



# Large-Building Duct Sealing

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Carrier Aeroseal

**AEROSEAL**<sup>®</sup>  
Certified Duct Diagnostics & Sealing



**GovEnergy**  
[www.govenergy.gov](http://www.govenergy.gov)

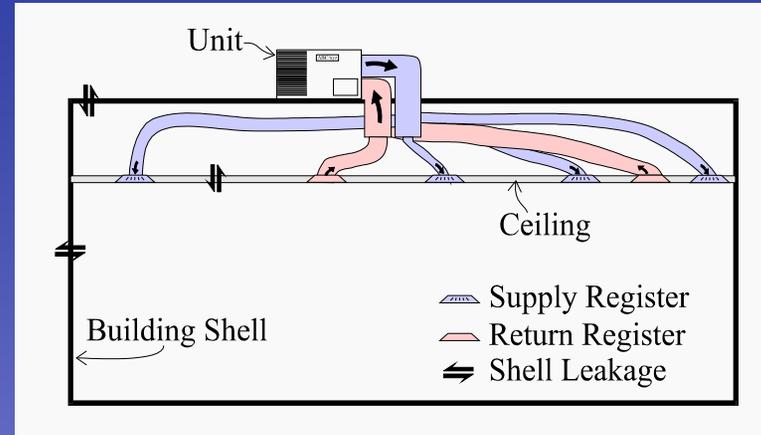


# Presentation Overview

- Energy waste due to duct leaks in large buildings
- Diagnosis and analysis of different types of systems/buildings
- Aero-seal technology for sealing duct leaks remotely
- Applications and results of large-building duct sealing

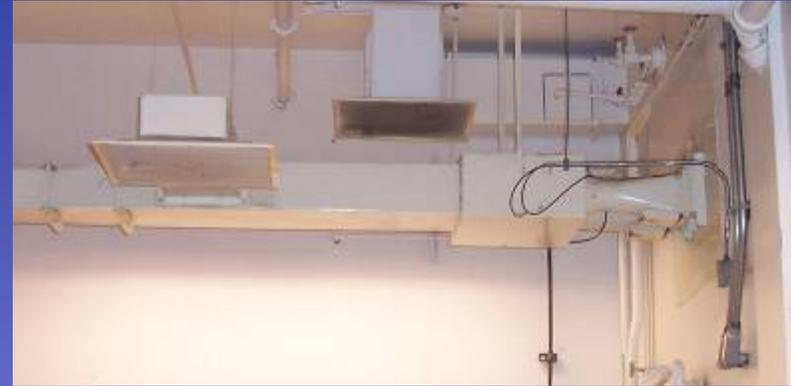
# Energy Waste due to Duct Leakage

- Impacts depend on Building/System Type
  - Small Rooftop Packaged Units
    - Thermal losses from ducts above ceiling insulation
  - Exhaust Systems (Toilet, Sleeping Room, Laboratory)
    - Fan power scales with cube of flow rate
    - Extra flow creates extra heating and cooling loads



# Energy Waste due to Duct Leakage

- Impacts depend on Building/System Type
  - Office VAV Supply System
    - Leaks act a short circuit to fan
    - Fan power scales with flow rate to power 2.4
  - Laboratory/Hospital Supply Systems
    - Fan power impacts
    - 100% outside air creates large heating/cooling loads





# Ventilation Fan Energy Waste

- Fan Power

- Pressure varies with square of flow for ventilation
- Duct leaks create a need to move more air to meet zone flow requirements
- Example
  - 25% exhaust leak
  - 137% excess fan power
  - Sealing 85% of leakage implies 53% reduction in fan power





# Heating/Cooling Energy Waste

- Office Buildings
  - Increased outdoor air flows – fixed fraction control
  - Increased fan heat generation
- Laboratory Buildings
  - 100% outdoor air flows often controlled by pressure
- Ventilation Systems
  - Impacts depend on where exhaust leaks pull from

