWARD	
9	Confirm positive pressure in the office
10	Record the pressure difference
OPERATE CEILING FAN RUNNING FORWARD ONLY	
11	Confirm positive pressure in the office
12	Record the pressure difference
OPERATE CEILING FAN RUNNING BACKWARD ONLY	
13	Confirm positive pressure in the office
14	Record the pressure difference
WRAP-UP	
15	Make or verify that the unit is operating under normal conditions.
16	Release all overrides and return the system to normal operations.

Space Pressurization Test

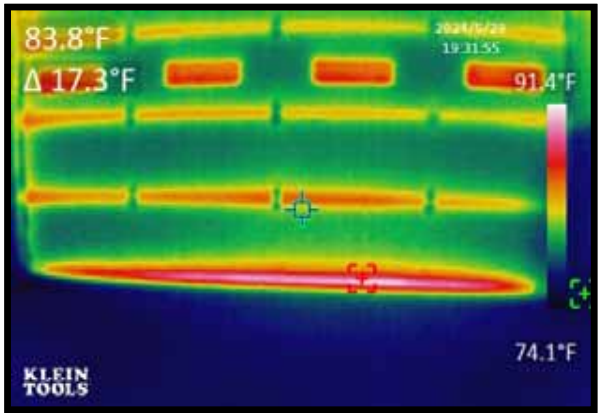


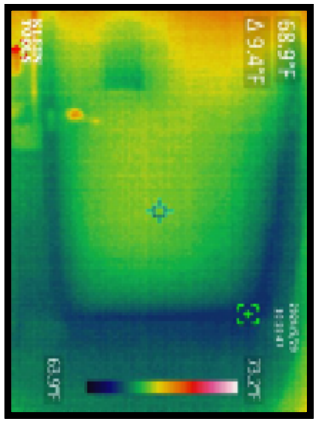
Space Pressurization Test Results

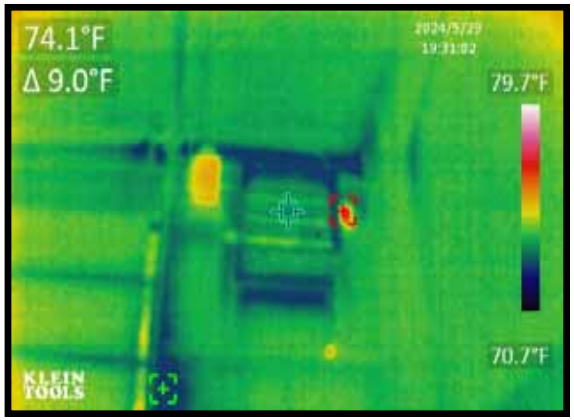
OFFICE A

OFFICE B

Issues Identified with Existing Systems







Issues Identified with Existing Systems

Phase 2: Integrated System Testing (IST)

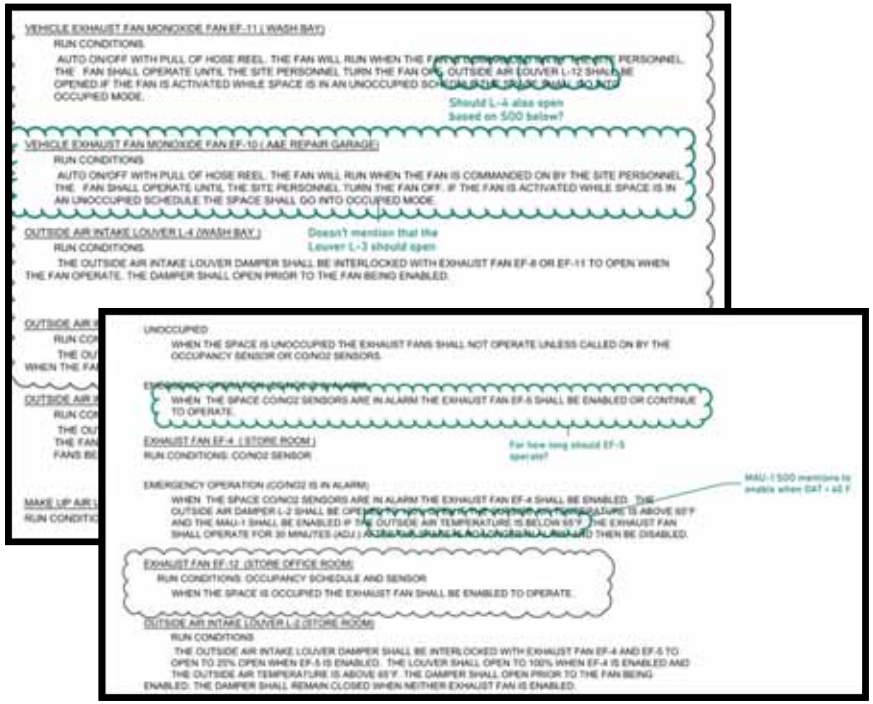
- Integrated System Testing is a commissioning phase during which all major building systems are exercised together under realistic operating conditions.
- It goes beyond individual component or subsystem verification, to ensure that systems such as HVAC, electrical, controls, fire/life safety, building automation, etc., actually work in sync.
- The key objective: Verify that the performance of the fully integrated facility meets the Owner's Project Requirements (OPR) and design intent under combined operation and abnormal conditions.

