

Aerosol Sealing: From Lab to Market to University to Market Again

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Lawrence Berkeley National Laboratory

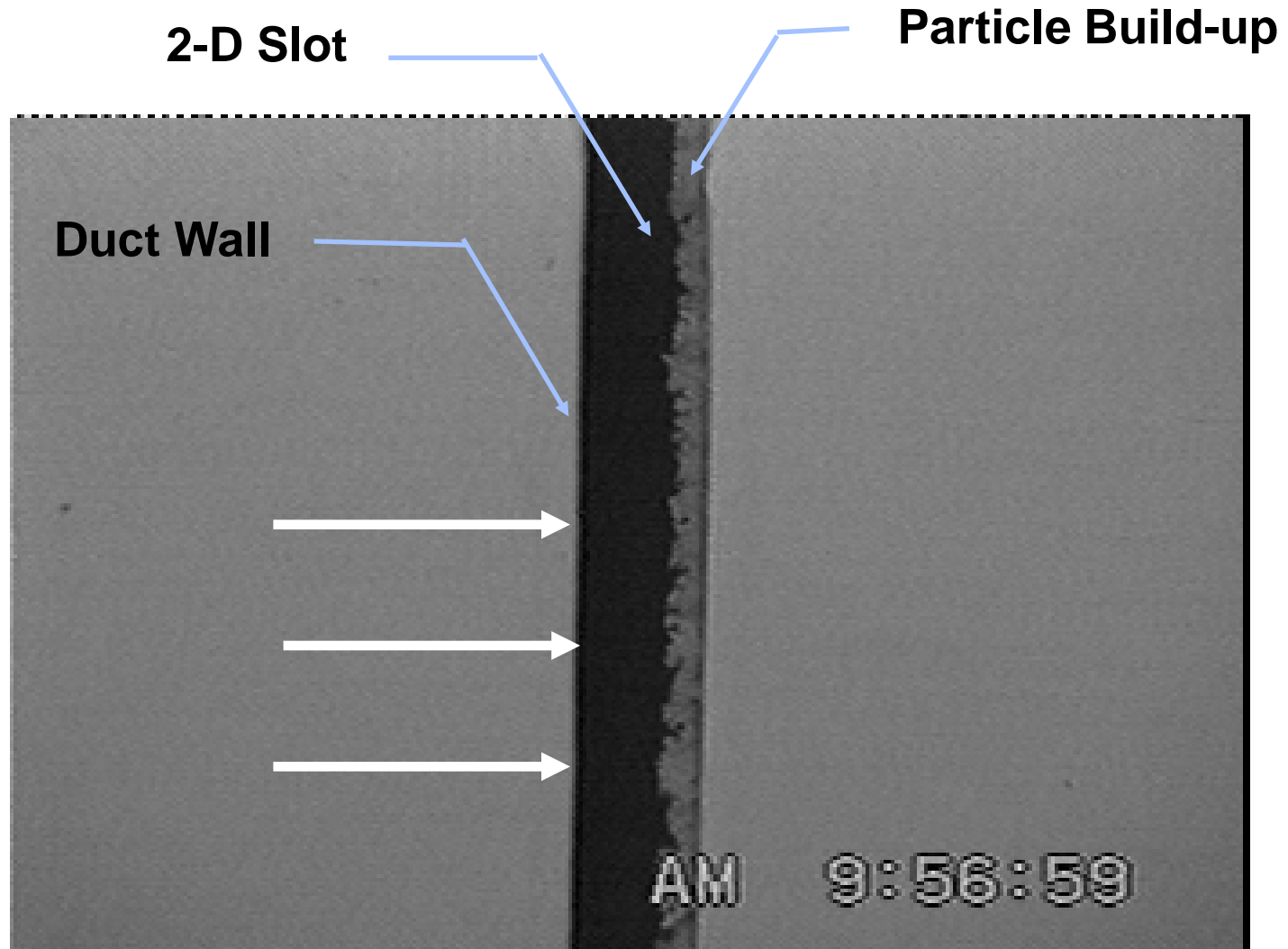
Presentation Overview

- Brief History of Aerosol Sealing
- Evolution of duct sealing TECHNOLOGY
- Turning a TECHNOLOGY into a BUSINESS
- Adding new applications/markets
- New TECHNOLOGY development – Envelope Sealing
- Q&A

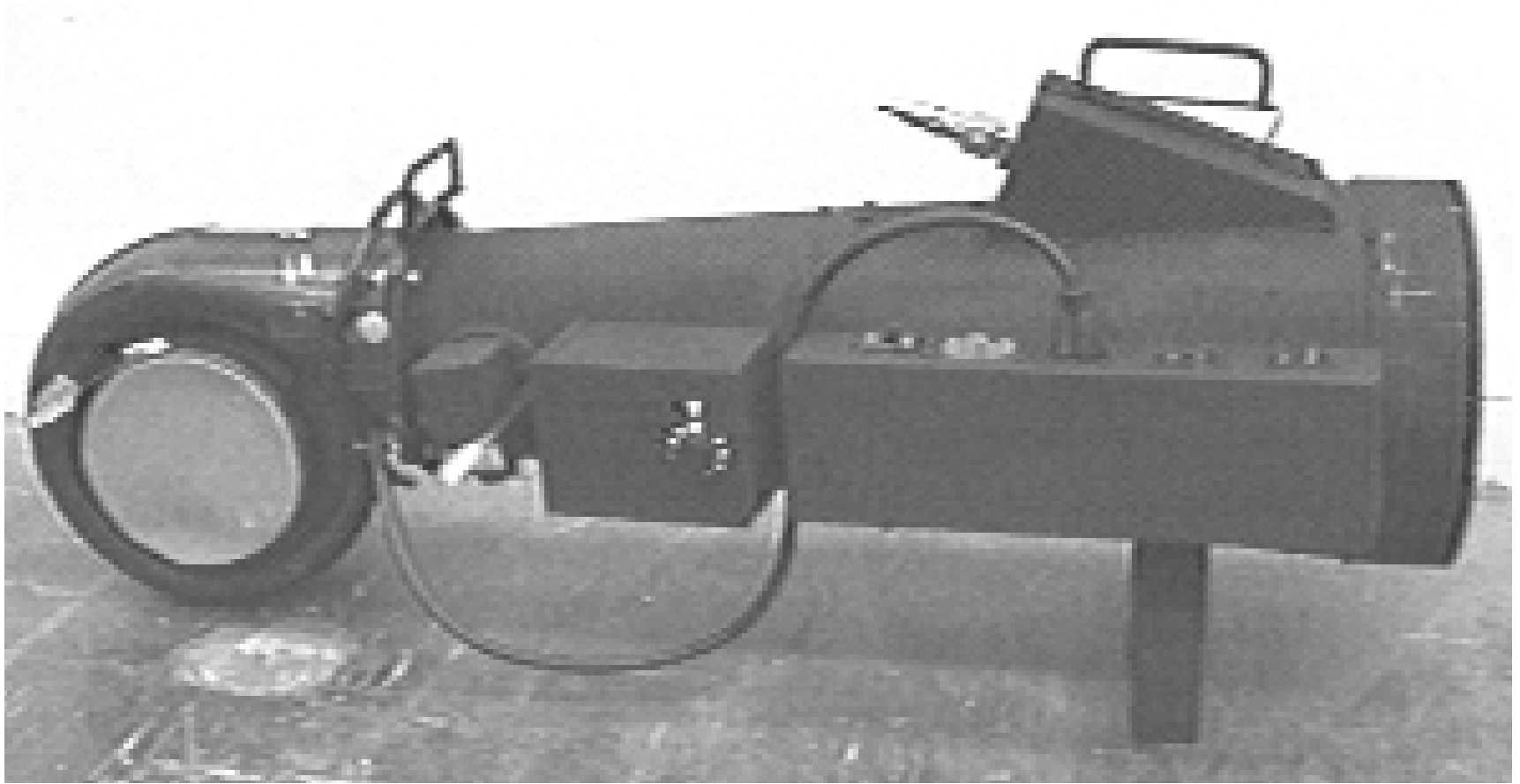
Brief History of the World of Aerosol Sealing

