Fans, Ducts and Air Handling Systems: Design, Performance and Commissioning Issues

Louvers and Dampers

Instructor:

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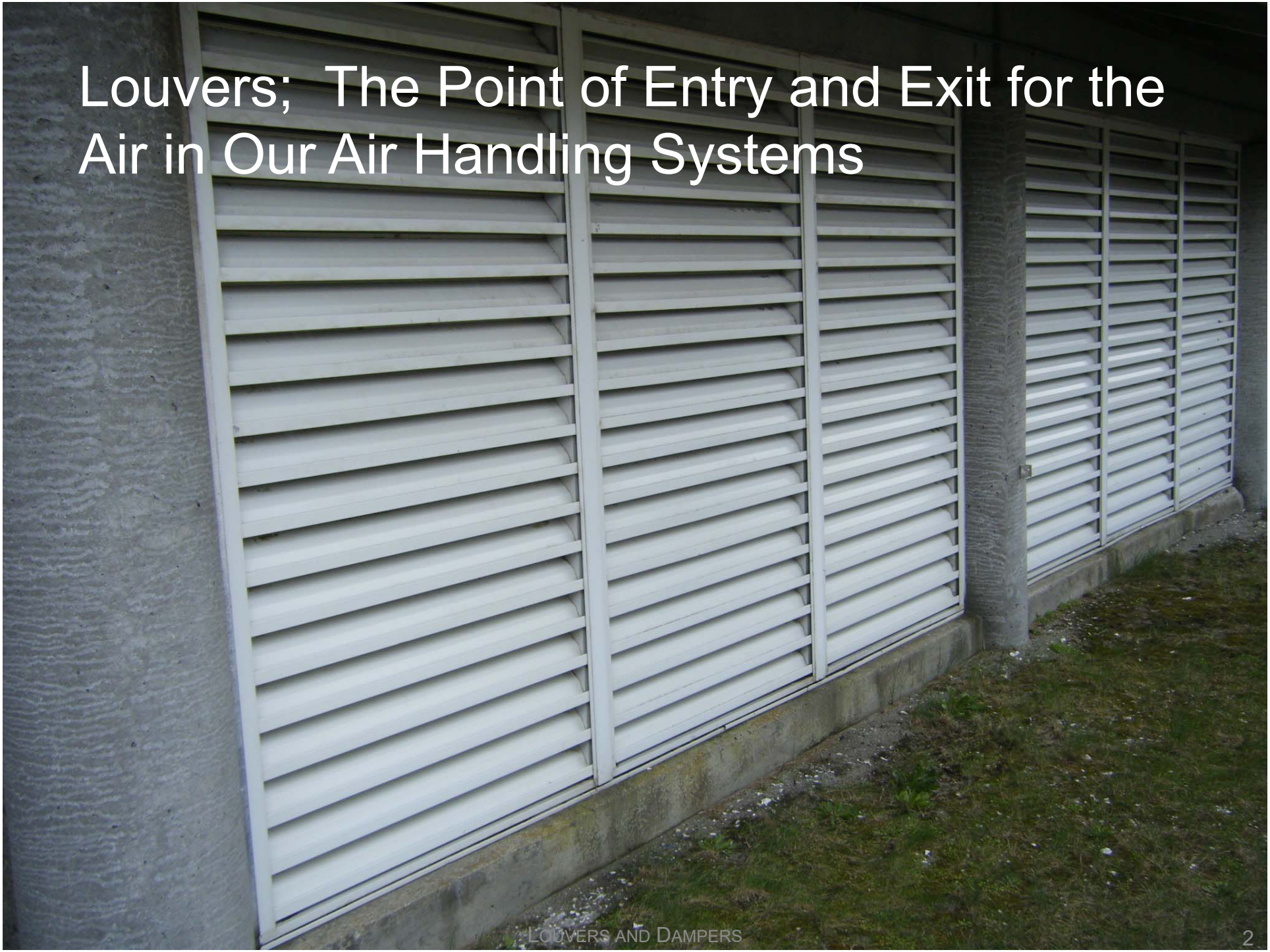
Facility Dynamics Engineering

November 7, 2017

Louvers; The Point of Entry and Exit for the Air in Our Air Handling Systems



Louvers; Main Functions

Architectural appearance

Above all else, it is of critical importance that the louvers appeal to the senses of the casual passer by; that they somehow beckon and call out to them, causing them to pause and contemplate, even relish the possibility of entering the building and securing a tour of the air handling systems and major mechanical spaces

