



Withstanding High Wind Impacts on Biocontainment Facilities

ABSA International 59th Annual Biological Safety Conference

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Eugene Cole

Program Technical Director
NBAF Program Executive Office
DHS Science and Technology Directorate
1980 Denison Ave.
Manhattan, KS 66502



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NBAF Mission



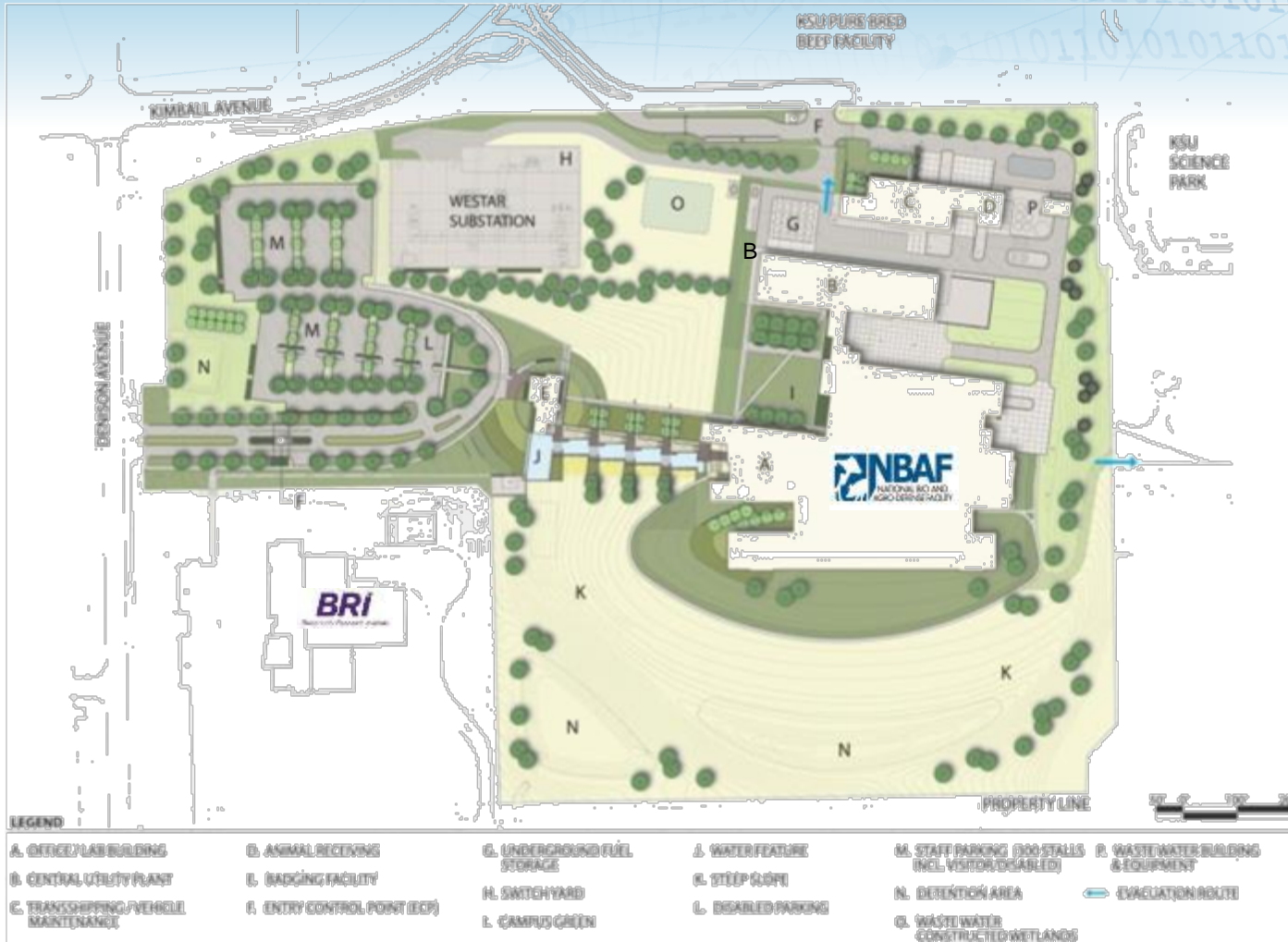
The NBAF, a new, state-of-the-art biosafety level (BSL) 3 & 4 facility, located in Manhattan, KS, will enable the U.S. to conduct comprehensive research, develop vaccines and anti-virals, and provide enhanced diagnostic capabilities to protect our country from numerous foreign animal, emerging and zoonotic diseases to assist in protecting our food supply and the nation's agriculture economy and public health.