# Diagnosis of Duct Leakage

- Test and Balance Reports
  - Discrepancy between fan and grille/floor flows
- Direct Leakage Measurement
  - Downstream of VAV boxes
- Leakage Indicators
  - Inadequate flow performance
  - Visual/sensual evidence



# Diagnosis of Duct Leakage

- Direct Leakage Measurement
  - Fan pressurization for leakage downstream of VAV boxes



# Ventilation System Leakage Levels

Building	Fan Flow [cfm]	Leakage [%]	Notes
Condominium (40-Story)	950	74%	Building-Cavity Bathroom Exhaust
University Dorm (10-story)	2,300	70%	Bath/Shower Exhaust
University Dorm (7-story)	2,050	54%	Bath/Shower Exhaust
Navy BEQ (10-story dorm)	6,300	18%	Ducted Supply w/heat wheel
Navy BEQ (10-story dorm)	6,470	54%	Building-Cavity Exhaust w/heat wheel
Barracks (8 3-story buildings)	20,000	20%	Bath/Shower Exhaust
Office Toilet Exhaust (3-story)	8,700	9%	No pre-qualification of leakage
Hospital Exhaust (9-story)	8,200	19%	Sterilization room riser
Laboratory General Exhaust	22,000	27%	80 grilles on 2 floors
<b>AVERAGE</b>		<b>38%</b>	

# Analysis of Duct Leakage

System	Class A	Class B	Class C	Class D	Class E
	Lab Supply	Lab Exhaust	Toilet/Shower Supply/Exhaust Ventilation	Large Office Supply	Small Packaged Systems
<b>Approximate Sealing Price:</b> [\$/ft <sup>2</sup> building space]	\$0.30-\$0.70	\$0.20-\$0.50	\$0.10-\$0.40	\$0.30-\$0.80	\$0.40-\$1.00
<b>Leakage Range</b> [% Fan Flow]	5-40%	5-40%	10-80%	5-30%	10-50%