Integrated System Testing Process

- Ensure all individual systems have been designed, installed and operating correctly.
- Developing integration test scripts/sequence scenarios that capture both normal and abnormal operating modes.
- Coordinating across all trades (mechanical, electrical, controls, fire/life safety) to schedule and prepare required instrumentation and monitoring.
- Execute the scenarios, monitor system responses, identify deviations and document results for review.

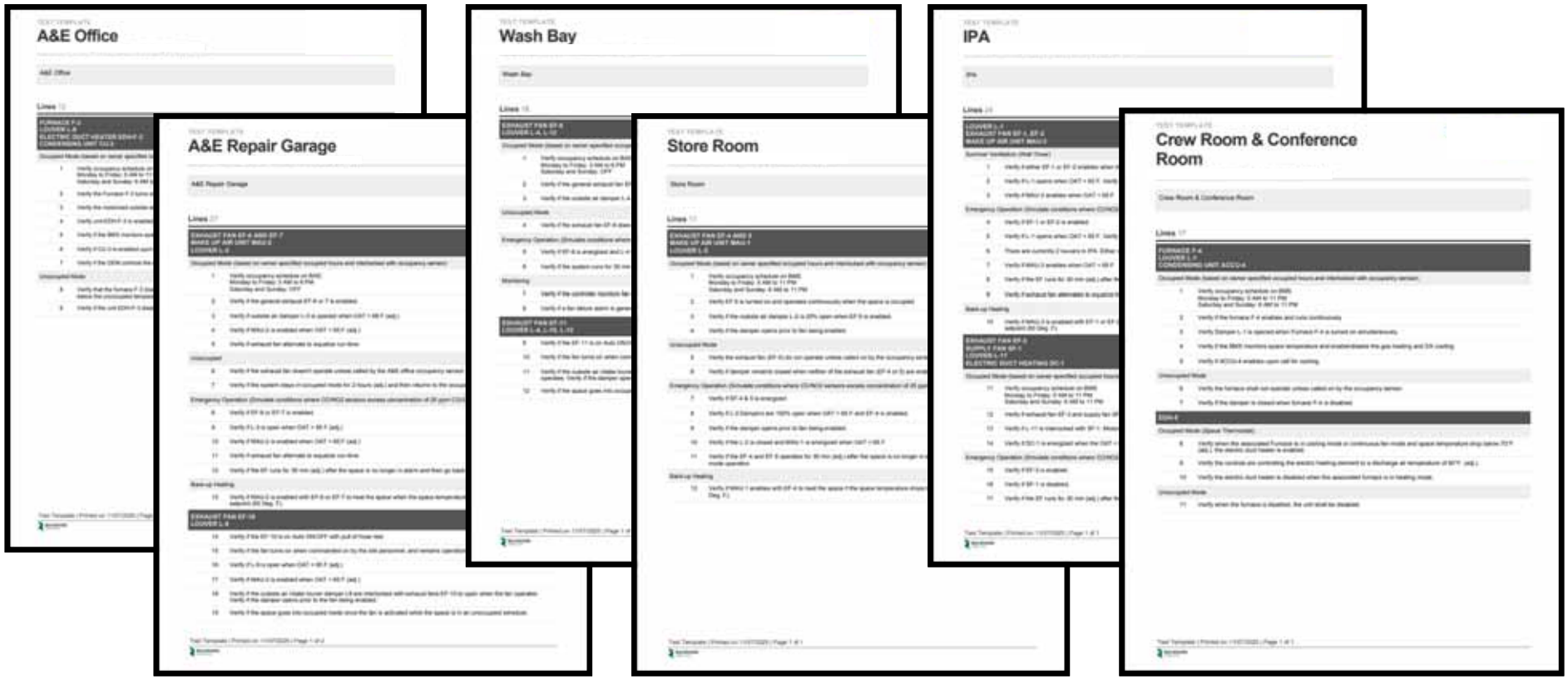
Design and Construction Process

Design Phase

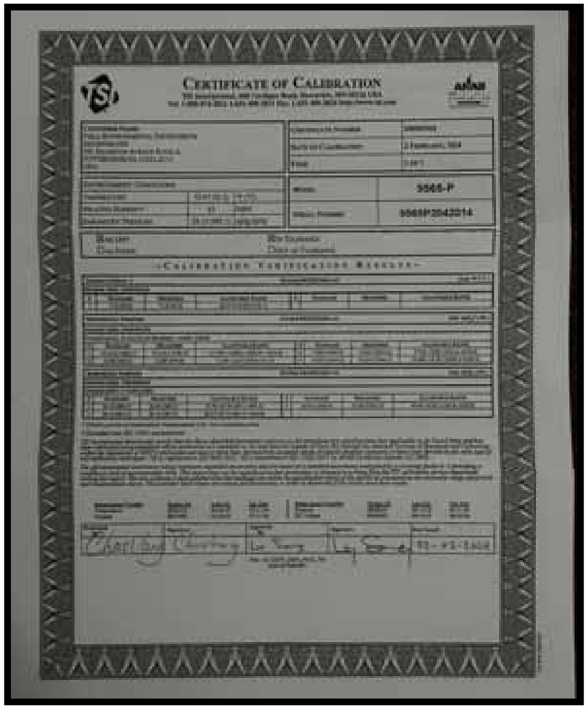


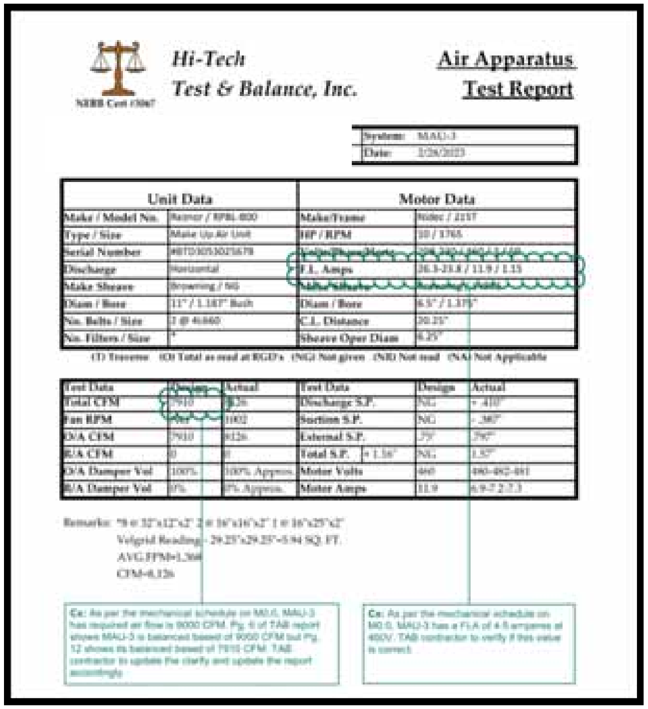
Construction Phase

IST Functional Performance Test Scripts