- 1979: Discovery that duct leakage is important
- 1987: First conception of aerosol sealing for ducts
- 1991: **Sacramento field study shows 18% savings from duct sealing**
- 1994: Laboratory proof of concept for aerosol duct sealing at LBNL
- 1996: Popular Science and DOE awards for aerosol duct sealing
- 1997: AEROSEAL founded
- 1999: First HVAC contractors selling AEROSEAL
- 2001: AEROSEAL purchased by Carrier
- 2006: Gen-2 AEROSEAL equipment released
- 2010: AEROSEAL spun out from Carrier
- 2011: First envelope sealing at UC Davis
- 2015: Aerosol Envelope sealing licensed to AeroSeal by UC Davis
- 2016: 10X Revenue growth since Carrier divestiture

Snapshot of Sealing (1994)

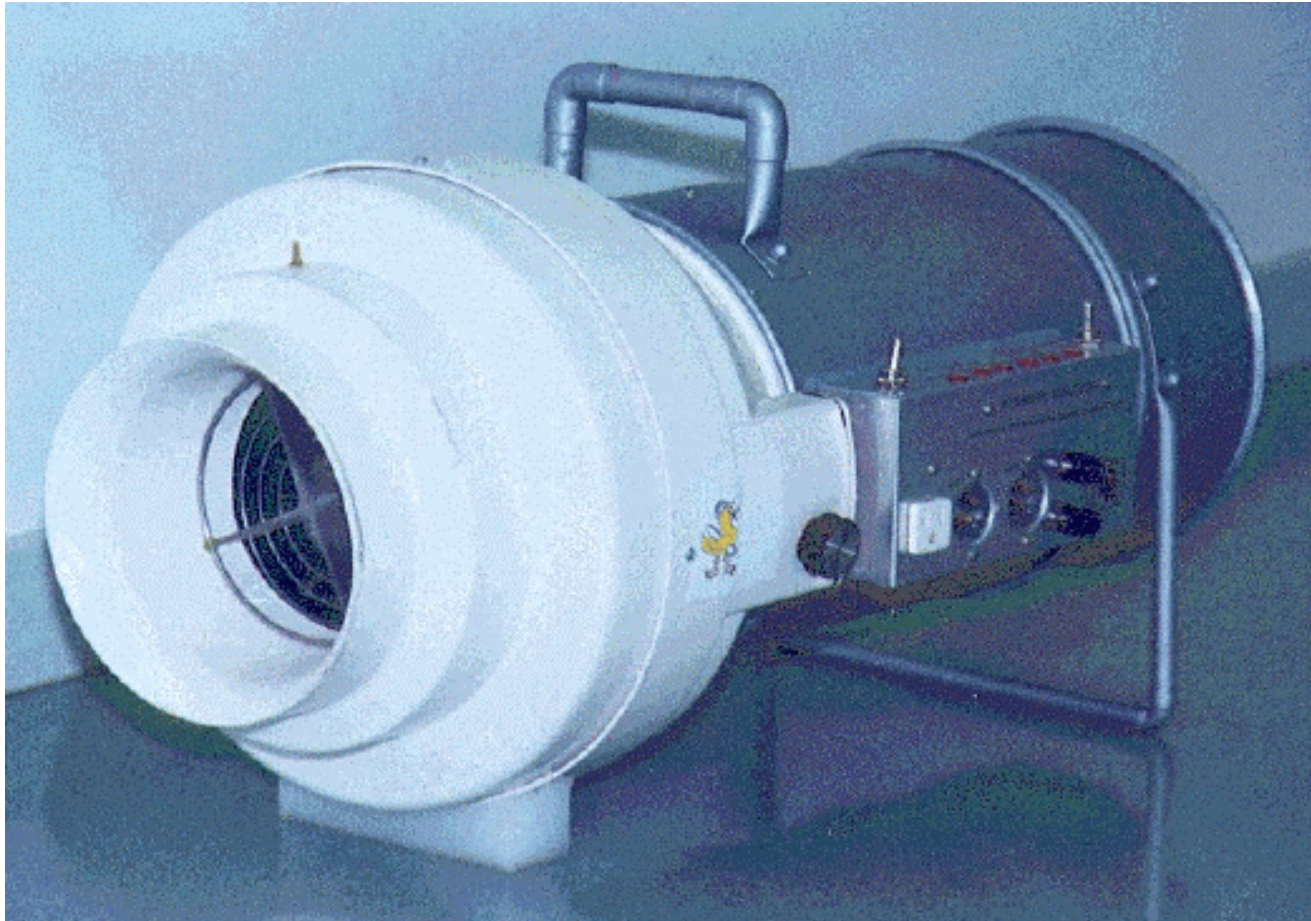


First Aerosol Duct Sealer



1994: First Field Test

Second Aerosol Duct Sealer



1995-1997:Used for BETA Testing in Houses

From the Lab to Market

STEP 1: Many steps taken at LBNL to prepare for commercialization

- Safety, practicality, sealant longevity, performance, value

STEP 2: Nobody wanted to license the technology

- No existing market
- Revolutionary vs. Evolutionary technology

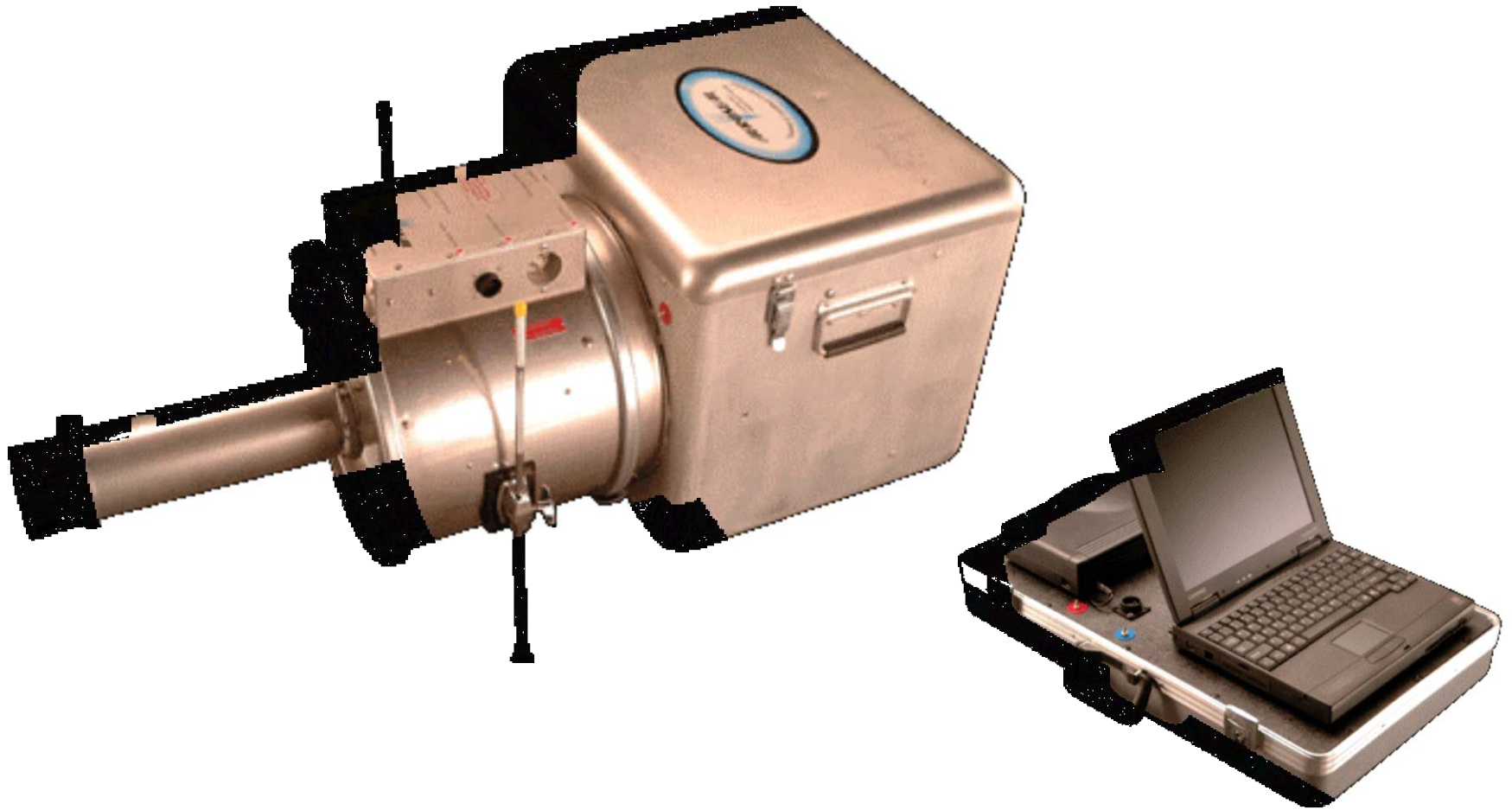
STEP 3: Licensee with strong motivation

- Make or break motivation
- Need someone to drink the Kool-Aid
- I turned out to be the best (potentially only) candidate

STEP 4: A wild ride