# Analysis of Duct Leakage: Class E

## Max Sealing Cost (\$/ft<sup>2</sup>) for 10-year Payback - CEILING INSULATION (3000 Total Hrs)

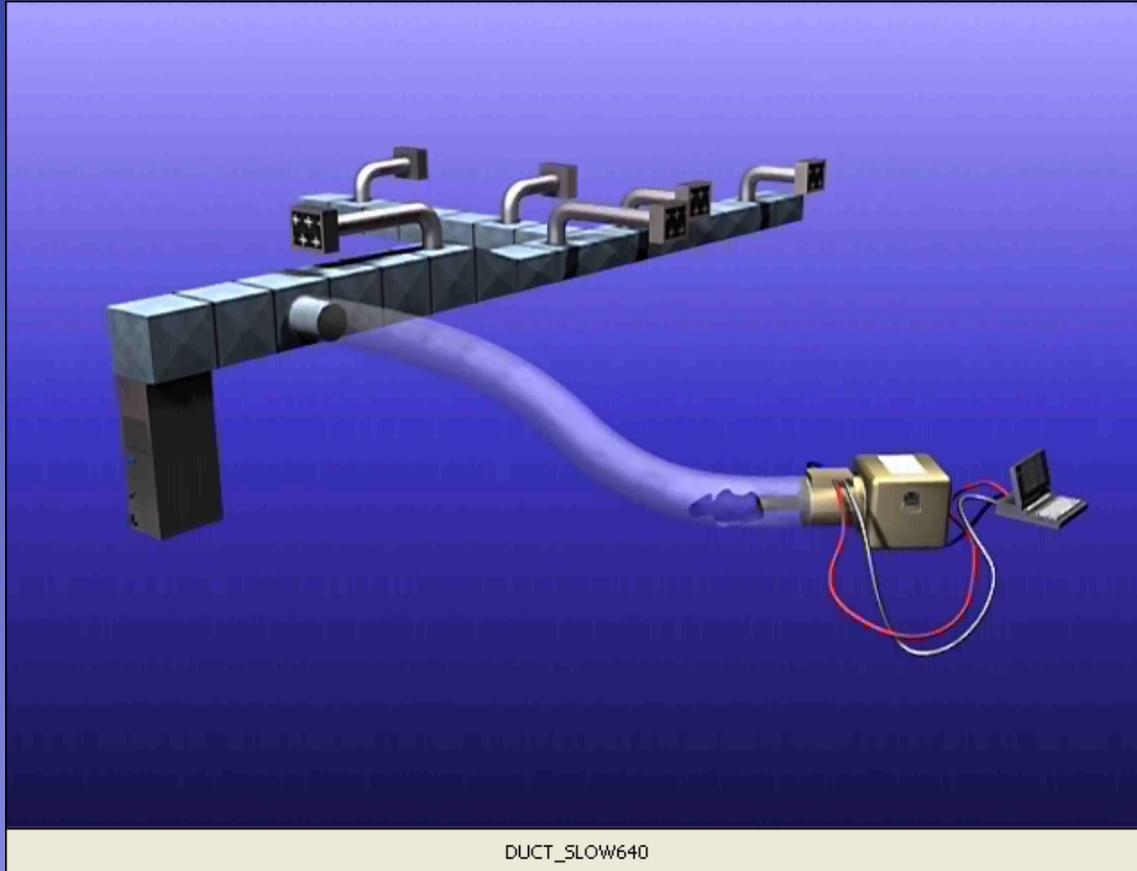
	Supply+Return Leakage (CoolingHoursFraction [Cooling/Total])							
Electric Cost [\$/KWH]/Gas Cost [\$/Therm]	10% (33%)	10% (66%)	20% (33%)	20% (66%)	30% (33%)	30% (66%)	40% (33%)	40% (66%)
<b>\$0.04/\$1.00</b>	\$0.62	\$0.45	\$1.23	\$0.89	\$1.85	\$1.34	\$2.47	\$1.79
<b>\$0.08/\$1.00</b>	\$0.71	\$0.63	\$1.42	\$1.26	\$2.13	\$1.89	\$2.47	\$1.79
<b>\$0.12/\$1.00</b>	\$0.80	\$0.81	\$1.60	\$1.63	\$2.40	\$2.44	\$3.20	\$3.26
<b>\$0.16/\$1.00</b>	\$0.89	\$1.00	\$1.79	\$2.00	\$2.68	\$3.00	\$3.57	\$4.00
<b>\$0.04/\$0.60</b>	\$0.41	<b>\$0.34</b>	\$0.81	\$0.68	\$1.22	\$1.02	\$1.63	\$1.37
<b>\$0.08/\$0.60</b>	\$0.50	\$0.53	\$1.00	\$1.05	\$1.50	\$1.53	\$1.99	\$2.10
<b>\$0.12/\$0.60</b>	\$0.59	\$0.71	\$1.18	\$1.42	\$1.77	\$2.13	\$2.36	\$2.84
<b>\$0.16/\$0.60</b>	\$0.68	\$0.89	\$1.37	\$1.79	\$2.05	\$2.68	\$2.73	\$3.58

# Analysis of Duct Leakage: Class E

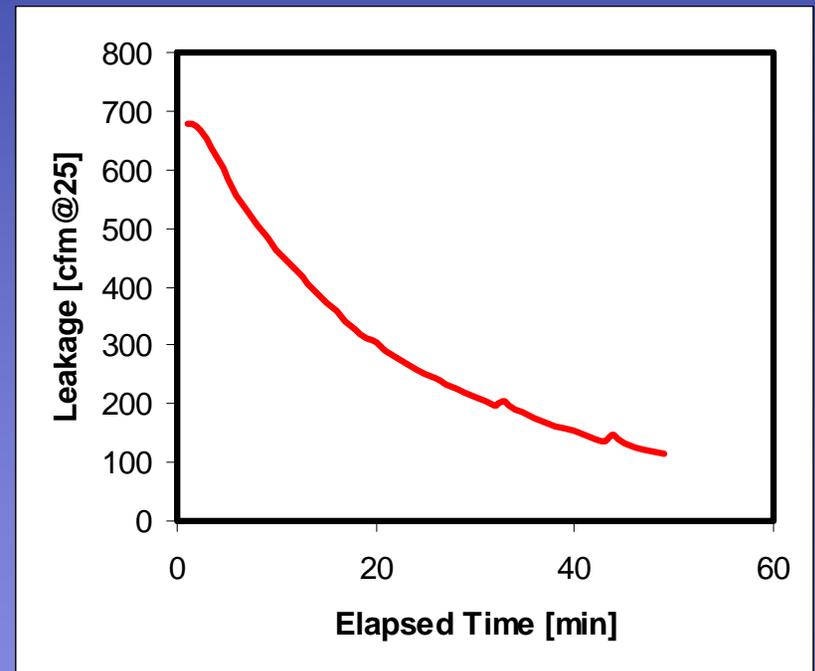
## Max Sealing Cost (\$/ft<sup>2</sup>) for 10-year Payback - ROOF INSULATION (3000 Total Hrs)