Calibration and TAB Report Review





Hi-Tech Test & Balance, Inc.
NEBB Cert #3067

Air Apparatus Test Report

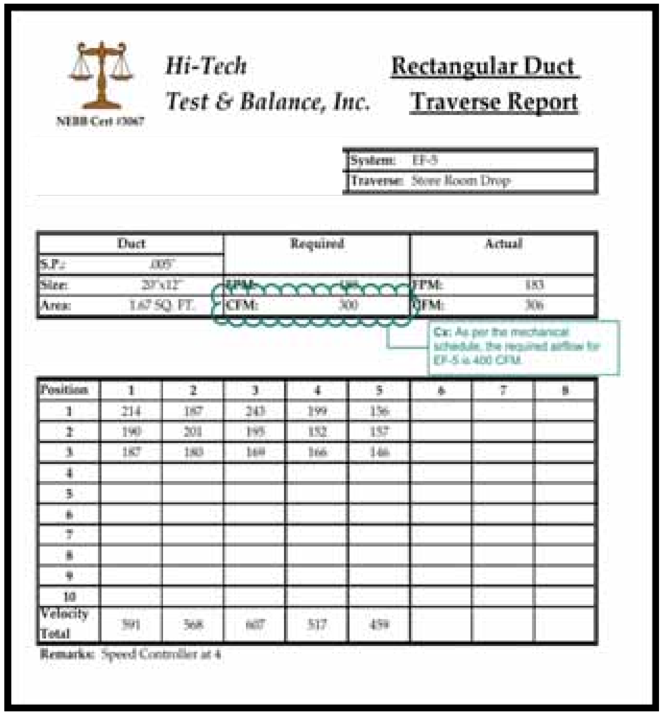
System:	MAU-3
Date:	2/28/2023

Unit Data		Motor Data	
Make / Model No.	Reznor / RPBL-800	Make/Frame	Nidec / 215T
Type / Size	Make Up Air Unit	HP / RPM	10 / 1765
Serial Number	#BTD3053025678	Volts/Phase/Hertz	208-230 / 460 / 3 / 60
Discharge	Horizontal	F.L. Amps	26.3-23.8 / 11.9 / 1.15
Make Sheave	Browning / NG	Make Sheave	Browning / [illegible]
Diam / Bore	11" / 1.187" Bush	Diam / Bore	6.5" / 1.375"
No. Belts / Size	2 @ 4L660	C.L. Distance	20.25"
No. Filters / Size	*	Sheave Oper Diam	6.25"

(T) Traverse (O) Total as read at RGD's (NG) Not given (NR) Not read (NA) Not Applicable