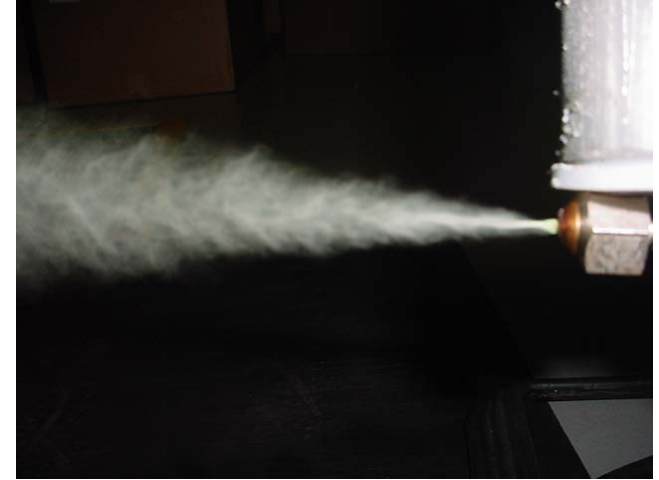
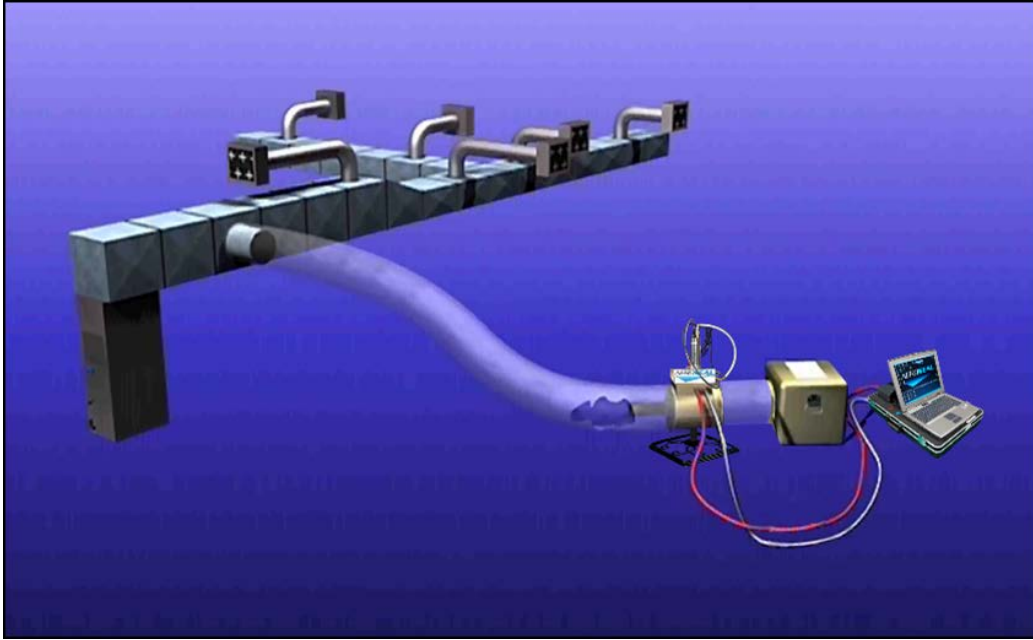
- Research institution turned investor
 - Could not pull the trigger
- Ex-funder partner \Rightarrow disaster
- Cowboy businessman partner \Rightarrow fair but unpredictable

Gen-1 AEROSEAL Machine



1999: First Commercial Product sold to HVAC Dealers

From the Lab to the Real World



- Block all grilles temporarily
- Pressurize duct system with aerosolized sealant
- Track process to watch it working



From a Technology to a Business

- Provide technician with immediate feedback
- Provide customer with proof of performance
- Assure that your business model creates revenue
 - Dealers pay by the application
 - Forced to upload data for machine to work

Certificate of Completion

Duct Sealing Performed for:
Licking Heights W Elem Sup Sec B-1
1490 Climbing Fig Rd
Blacklick, OH 43004
(614)334-9000

Overall Sealing Results

When we arrived,
YOUR DUCTS HAD:

3317 CFM of Leakage, equivalent to a
124 Square Inch Hole

After we finished,
YOUR DUCTS HAVE:

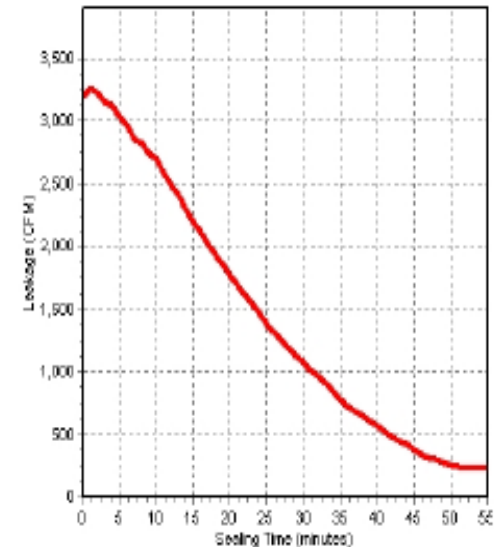
178 CFM of Leakage, equivalent to a
7 Square Inch Hole

This corresponds to a **95%
Reduction** in Duct Leakage

Note: Duct leakage results are calculated in cubic feet per minute (CFM) measured at your reported duct OPERATING PRESSURE of 375 Pa.