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NBAF Site Plan

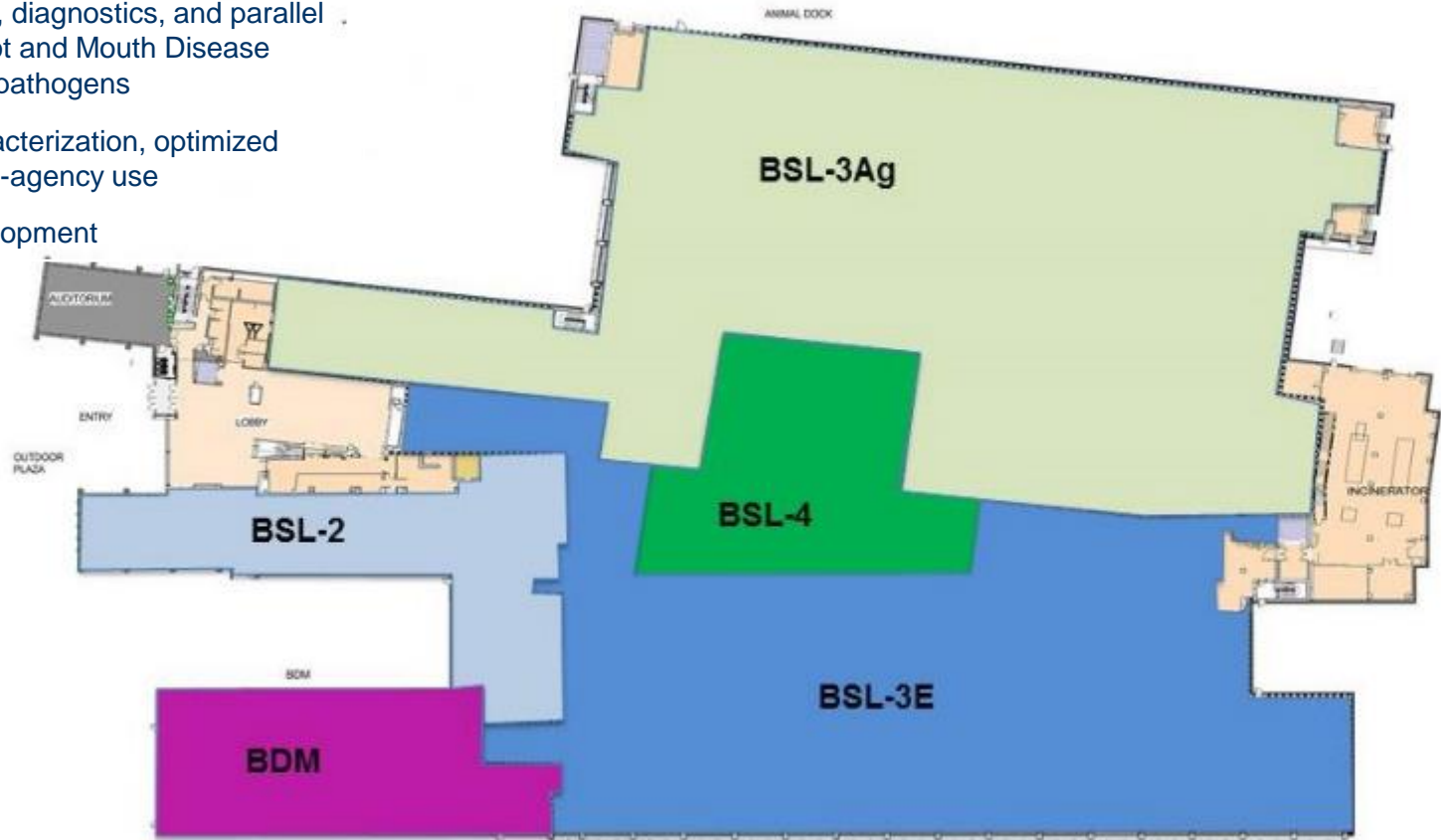


- Completed NBAF site will encompass over **700,000** sq.ft.
- Main lab building provides **574,000** sq.ft. of integrated laboratory space, support areas, and required safety systems.
- Other structures total **135,000** sq.ft.
- The Kansas State University Biosecurity Research Institute (BRI) will be leveraged for training, complementary research, and administration.

The Biotechnology Development Module (BDM), plus the nearby presence of commercial animal pharmaceutical and biopharmaceutical firms, will increase the speed with which new diagnostic tests, vaccines, and medicines are developed, tested, and put into use.

NBAF Laboratory Facility Plan

- **BSL-4:** High consequence zoonotic diseases
- **BSL-3E + BSL-3Ag:** Research and Development (R&D), diagnostics, and parallel vaccine trials for Foot and Mouth Disease (FAD) and zoonotic pathogens
- **BSL-2:** Assay, characterization, optimized throughput and multi-agency use
- **BDM:** Vaccine development



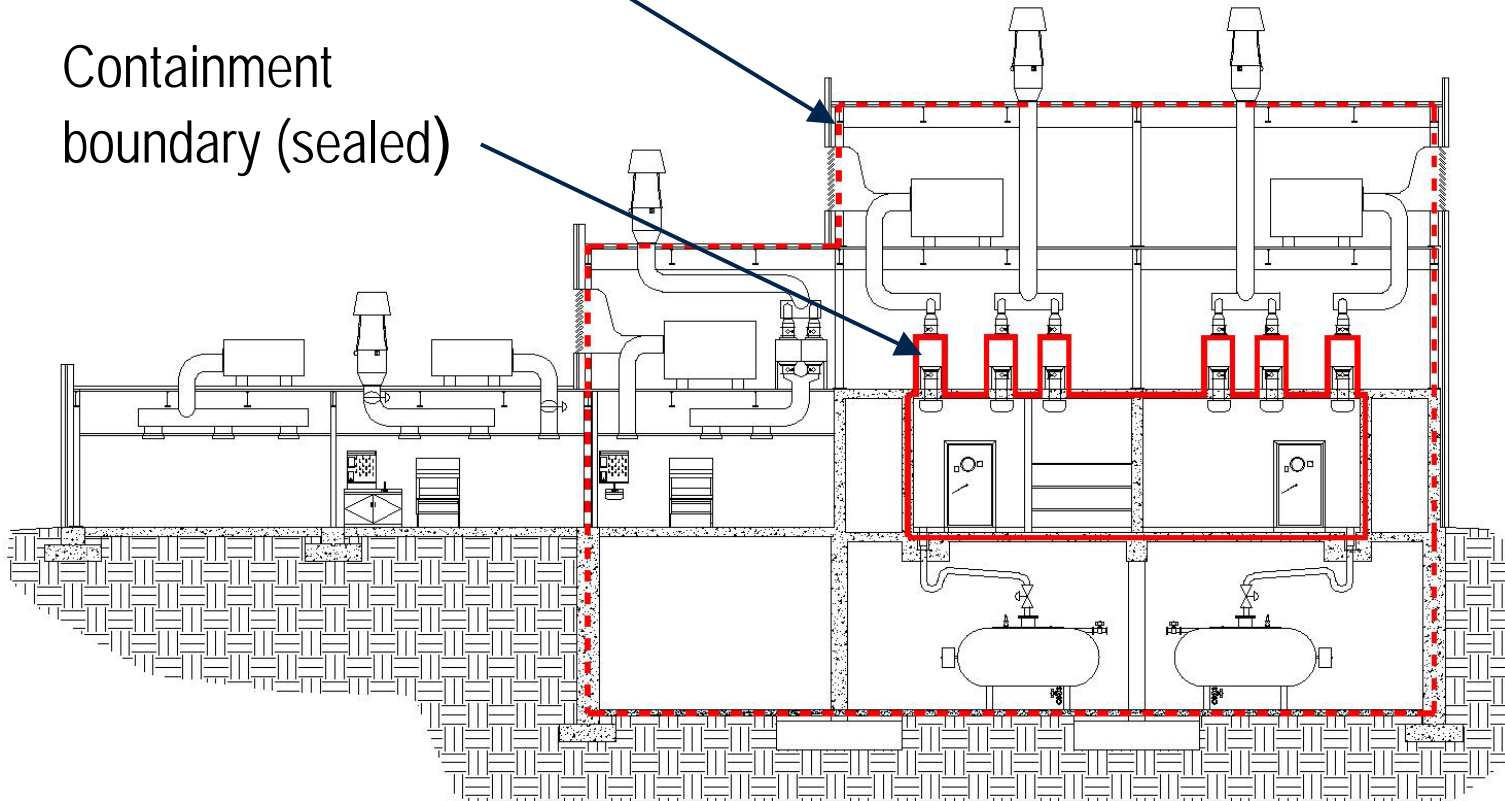
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Establish Containment and Structural Integrity Areas