Test Data	Design	Actual	Test Data		Design	Actual
Total CFM	7910	8126	Discharge S.P.		NG	+ .410"
Fan RPM	NG	1002	Suction S.P.		NG	- .387"
O/A CFM	7910	8126	External S.P.		.75"	.797"
R/A CFM	0	0	Total S.P.	+ 1.16"	NG	1.57"
O/A Damper Vol	100%	100% Approx.	Motor Volts		460	480-482-481
R/A Damper Vol	0%	0% Approx.	Motor Amps		11.9	6.9-7.2-7.3

Remarks: *8 @ 32"x12"x2" 2 @ 16"x16"x2" 1 @ 16"x25"x2"
Velgrid Reading - 29.25"x29.25"=5.94 SQ. FT.
AVG.FPM=1,368
CFM=8,126



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NEBB Cert #3067

Rectangular Duct Traverse Report

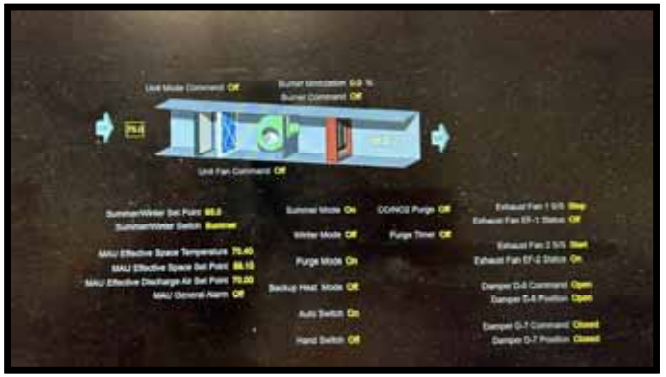
System:	EF-5
Traverse:	Store Room Drop

Duct		Required		Actual	
S.P.:	.005"				
Size:	20"x12"	FPM:	180	FPM:	183
Area:	1.67 SQ. FT.	CFM:	300	CFM:	306

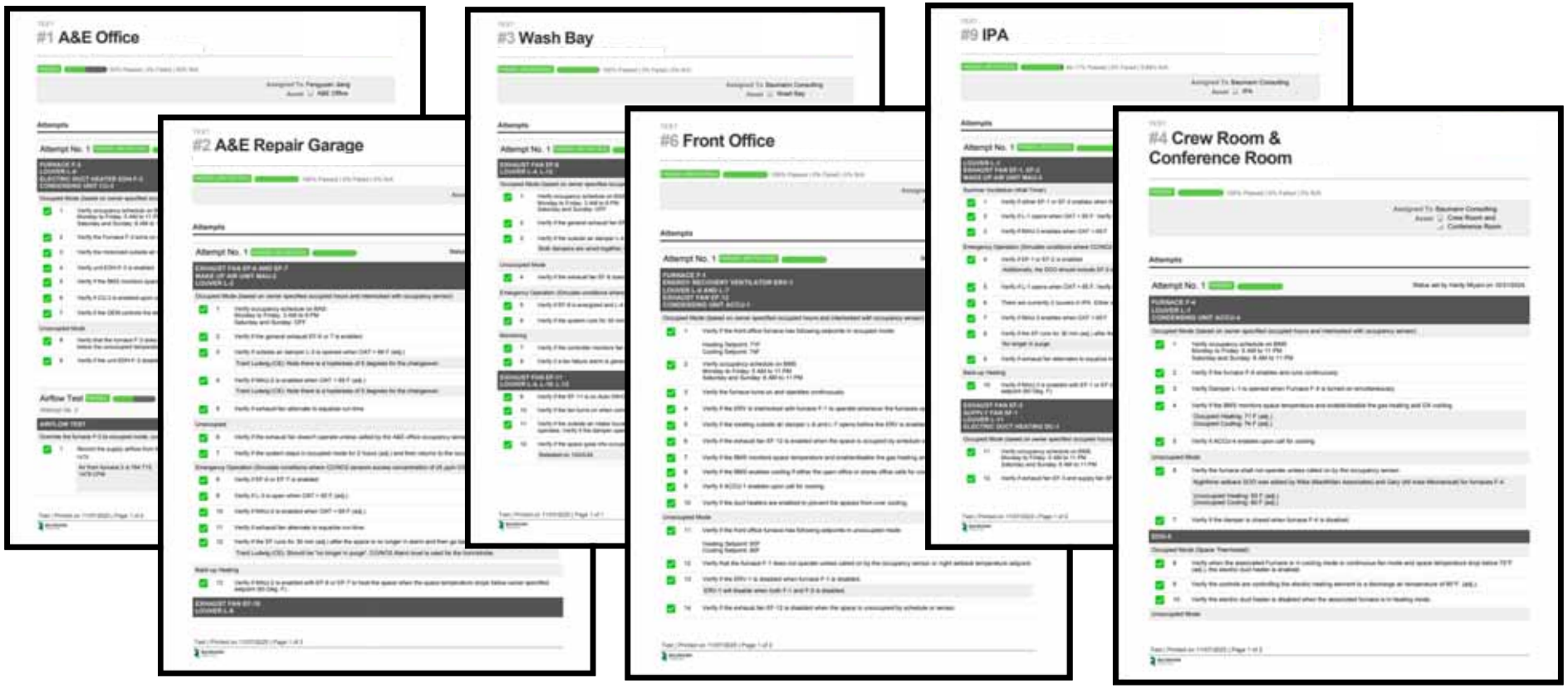
Position	1	2	3	4	5	6	7	8
1	214	187	243	199	156			
2	190	201	195	152	157			
3	187	180	169	166	146			
4								
5								
6								
7								
8								
9								
10								
Velocity Total	591	568	607	517	459			