Aerosol Sealing Profile



The flow capacity improvement for
this duct system was

314%

of fan flow based upon measured
leakage and operating pressure.

Aeroseal Technician: Tyler Smith
Aeroseal Equipment Serial #: 2153
Saturday, December 21, 2013

Industry Recognition: ASHRAE Standard 152

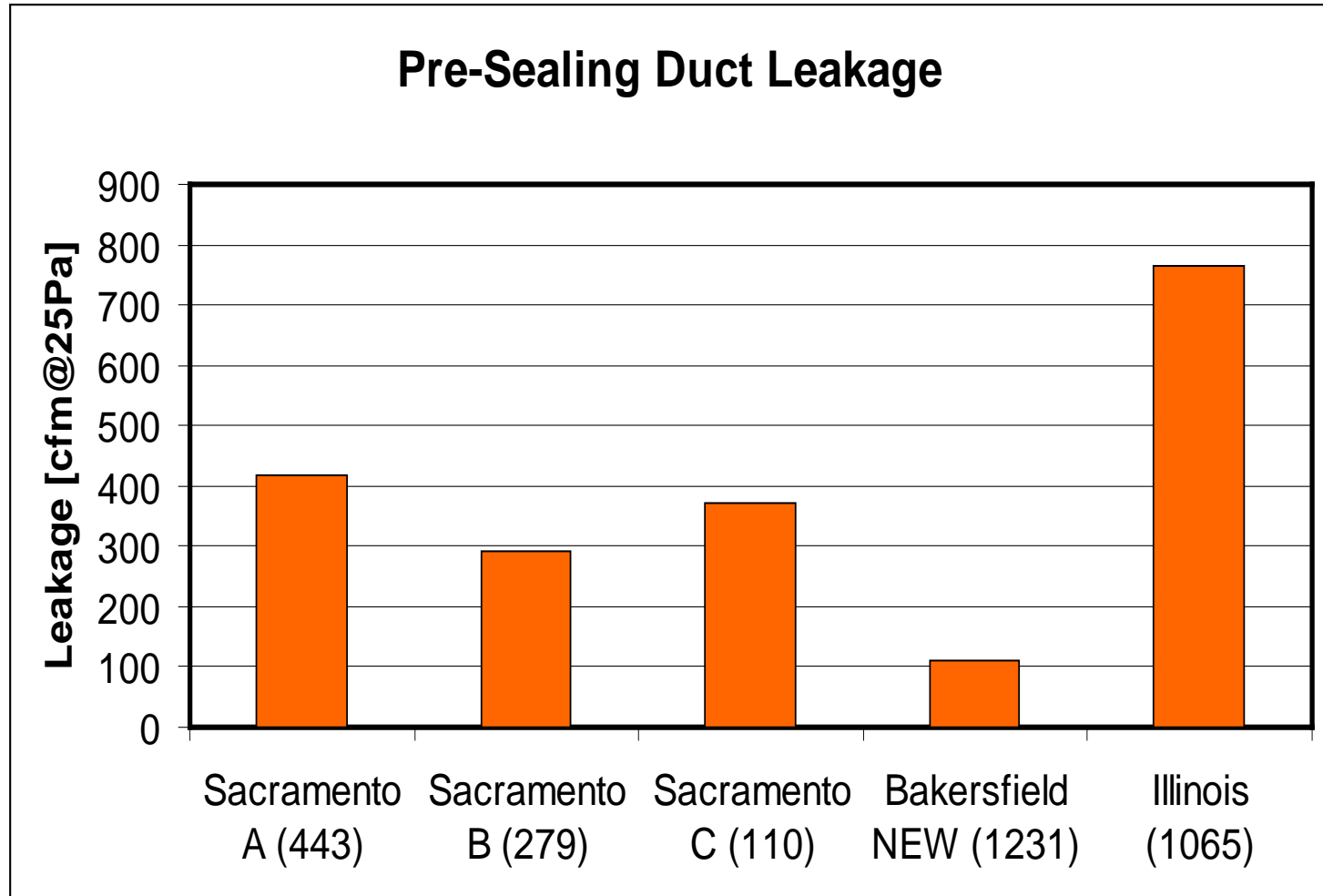
Technology-Agnostic Legitimization

- Test Procedures
- Design Efficiency Calculations (Performance)
- Seasonal Efficiency Calculations (Energy Savings)