Structural integrity
boundary (permeable)

Containment
boundary (sealed)



Structural and Containment Diagram

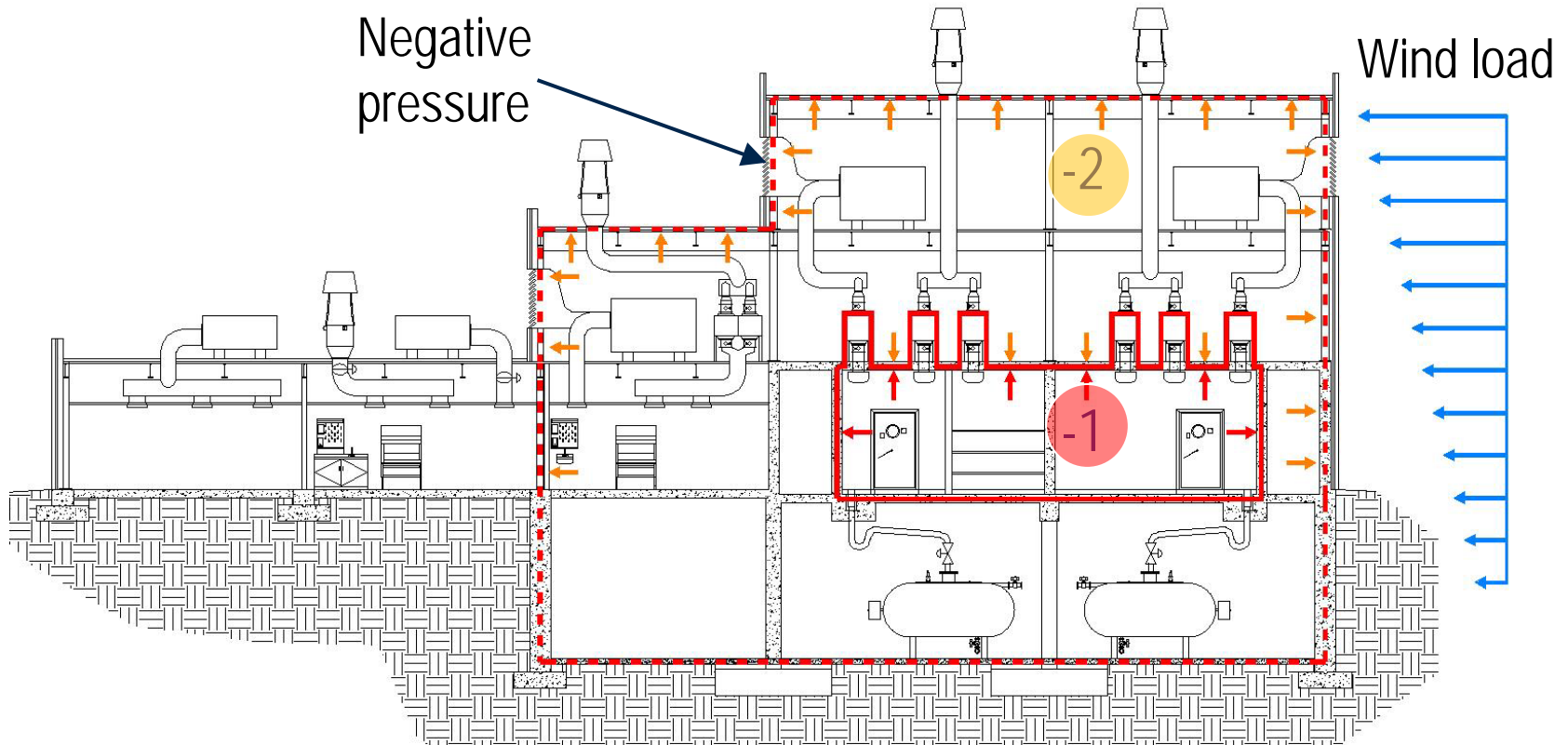


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Calculate Pressures at Each Boundary Condition

-3



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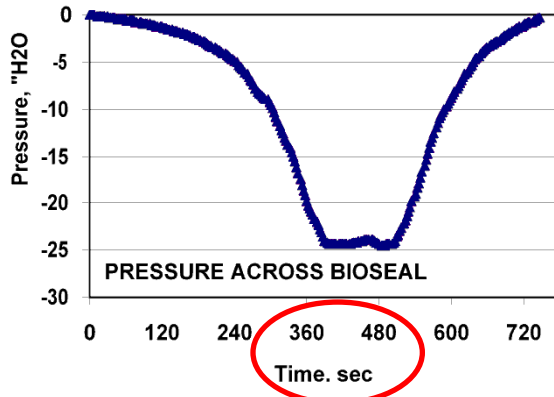
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Pressure Diagram