Remarks: Speed Controller at 4

Integrated System Testing



Integrated System Testing Results



Space Pressurization Test Reports

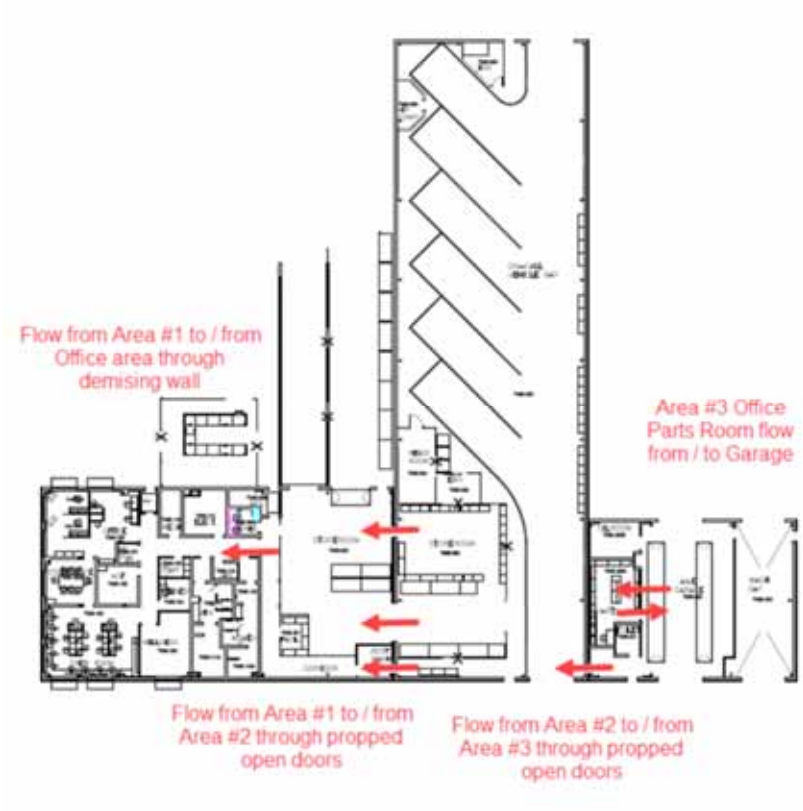
OFFICE A

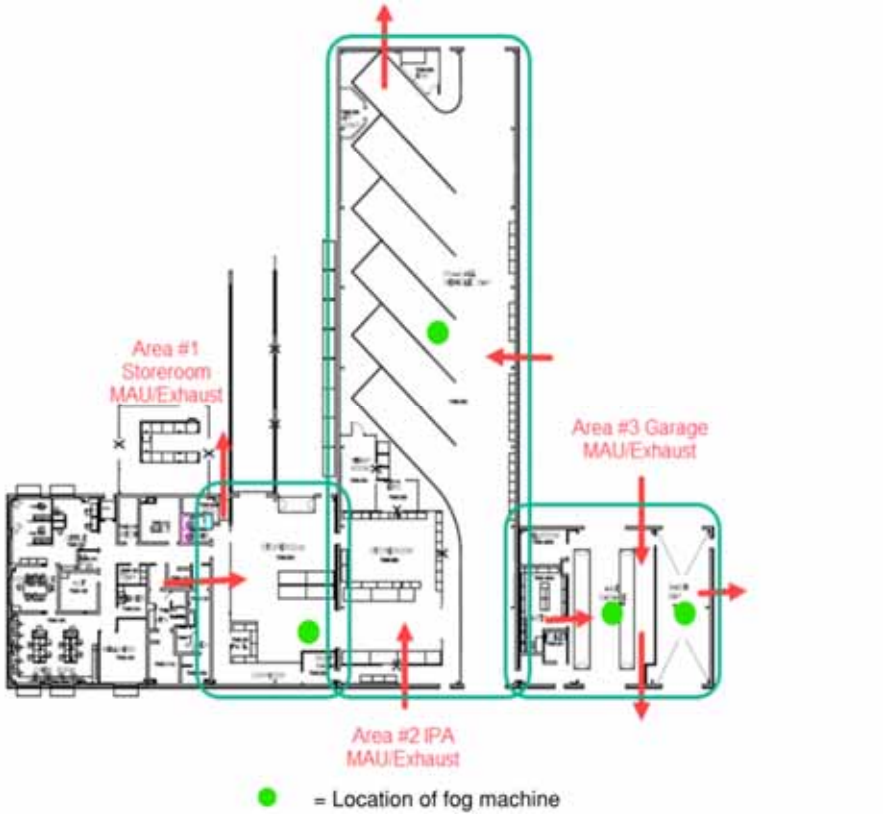
OFFICE B

Phase 3: Artificial Smoke Testing

- ASTM E1186-17 – Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
- Introduce artificial smoke in the testing area to validate the airflow movement of the MEP equipment and to identify potential air leakage in the building envelope.
- The test being performed is for a qualitative nature in determining the air leakage sites rather than determining quantitative leakage rates.