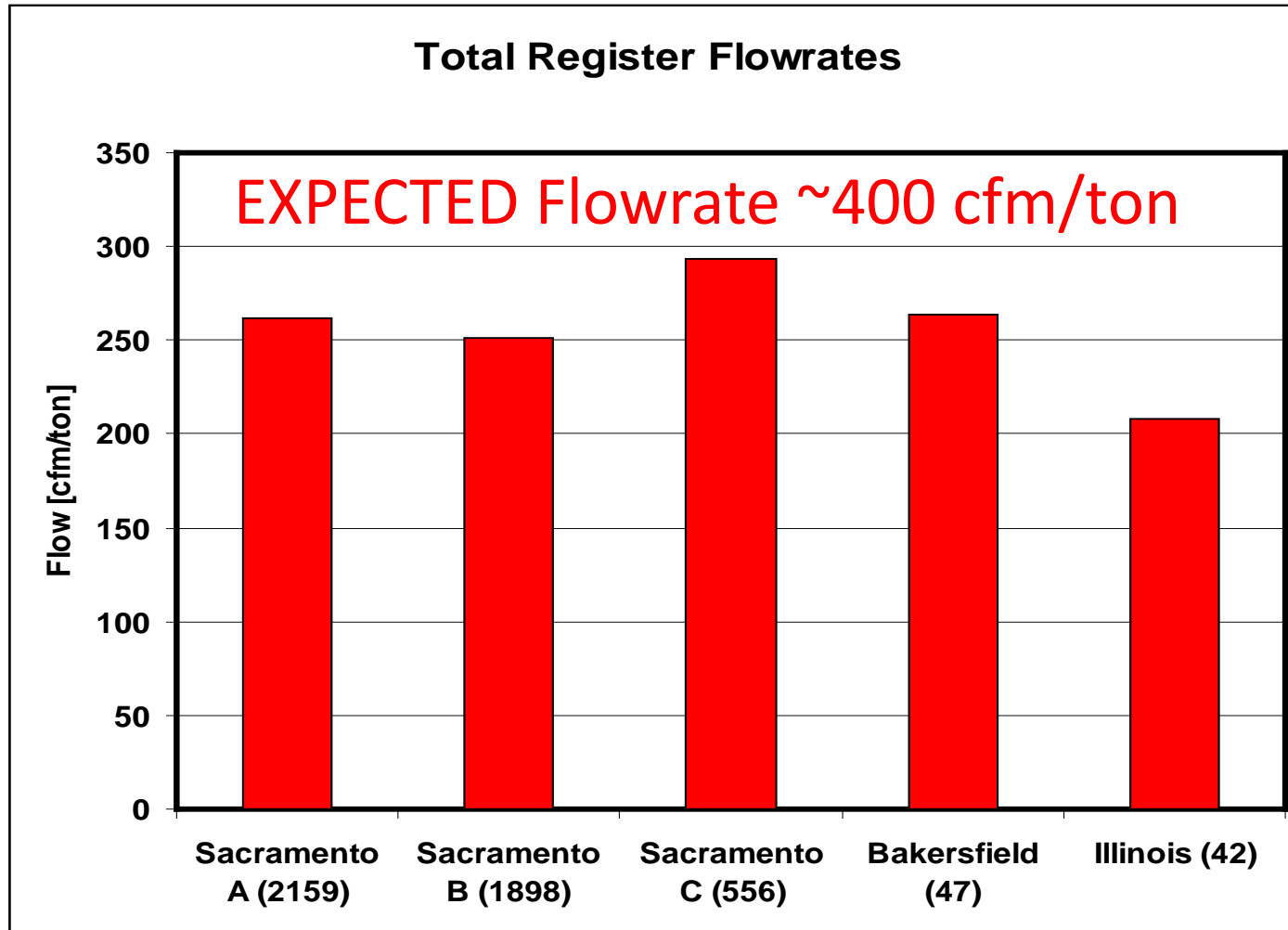


Leakage Data

Statistical Demonstration of Problem

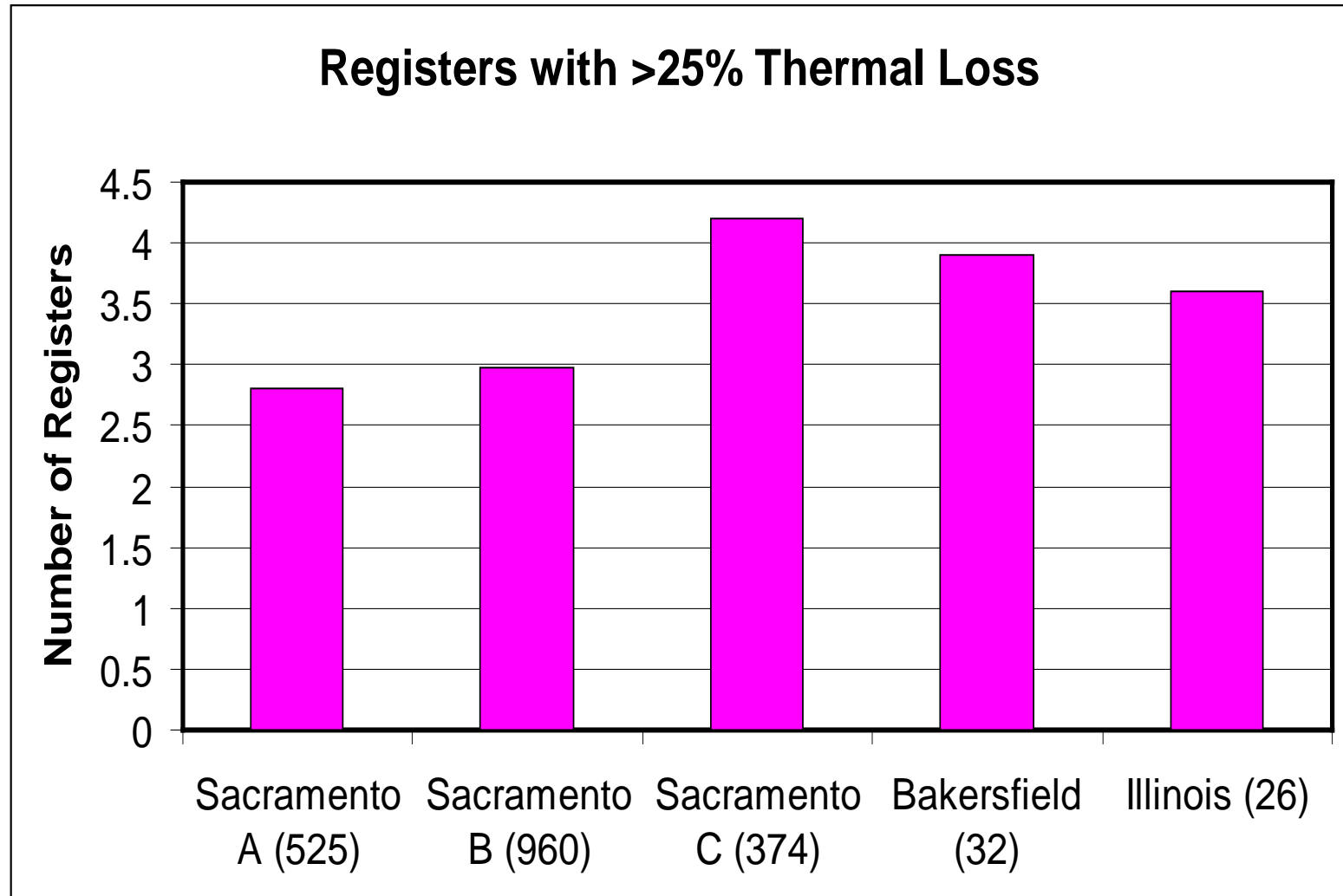


Solving Unrecognized Customer Problem: Diagnosis



Needed to produce complete diagnostic protocol to show value
VALUE PROPOSITION: Customers Not Getting the FLOW