Translation Speed Affects Pressure Differential

Slow Storm

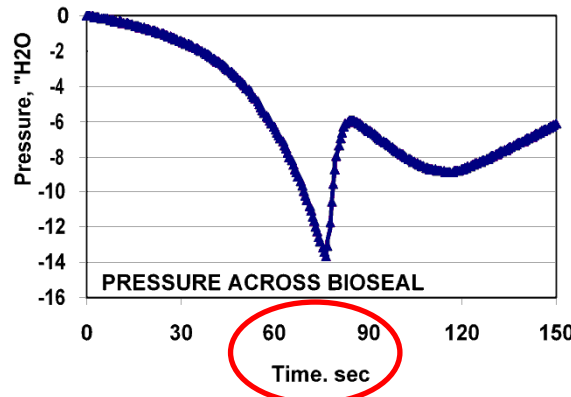
Vmax = 200 mph
Vtrans = 5 mph



-25

Medium Storm

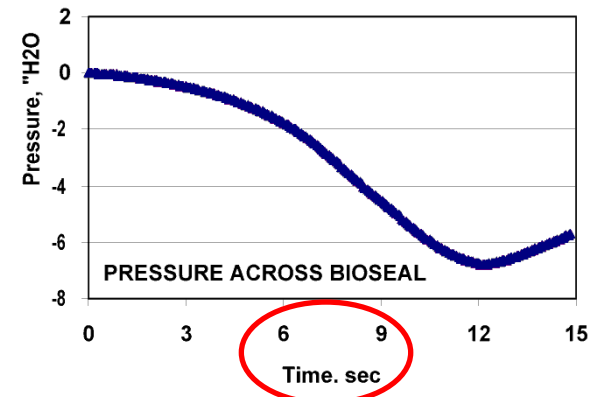
Vmax = 200 mph
Vtrans = 25 mph



-14

Fast Storm (NRC)