Artificial Smoke Test Planning





Artificial Smoke Test FPT Scripts

Phase 1:

Smoke Mode- 10 Min

Phase 2:

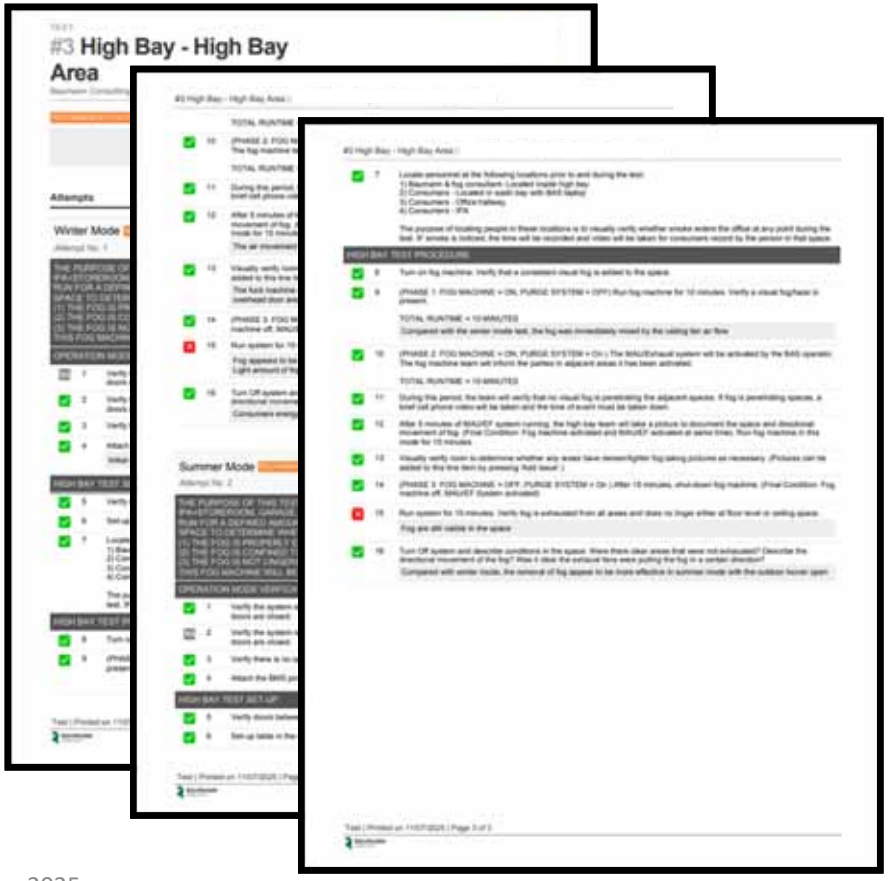
Purge Mode – 15 min

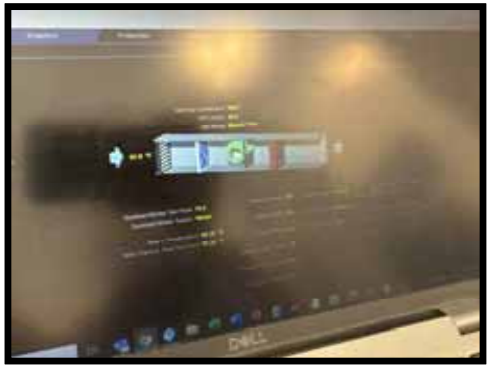
Phase 3:

Alarm Mode – 15 min

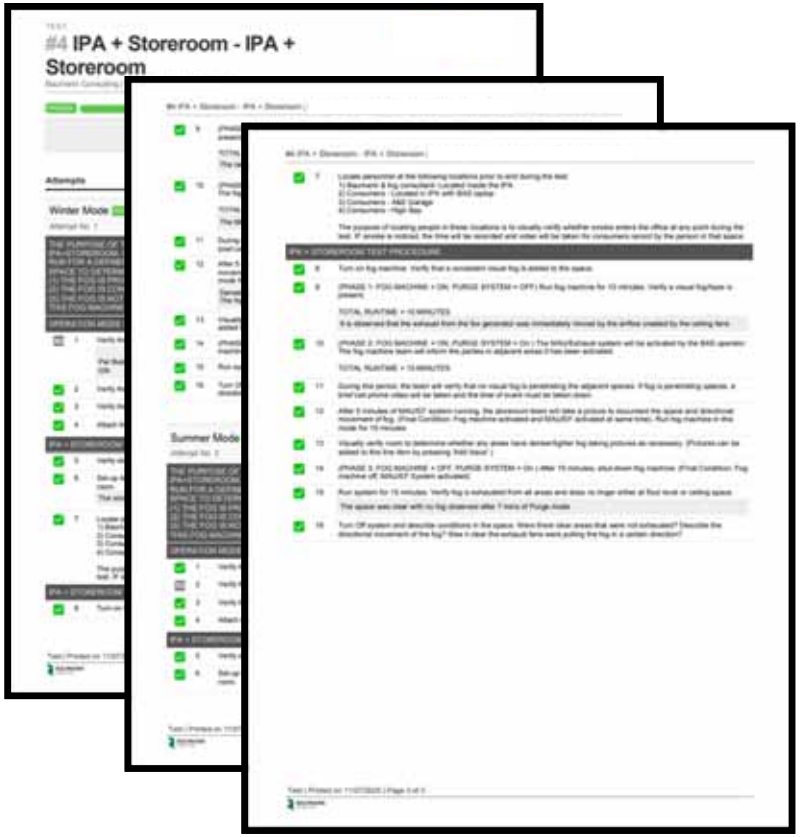

HYSTER

Artificial Smoke Test

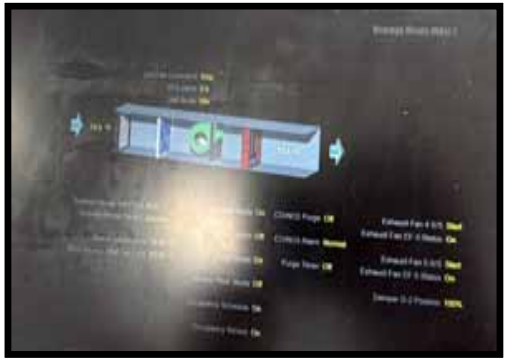


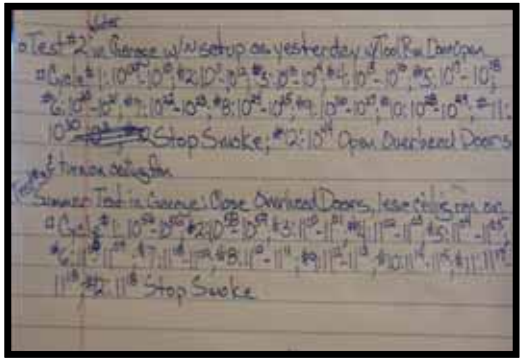


Artificial Smoke Test



Artificial Smoke Test





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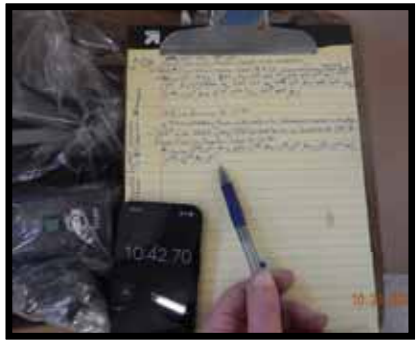
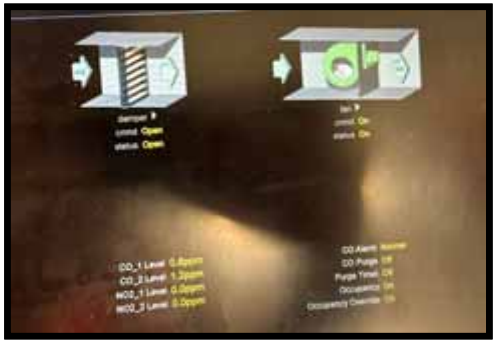
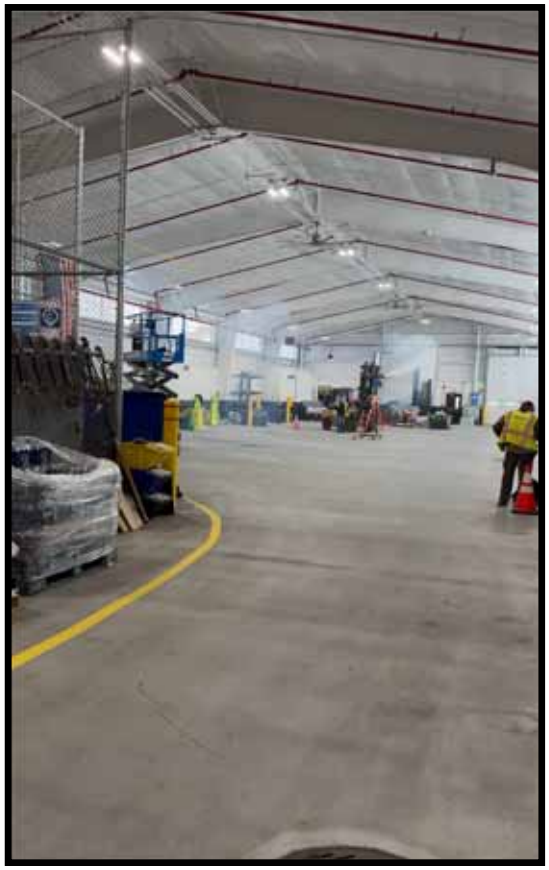