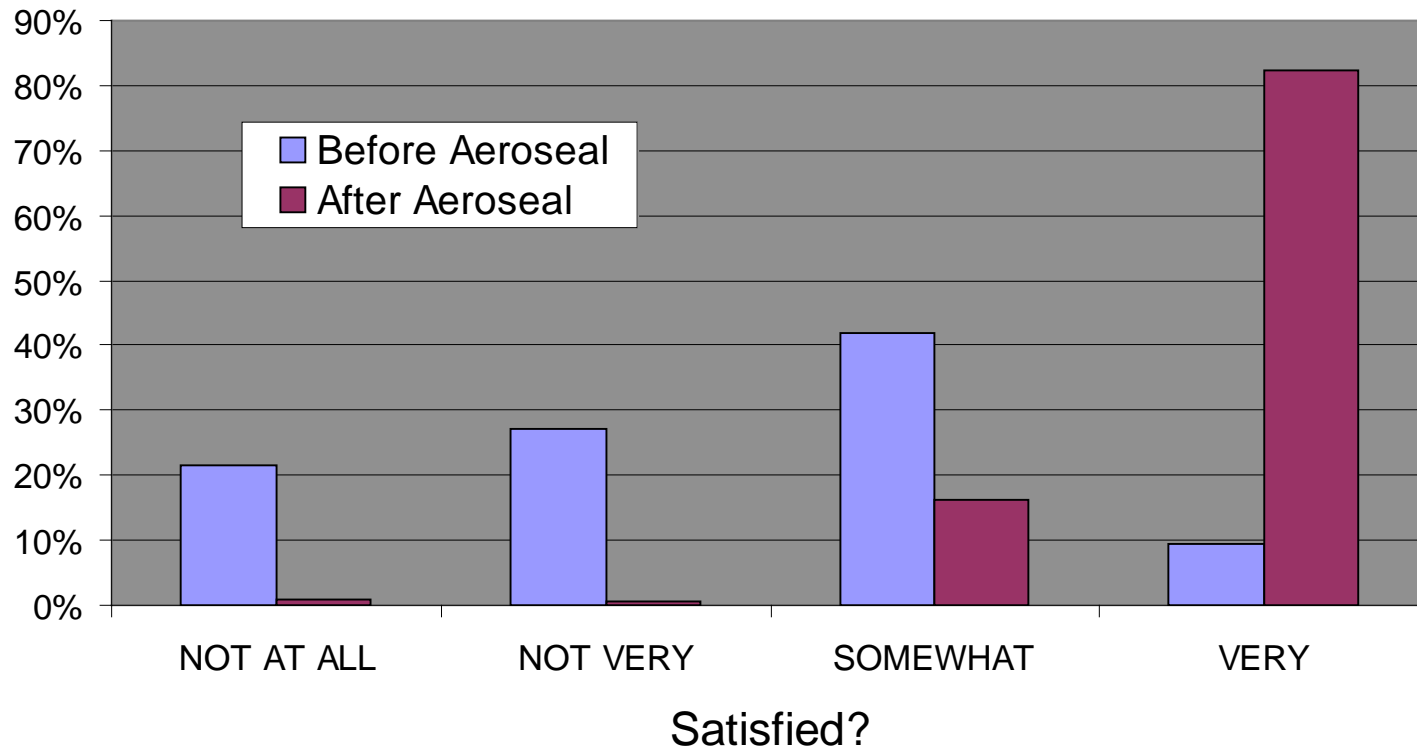
Solving Unrecognized Customer Problem: Diagnosis



Customers Not Getting the desired TEMPERATURE

Utility Survey of HVAC Satisfaction

Satisfaction with HVAC System



**Customer Satisfaction and 3rd Party Verification
Make the Difference**

Generation-2: Modular Sealing Equipment



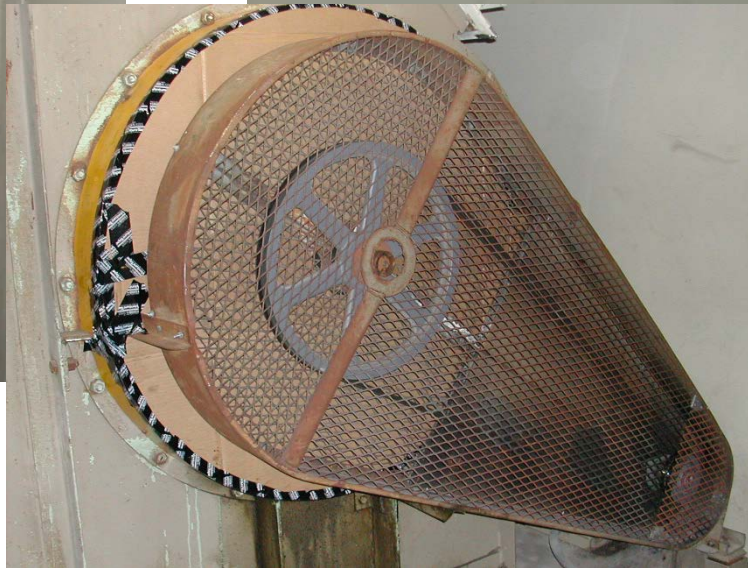
Injection
Wand

Control
Box

Heat
Cylinder

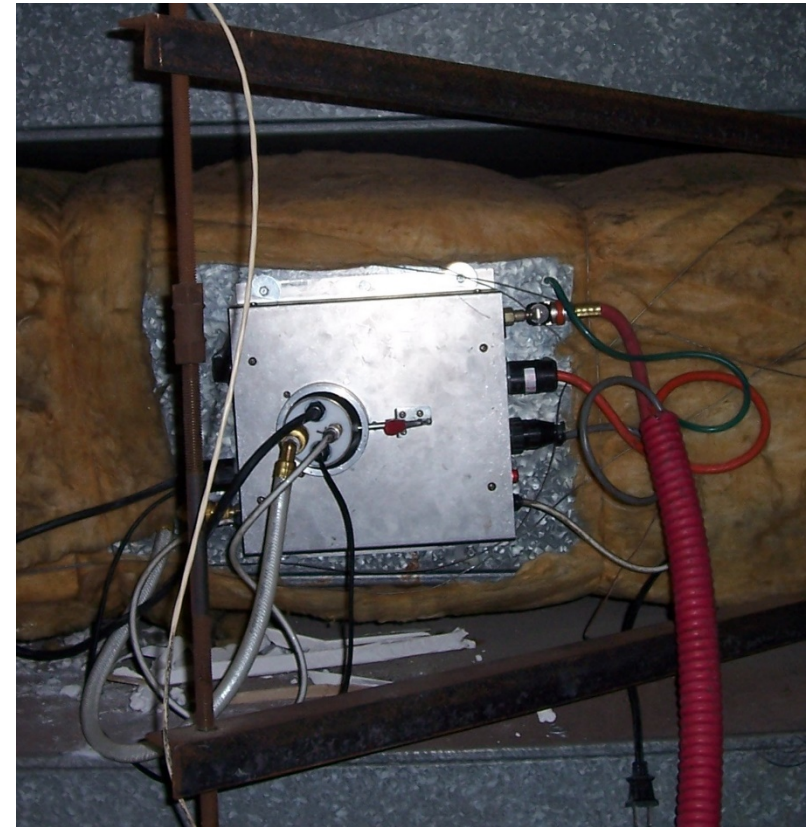
Smaller Particles and More Sealant Flow Sped Up Sealing by Factor of 5-10
Modular Design Facilitated Application in Commercial Buildings

Aerosealing Large Commercial Ducts – Bldg 90



Aerosealing Large Commercial Ducts -LBNL Building 70

➤ LABORATORY Dual Deck Supply Sealing



Aerosealing Large Commercial Ducts -LBNL Building 50

➤ Supply Shaft Sealing



Aerosealing Large Commercial Ducts -LBNL Building 50

➤ Supply Shaft Sealing



Start-Up to Start-Up

STEP 1: Sold company to large corporation

- 16-month negotiation process – very time-consuming
 - Terms and Conditions are king
- Opportune and Inopportune sale timing
 - 2 weeks before 9/11/2001

STEP 2: Pluses and Minuses of a large corporation

- Professionalization and credibility
- Distribution network
- Aero seal was in the financial noise
- Evolution of corporate personnel and priorities

STEP 3: Nine years later

- Contract made corporate divestiture work
- Alternative was complete write-off
- Welcome to the world of private finance

Commercial-Building Sealing – 12 years later

Health Care/Labs



Government



Higher Ed



Property Mgmt



Hospitality



Product Improvement: Current AeroSeal Residential Equipment



New Technology: Building Envelope Sealing

Basic Concept

- Seal New-Construction Building Shells at Rough-In
- Seal Existing Construction at time of occupancy change, or from attic and/or crawlspace
- Reduce cost, get better tightness and get automated certification