Vmax = 230 mph
Vtrans = 46 mph



-7

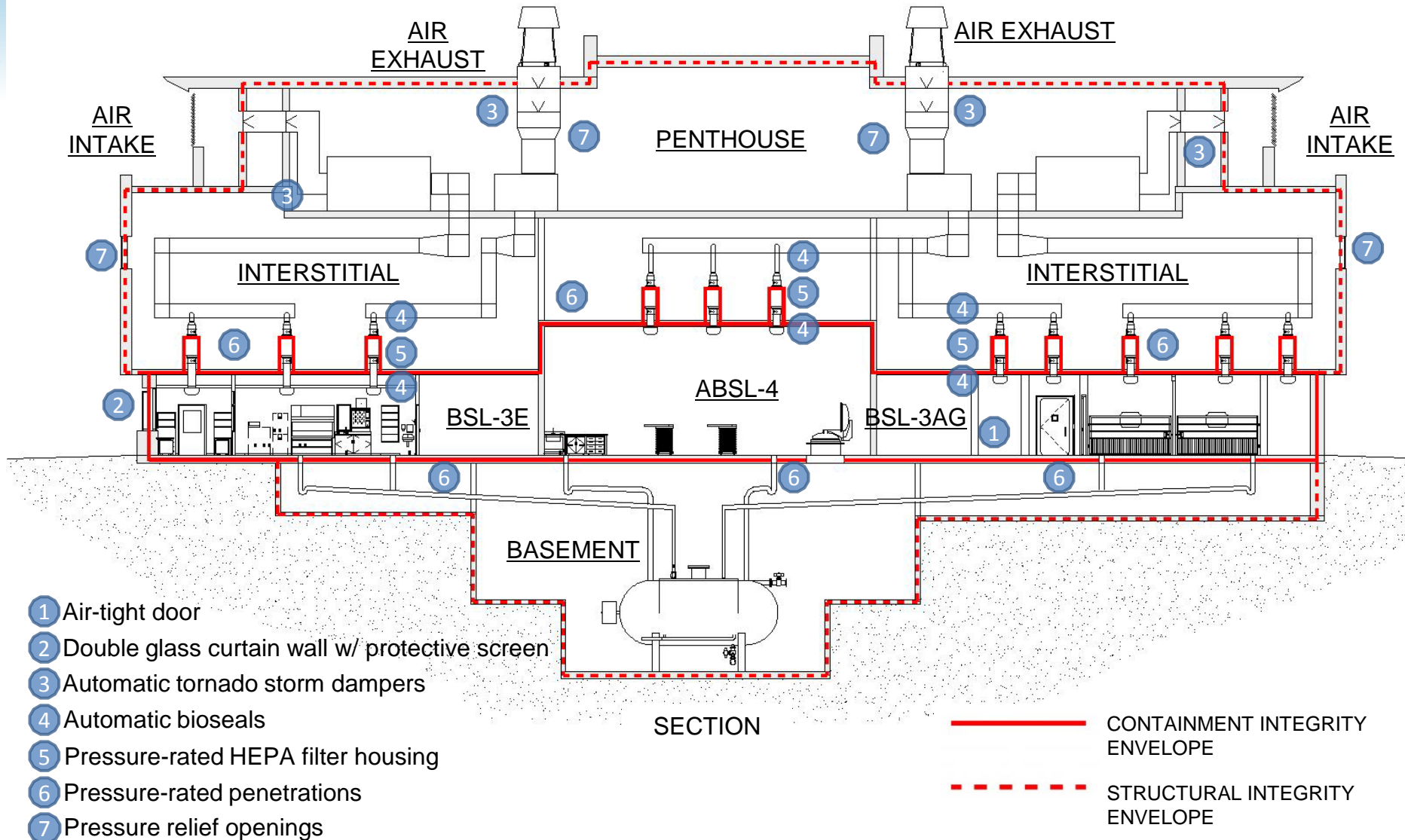


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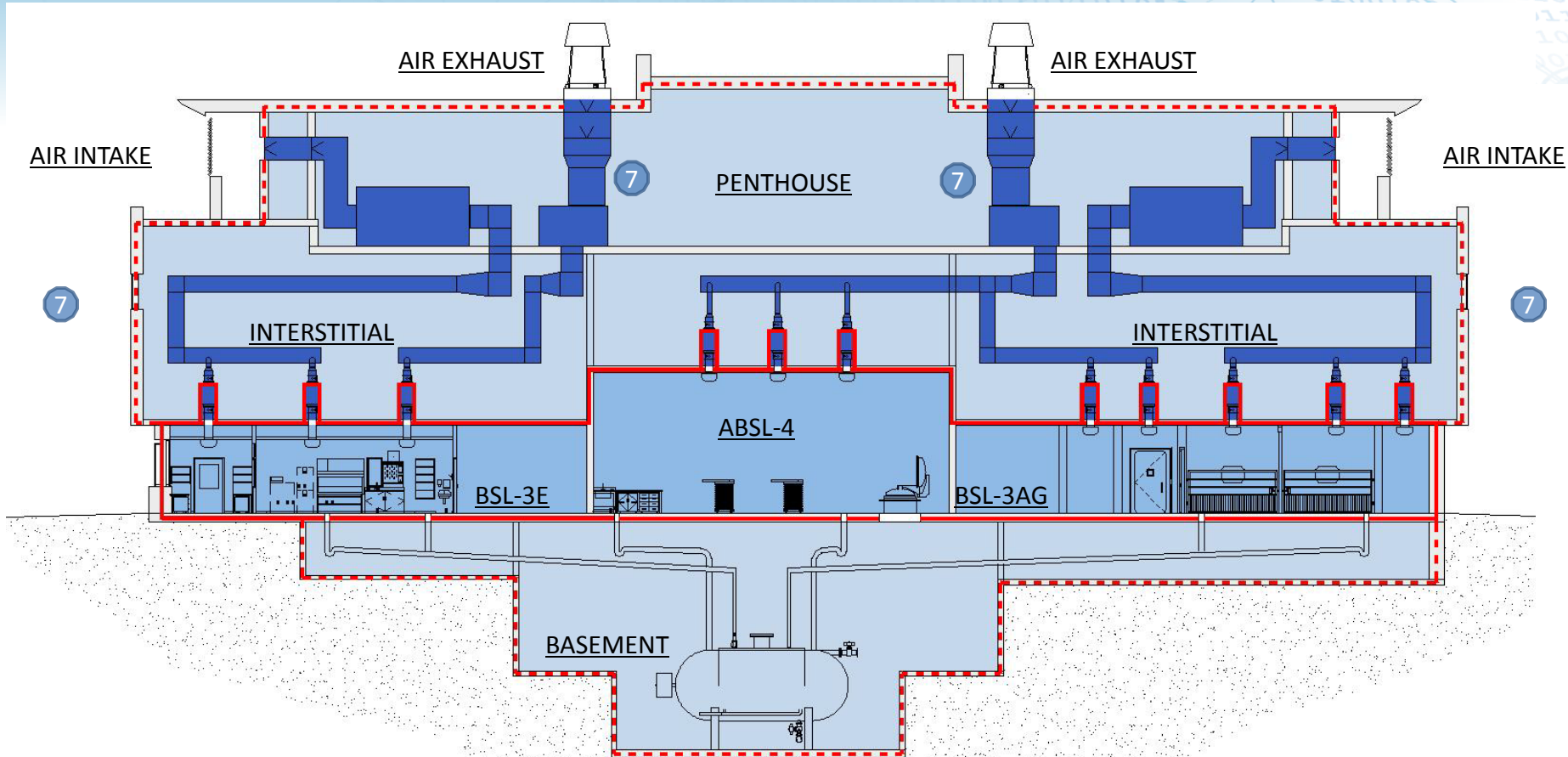
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1 inch water gauge = 5.2 pounds-force/square foot (psf)