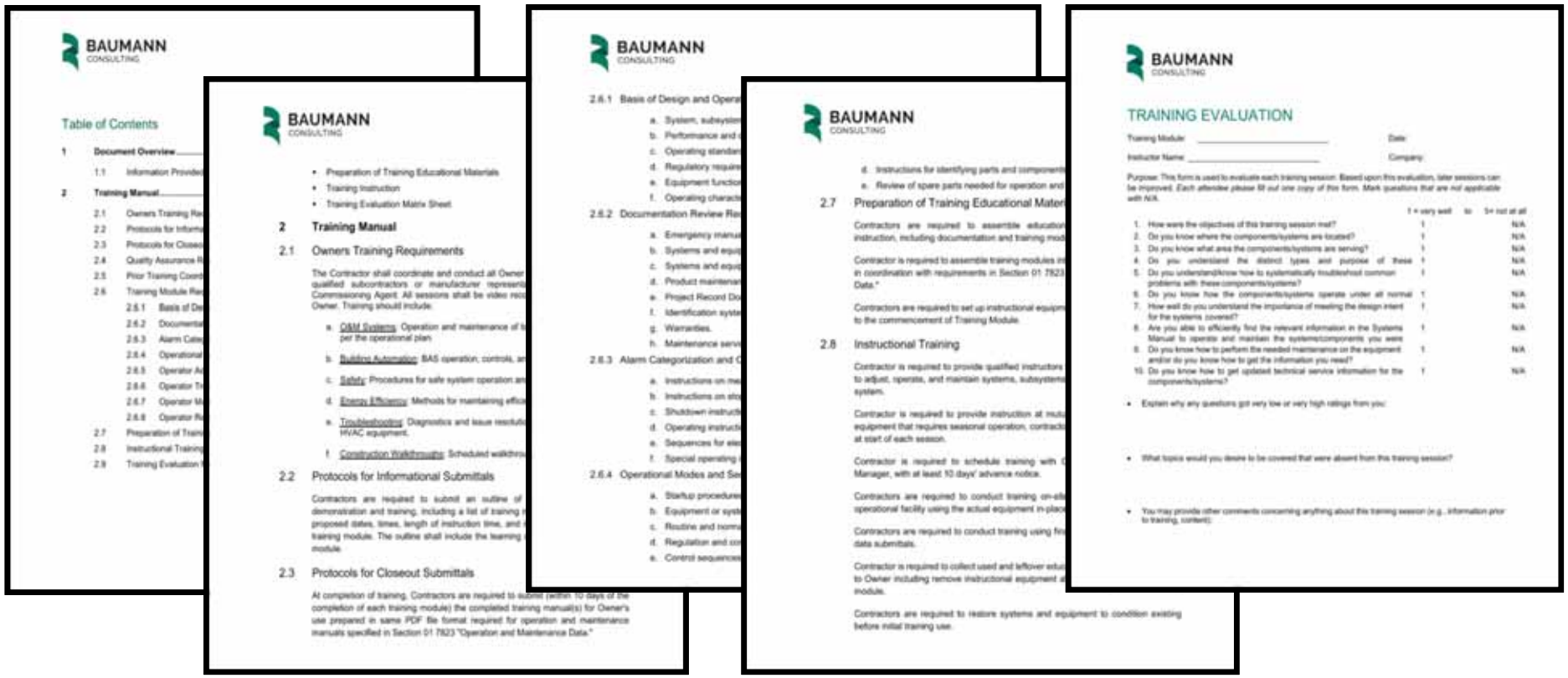


Standard Operating Procedure

- No Ilding signage across the facility.
- Open overhead doors when space is in alarm.
- Keeping doors closed between adjacent spaces.
- Calibrate/replace the CO/NO_2 sensors
- Replacing filters every 3 months.
- Changing ceiling fans forward and reverse direction based on season.



Training Program



10-month Post Occupancy Walk Through

- Thermostats, CO/NO_2 sensors, and exhaust fans were operational and properly tagged.
- Filters have been regularly replaced per routine maintenance.
- Door between different spaces were left open with a door stopper installed.
- MAU supply grille blocked by stored items.
- Recent staff onboarding did not include key system details (sensor passwords, alarm setpoints, drawings, O&M manuals, calibration procedures, etc.).

Lessons Learned

- Proper pressurization is crucial to prevent contaminant migration and protect indoor air quality and occupant safety.
- Integrated system testing and smoke tests are essential for identifying interactions between systems and resolving pressurization issues.
- Regular CO/NO_2 sensor testing and sequence verification ensure ventilation systems respond correctly to maintain safe environments.
- Clear SOPs and ongoing staff training are necessary to sustain proper pressurization control and long-term operational performance.

Questions?

Hardik Miyani, PE, CEM, CRE, CPHC, LEED Green Associate
Energy and Decarbonization Project Manager
h.miyani@baumann-us.com