Aerosol Building Sealing



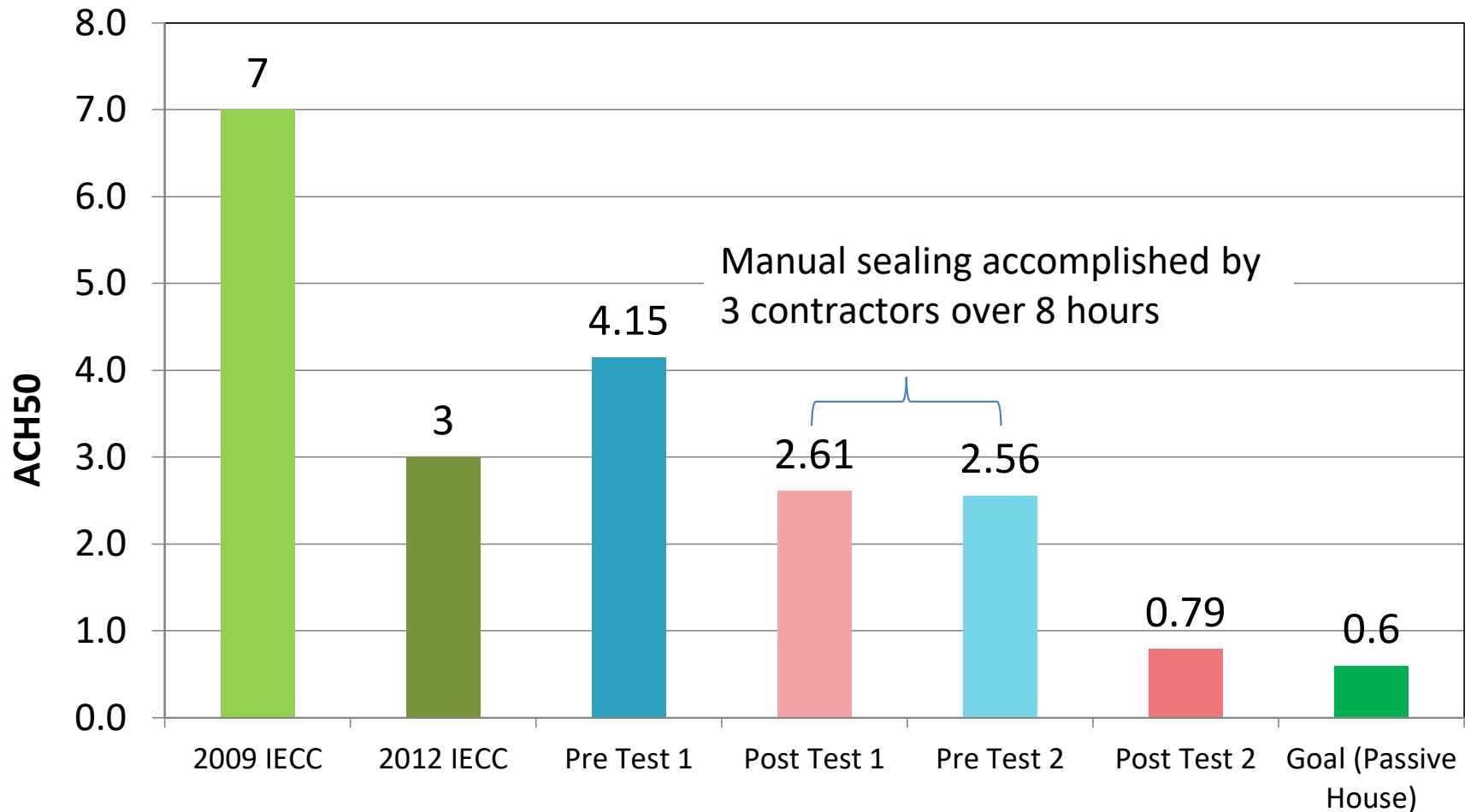
Post-Sheetrock Sealed Leaks



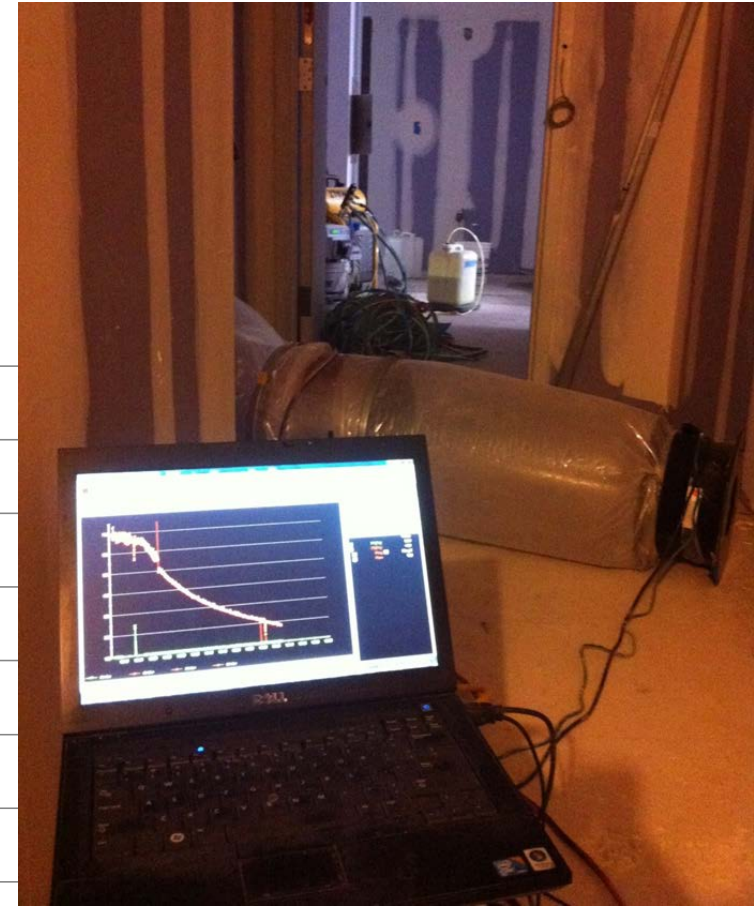
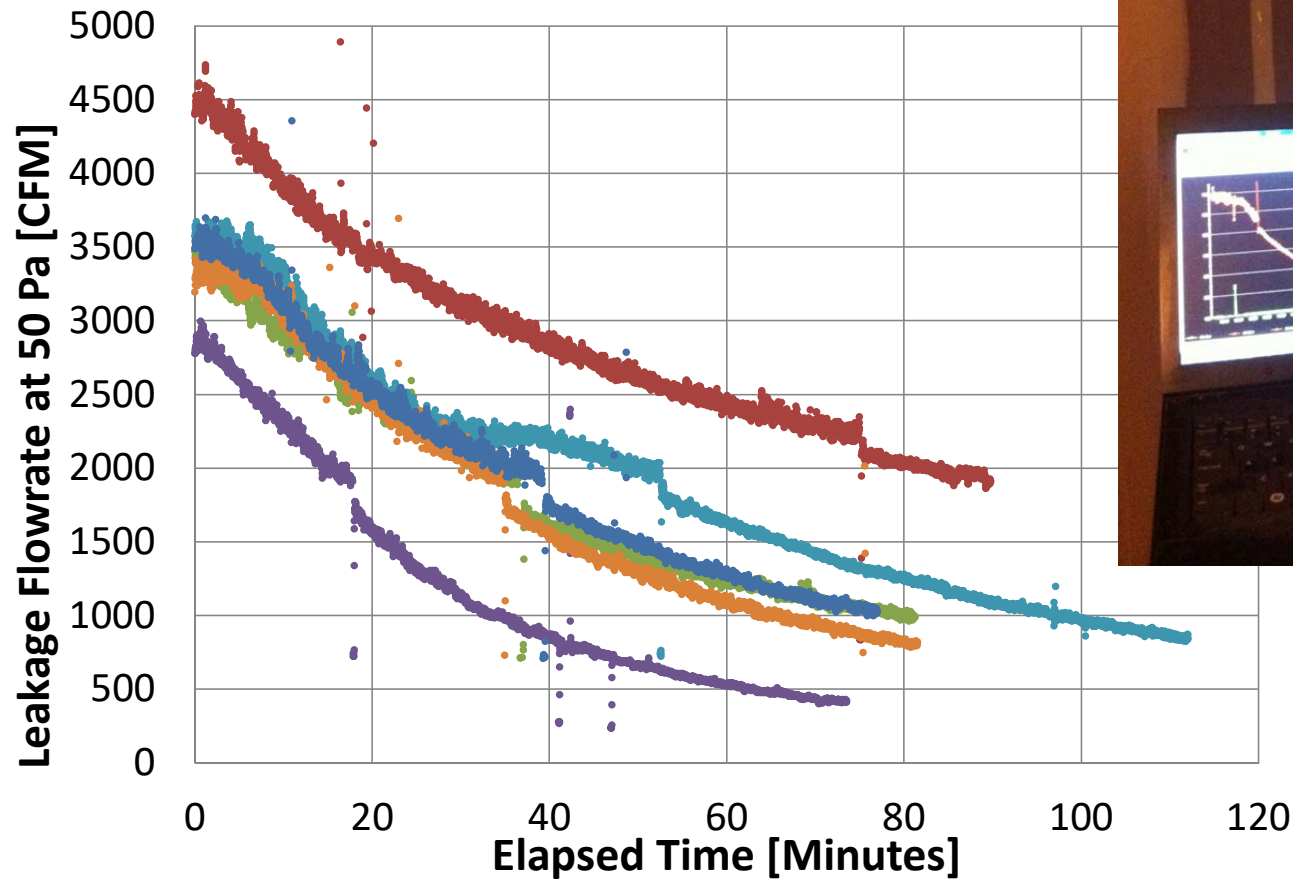
Pre-Sheetrock Sealed Leaks