Design Approaches for Protection in High Wind Events

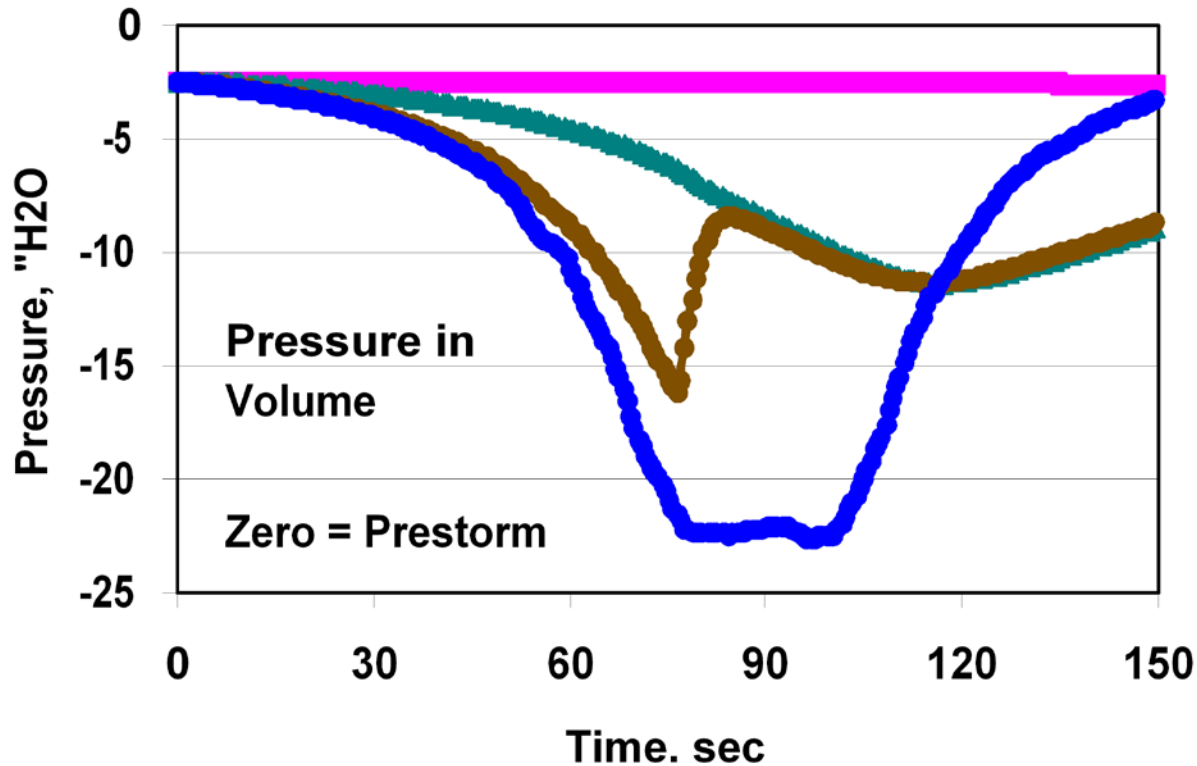


Internal Pressure Volume Differentials



-  VOL 1 Ductwork
-  VOL 2 Combined Penthouse, Interstitial, & Basement
-  VOL 3 Research Floor
-  Pressure relief openings
-  CONTAINMENT INTEGRITY ENVELOPE
-  STRUCTURAL INTEGRITY ENVELOPE

Internal Pressure Time Differentials



Vmax = 200 mph
Vtrans = 25 mph

— Research
— Comb Vol
— Ducts
— Atmos Pr

Tornado Damper = 2.29 ft²
BioSeal Area = 0.0325 ft²
Comb Vol Vent = 10 ft²
Duct Relief Door = 10 ft²



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Mock-ups



Test platform “clean room” enclosure intent with limitations

Structural steel platform to support simulated low shrink concrete interstitial slab for tested embeds



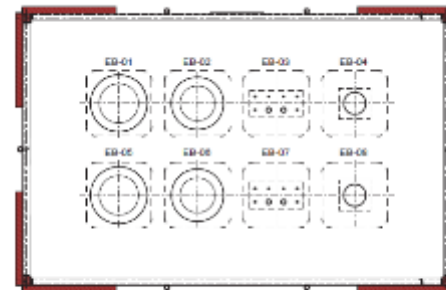
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Embed Test Types



Varied embed type and size and amount of water stop material



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Testing Procedures and Conditions

- Secure test chamber to underside of each embed location.
- Pressurize the test chamber to a minimum of 33 inches water column.
- Once initial pressure equalizes, record pressure and temperature inside of chamber at one minute intervals for a minimum of 30 minutes.
- If pressure decay (loss) occurs over 30 minute interval, perform particle challenge of embed by introducing 0.3 micron spheres through the test chamber at a pressure near 33 inches of water column to attempt to identify leak locations at top of embed platform around perimeter edge of tested embed by particle counts.

Notes:

- Test 1 occurred after 90 days of curing time for the low shrink concrete.
- Test 2 occurred after 180 days of curing time. A temperature probe was added to the chamber for recording temperatures along with the exterior temperatures to account for the small pressure changes experienced during Test 1. **A 0.3 degree F change in temperature equals a 0.2 change in inH2O.**
- Test 3 occurred after the high performance coating was applied to the underside of the elevated slab to simulate the final finish at the embed locations.



Testing Apparatus

HEPA filtered
air supply

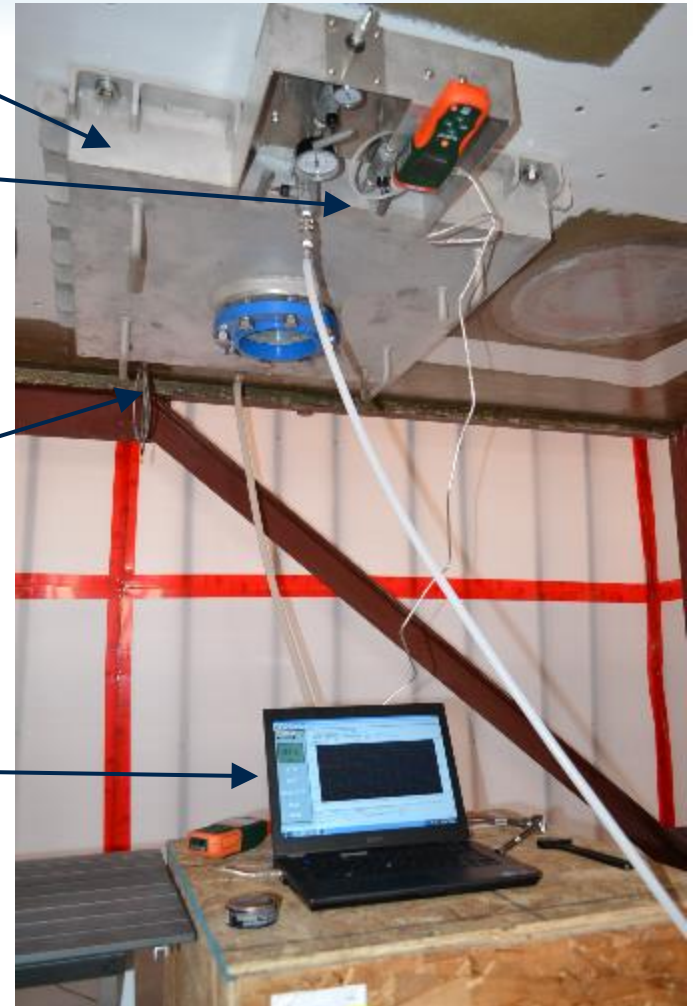


Pressure testing
chamber

Differential
pressure
manometer

Temperature
thermocouple
for chamber

Recording
laptop
computer



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Testing Apparatus



Particle count scanning equipment



Shop vac with mixing canister for the particulate challenge



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Test Report Sample

HWM Test #3 (4/27/16) - Embed Pressure Decay/Leak Test Report

Terracon
Consulting Engineers & Scientists

AccuTec
Services, Inc.
www.atsusa.com

Project: NBAF GMP3 HWM
Project No.: Rectan F1156089
Notes: EMBED 01 TEST #8
P30-S1 (2 Synkoflex + Flange)
I.D. Number: EB-01