Electric Cost [\$/KWH]/Gas Cost [\$/Therm]	Supply+Return Leakage (CoolingHoursFraction [Cooling/Total])							
	10% (33%)	10% (66%)	20% (33%)	20% (66%)	30% (33%)	30% (66%)	40% (33%)	40% (66%)
\$0.04/\$1.00	\$0.20	\$0.13	\$0.39	\$0.26	\$0.59	\$0.38	\$0.78	\$0.51
\$0.08/\$1.00	\$0.22	\$0.17	\$0.43	\$0.34	\$0.65	\$0.51	\$0.86	\$0.68
\$0.12/\$1.00	\$0.24	\$0.21	\$0.47	\$0.42	\$0.71	\$0.63	\$0.94	\$0.84
\$0.16/\$1.00	\$0.26	\$0.25	\$0.51	\$0.50	\$0.77	\$0.75	\$1.03	\$1.00
\$0.04/\$0.60	\$0.13	\$0.09	\$0.25	\$0.19	\$0.38	\$0.28	\$0.50	\$0.37
\$0.08/\$0.60	\$0.15	\$0.13	\$0.29	\$0.27	\$0.44	\$0.40	\$0.58	\$0.54
\$0.12/\$0.60	\$0.17	\$0.18	\$0.33	\$0.35	\$0.50	\$0.53	\$0.66	\$0.70
\$0.16/\$0.60	\$0.19	\$0.22	\$0.37	\$0.43	\$0.56	\$0.65	\$0.75	\$0.86

# Aeroseal Sealing Process



# Aeroseal Sealing Process





# Aeroseal Process FAQs

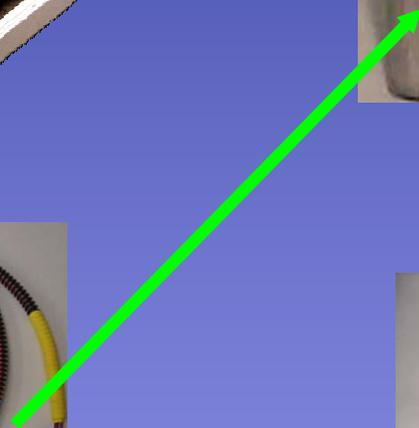
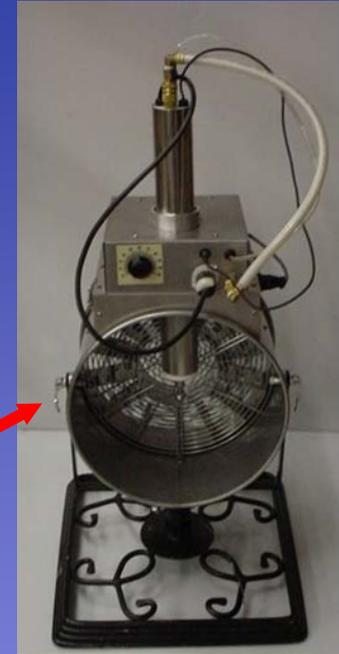
- Seals holes up to **1/2"** across
- Sealant remains **rubbery**
- **Need not clean before sealing** (with caveats)
- **Cleaning after sealing generally does not hurt seals**
- **Does not coat the ducts**
- **Vinyl polymer is safe**
- **No lingering odors or off-gassing**
- **Lasts 10+ years**