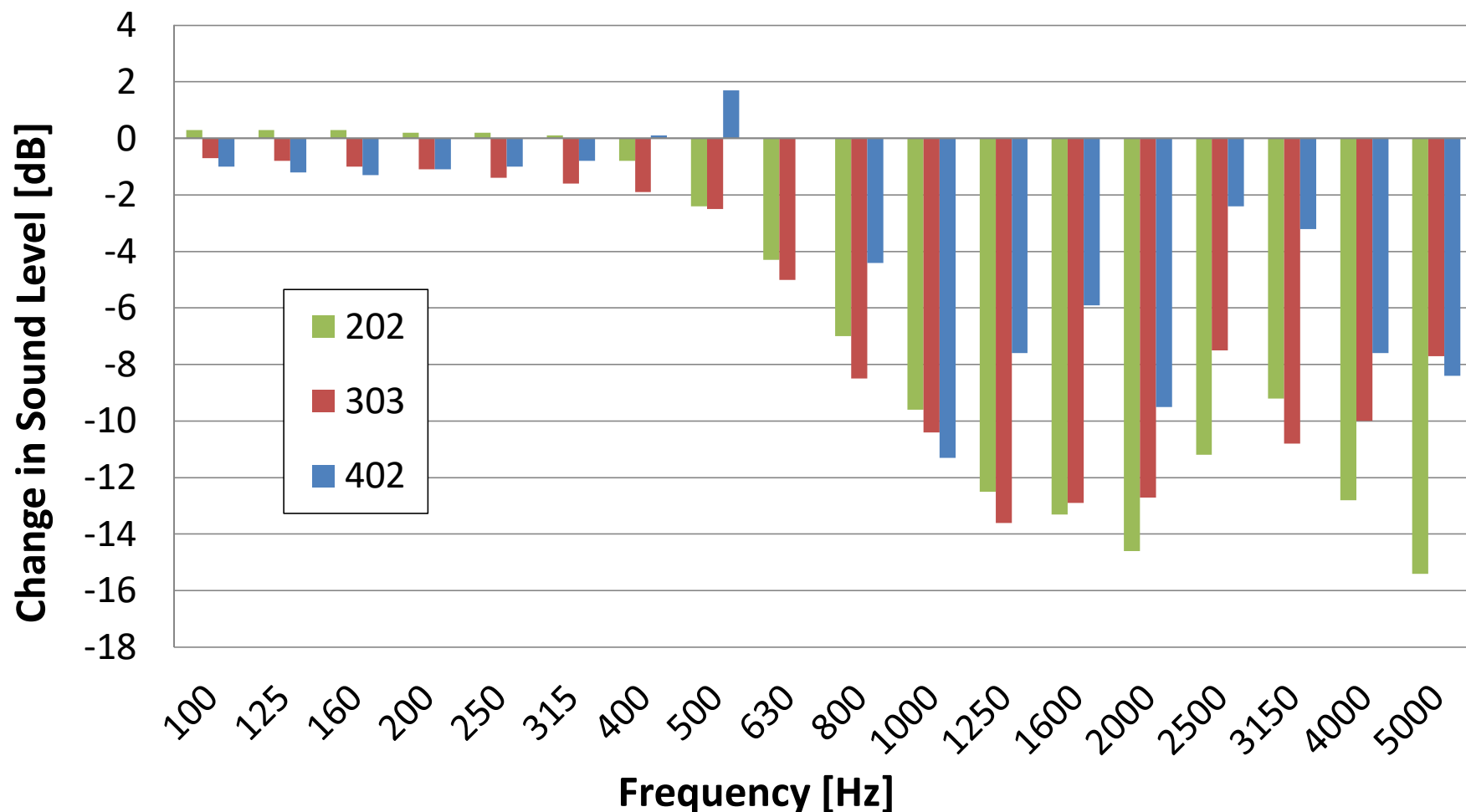
Aerosol Envelope Sealing Comparison with Manual Sealing



Aerosol Building Sealing



Auxiliary Benefit– Sound Transfer Reduction



Aerosol sealing dramatically reduces sound transmission above 800 Hz

From the Lab to Market (Round 2)

STEP 1: Licensing

- Not as hard this time
- Seven firms interested in licensing
- Aeroseal ultimately got the license
 - Conflict of interest kept me out of the process

STEP 2: Addressing Large Range of Applications

- Need technical sophistication
- Need market partners
- **Not yet clear how it will work out**



WCEC MISSION

“Accelerate the development and commercialization of efficient heating, cooling, and energy distribution solutions through stakeholder engagement, innovation, R&D, education, and outreach.”

**Would have accelerated the
Aerosol Commercialization
Process**

ANY QUESTIONS?