Embed Pressure Decay Test Information:

	Test Start	Test End	Duration / Change	Equivalent pressure change (Pa)
Time of Test	17:21:40	17:51:40	0:30	
Chamber Pressure (Inches of H ₂ O)	33.49	33.10	-0.39	
Chamber Pressure (Pa)	8341.99	8244.84	-97.15	
Temperature (°F) Inside Chamber (T1)	68.5	68.2	-0.30	
Temperature (°C) Inside Chamber	20.28	20.11	-0.17	-59.50
Temperature (°F) Inside Enclosure (T2)	67.4	67.2	-0.20	
Temperature (°C) Inside Enclosure	19.67	19.56	-0.11	
Temperature (°F) Inside Building (T3)	64.7	65.3	0.60	
Temperature (°C) Inside Building	18.17	18.50	0.33	
Outdoor Atmospheric Pressure (In. Hg)	29.61	29.61	0.00	
Outdoor Atmospheric Pressure (Pa)	100270.98	100270.98	0.00	0.00
End Chamber Pressure (Pa) corrected for Temp & Atmospheric changes =				8304.34
Corrected Chamber Pressure Decay	8341.99	8304.34	-37.65	Pa
Corrected Chamber Pressure Decay	33.49	33.34	-0.15	Inches of H ₂ O

Pressure loss correction due to temperature and atmospheric changes

Hourly leak rate: -6.53E-04 (Ref. ISO 10648-2)

PRESSURE RECORDING DEVICE

RANGE

EXTECH Model HD700	-55.40	55.40	Inches of H ₂ O
ACCURACY = ±0.3%FS (@25°C)	-0.17	0.17	Inches of H ₂ O
RESOLUTION = 0.01			

Test Performed By: PRESRAY (Robert) Date: April 27, 2016
Test Observed By: TERRACON (Philip W. Nigus, P.E.) Date: April 27, 2016



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Test 3 Results

SUMMARY OF EMBED PRESSURE DECAY/LEAK TEST RESULTS

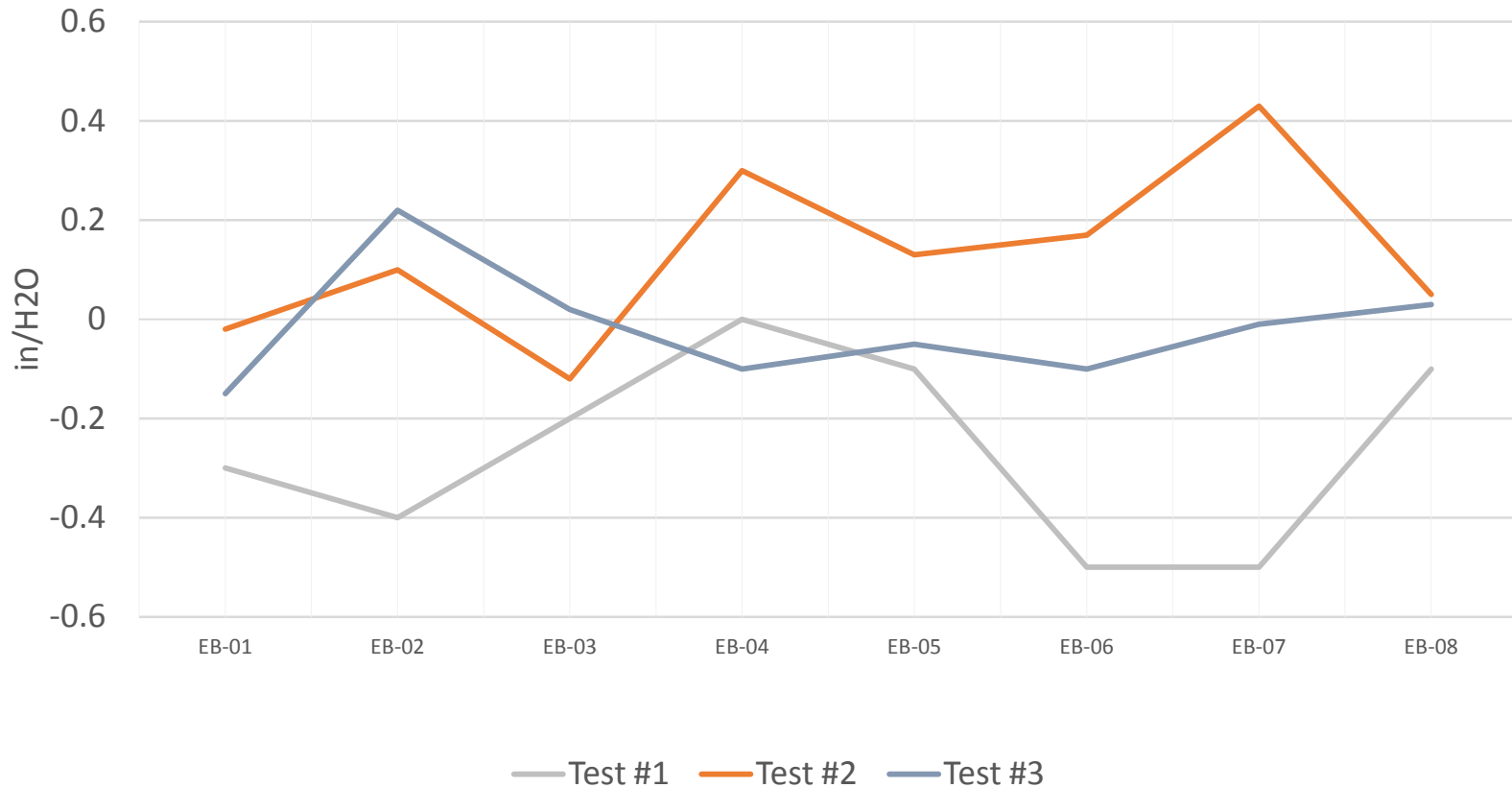
EMBED #	EMBED TYPE	START & END TIME	START & END PRESSURE (inH2O)	PRESSURE DECAY (inH2O) UNCORRECTED	START & END TEMPERATURE (°F)	PRESSURE DECAY (inH2O) (CORRECTED FOR TEMPERATURE & ATMOSPHERIC PRESSURE)	HOURLY LEAK RATE
EB-01	2 SYNKO + FLANGE	1721 - 1751	33.49 – 33.10	-0.39	68.5 - 68.2	-0.15	-6.53E-04
EB-02	1 SYNKO	1616 - 1646	33.45 – 33.36	-0.09	68.7 - 68.3	0.22	1.10E-03
EB-03	1 SYNKO	1512 - 1542	33.40 – 33.13	-0.27	68.7 - 68.5	0.02	1.42E-04
EB-04	1 SYNKO	1333 - 1403	33.34 – 32.87	-0.47	69.0 - 68.7	-0.10	-4.01E-04
EB-05	NONE	0828 - 0858	33.55 – 33.62	0.07	66.9 - 66.7	-0.05	-1.69E-04
EB-06	2 SYNKO	0931 - 1001	33.93 – 33.71	-0.22	68.1 - 67.6	-0.10	-3.66E-04
EB-07	NONE	1021 - 1051	33.42 – 33.27	-0.15	68.0 - 68.0	-0.01	-6.46E-05
EB-08	NONE	1231 - 1301	33.51 – 33.25	-0.26	68.7 - 68.5	0.03	1.87E-04