# Aeroseal Process: Brief History

- **Technology developed at Lawrence Berkeley National Laboratory**
- **First sold by Aeroseal in 1999 for Residential applications - ~30,000 to date**
- **Aeroseal purchased by Carrier in 2001**
- **Large-Building sealing first sold by Carrier in 2003**
- **Carrier Commercial Service incorporating duct sealing in large buildings nationwide**

# Aeroseal Process Equipment



# Aeroseal Applications



## ➤ Blocking Diffusers



# Aeroseal Applications

## ➤ Slot Diffuser System



# Aeroseal Applications

## ➤ Downstream of VAV boxes



# Aeroseal Applications

## ➤ Downstream of VAV Boxes



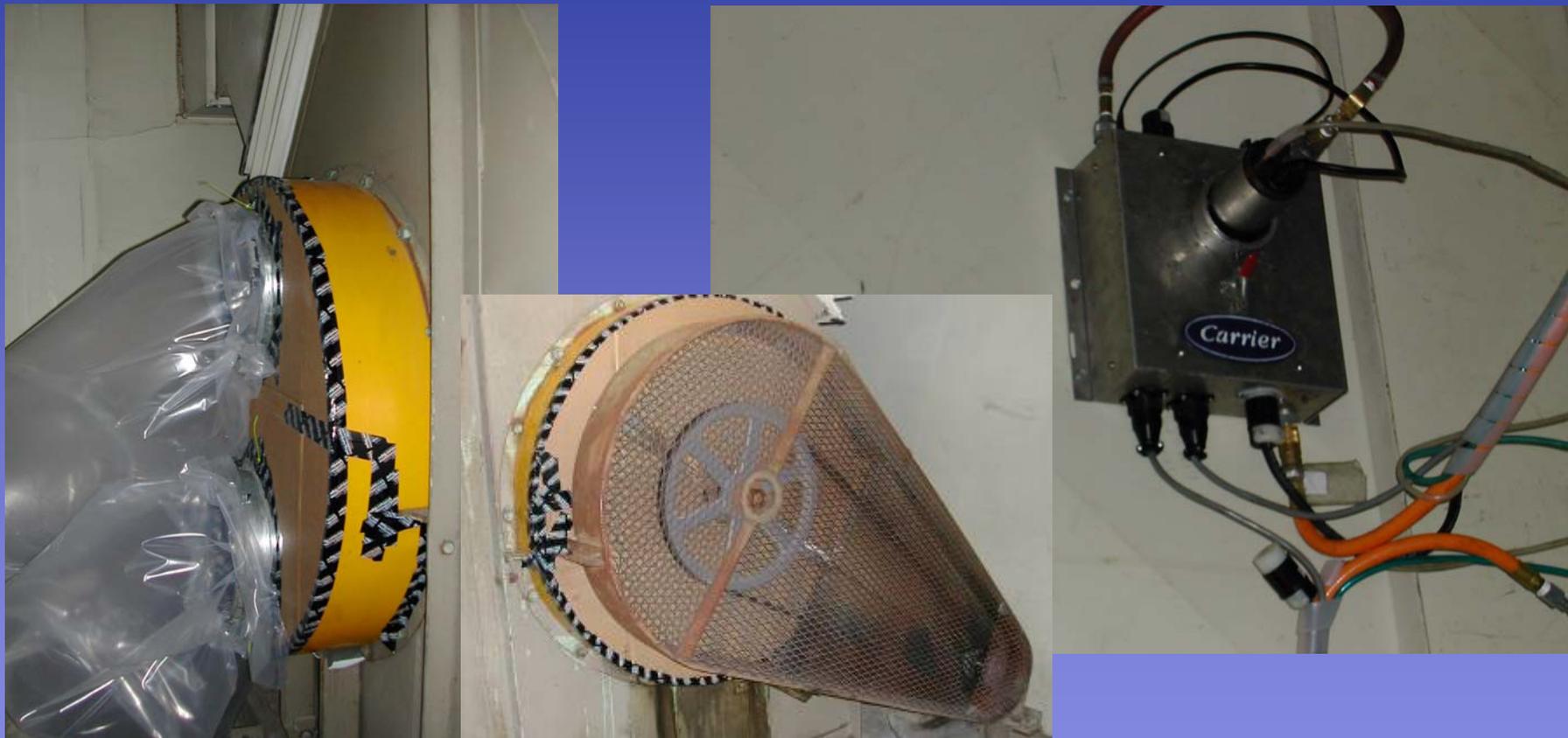
# Aeroseal Applications

- SCRUBBER FANS
- Capture particles in occupied spaces or above ceiling tiles



# Aeroseal Applications

## ➤ Sealing Through Main Supply Fan



# Aeroseal Applications

## ➤ Sealing Through Pneumatic-Control Terminal Boxes



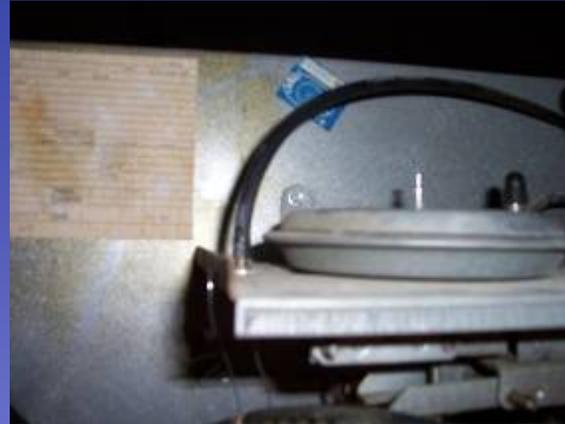
# Aeroseal Applications

## ➤ Sealing Through Pneumatic-Control Terminal Boxes



# Aeroseal Applications

## ➤ Sealing Through Pneumatic-Control Terminal Boxes



# Aeroseal Applications

## ➤ Dual Deck Laboratory Supply Sealing



# Aeroseal Applications

## ➤ Dual Deck Laboratory Supply Sealing



# Aeroseal Applications

## ➤ Supply Shaft Sealing



# Aeroseal Applications

## ➤ Supply Shaft Sealing



# Aeroseal Applications

## ➤ Small Lab Exhaust Sealing



# Aeroseal Applications

## Large Lab Exhaust Sealing



# Aeroseal Applications

System Type	Fan Flow [cfm]	Initial Leakage [%]	Fraction Sealed