NOTES:

1. Test start and end times are reported for Central Time zone.
2. Atmospheric pressure information in Attachment 2 was obtained from closest NWS recording station (Manhattan Regional Airport)



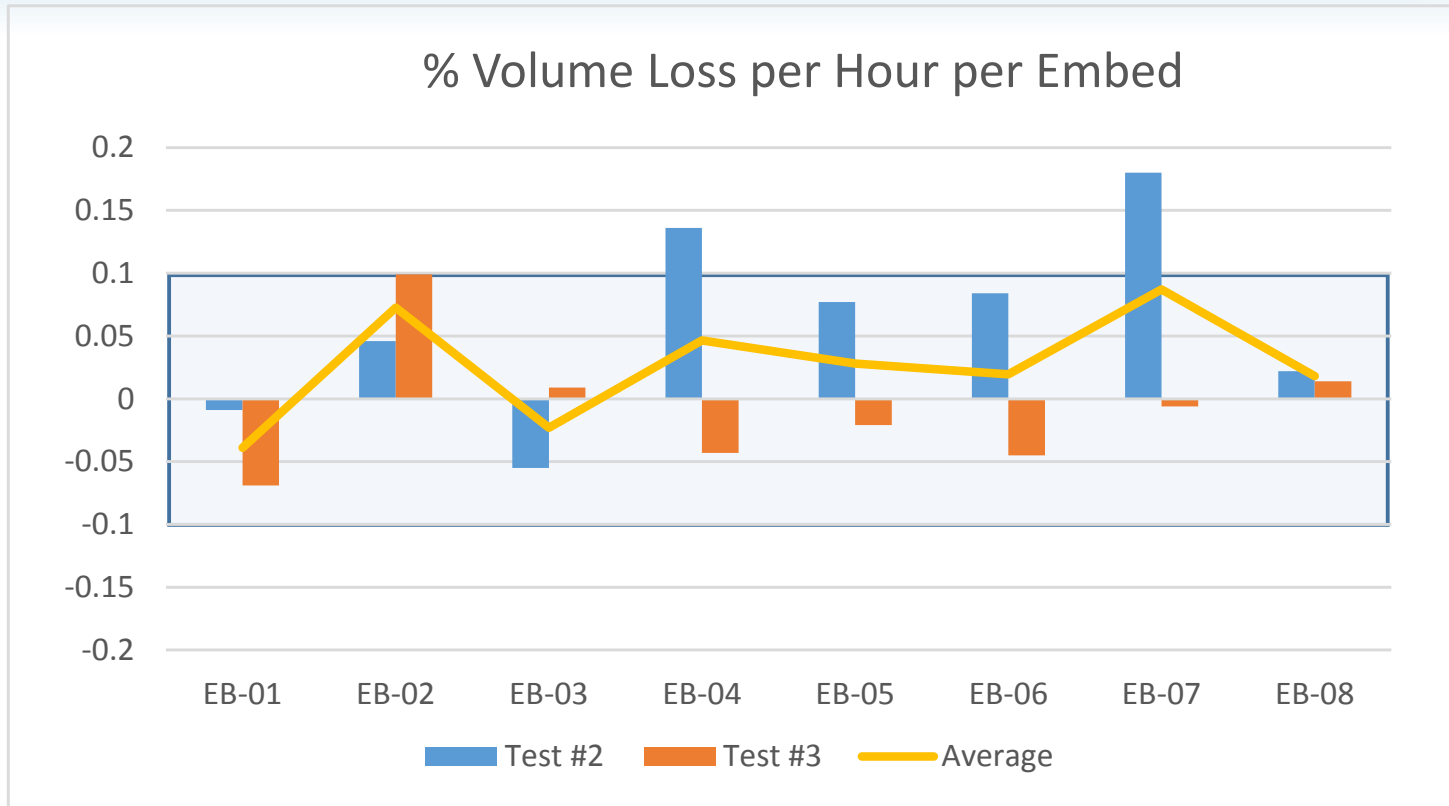
Embed Pressure Decay Comparison



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Embed % Volume Loss per Hour



Class III microbiological safety cabinets range from .03 to .10 % volume loss per hour



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Summary of test results

- The additional water stop material did not affect the results
- The percent of volume loss or gain per hour for the embeds is similar to a Class III microbiological safety cabinets and very high containment isolators
- Chamber pressure changes (+/-) are directly affected by temperature and atmospheric pressure changes
- The environment of the field mock-up contributed to the variation of the results



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