Constant Volume Supply	69,000	19%	87%
Dual Duct Supply	93,000	36%	78%
CV Exhaust	22,000	27%	85%
CV Exhaust	20,000	20%	93%
Constant Volume Supply	14,000	19%	87%
VAV Supply	46,200	19%	92%
CV Exhaust	10,000	10%	90%
VAV Induction Supply	16,610	15%	92%
CV Supply/Exhaust	10,995	1% - 23%	87%
CV Exhaust	8,200	19%	85%
CV Exhaust	4,350	54-70%	75%
Constant Volume Supply	63,000	29%	89%
Supply/Return Risers	18,000	17%	91%
<b>AVERAGE</b>		<b>23%</b>	<b>87%</b>



# Summary

- **Duct leakage wastes energy in large buildings**
  - even when leaks are all inside the conditioned space
  - Use Test and Balance Reports, Diagnostics, or Physical Evidence to uncover leaky duct systems
- **Aeroseal can seal duct leaks in many different large-building applications**
- **Duct leakage sealing is cost-effective in large buildings**
  - generally meets 10-year payback criteria
  - paybacks often less than 5 years
  - TECVAL is developing a decision-tree tool



# For More Information

- Would you like to know more about this topic?
  - Visit Carrier AeroSeal ([www.aeroseal.com](http://www.aeroseal.com))
  - Contact Mark Modera
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Don't forget to fill out and drop off your session evaluations!



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