Unknown

Louvers; Main Functions

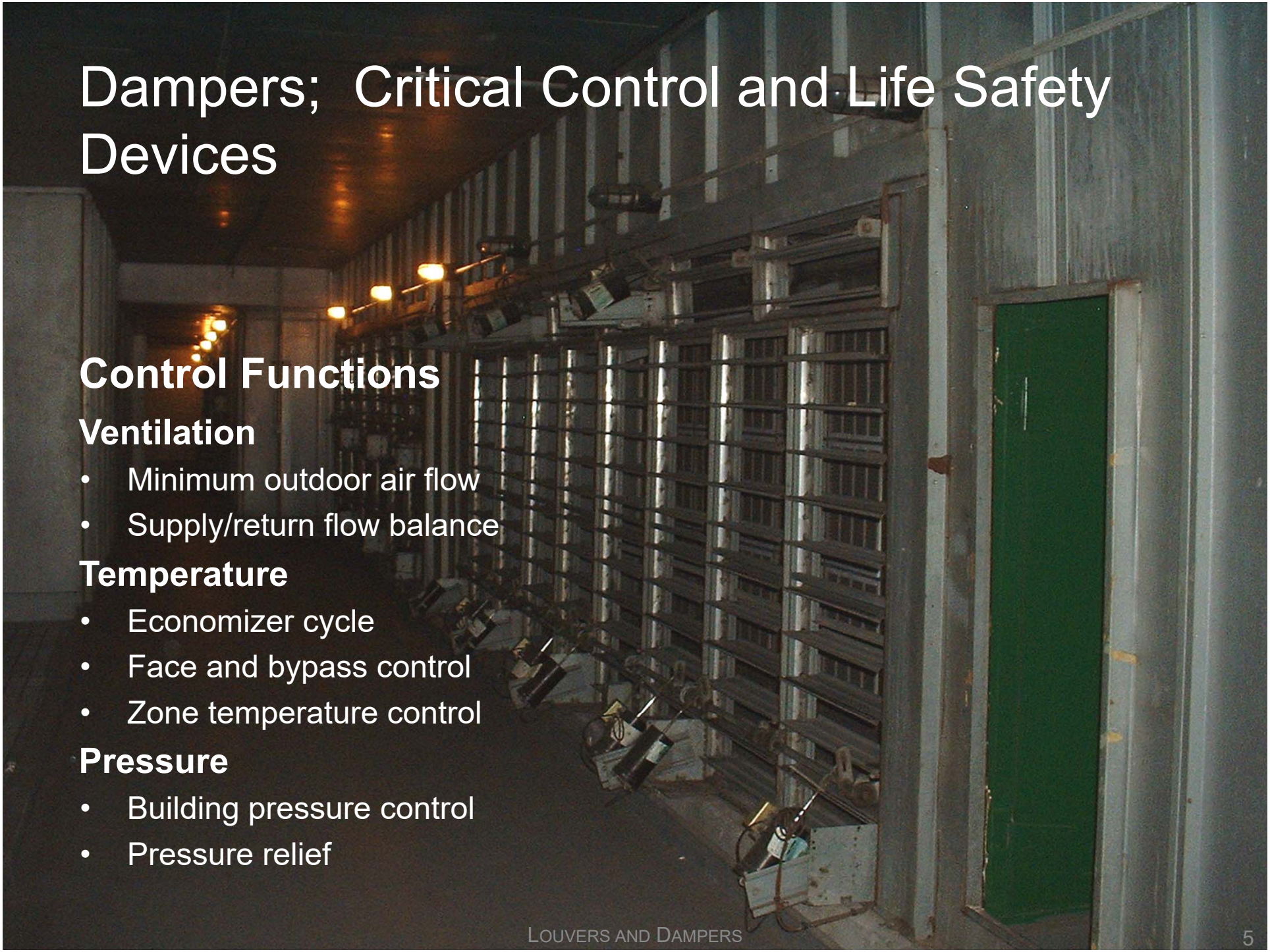
Architectural appearance

Only let air in (or out)

- Keep out the bugs and birds (and bats)
- Keep out the rain
- Secure the envelope penetration

Have minimal pressure drop

Dampers; Critical Control and Life Safety Devices



Control Functions

Ventilation

- Minimum outdoor air flow
- Supply/return flow balance

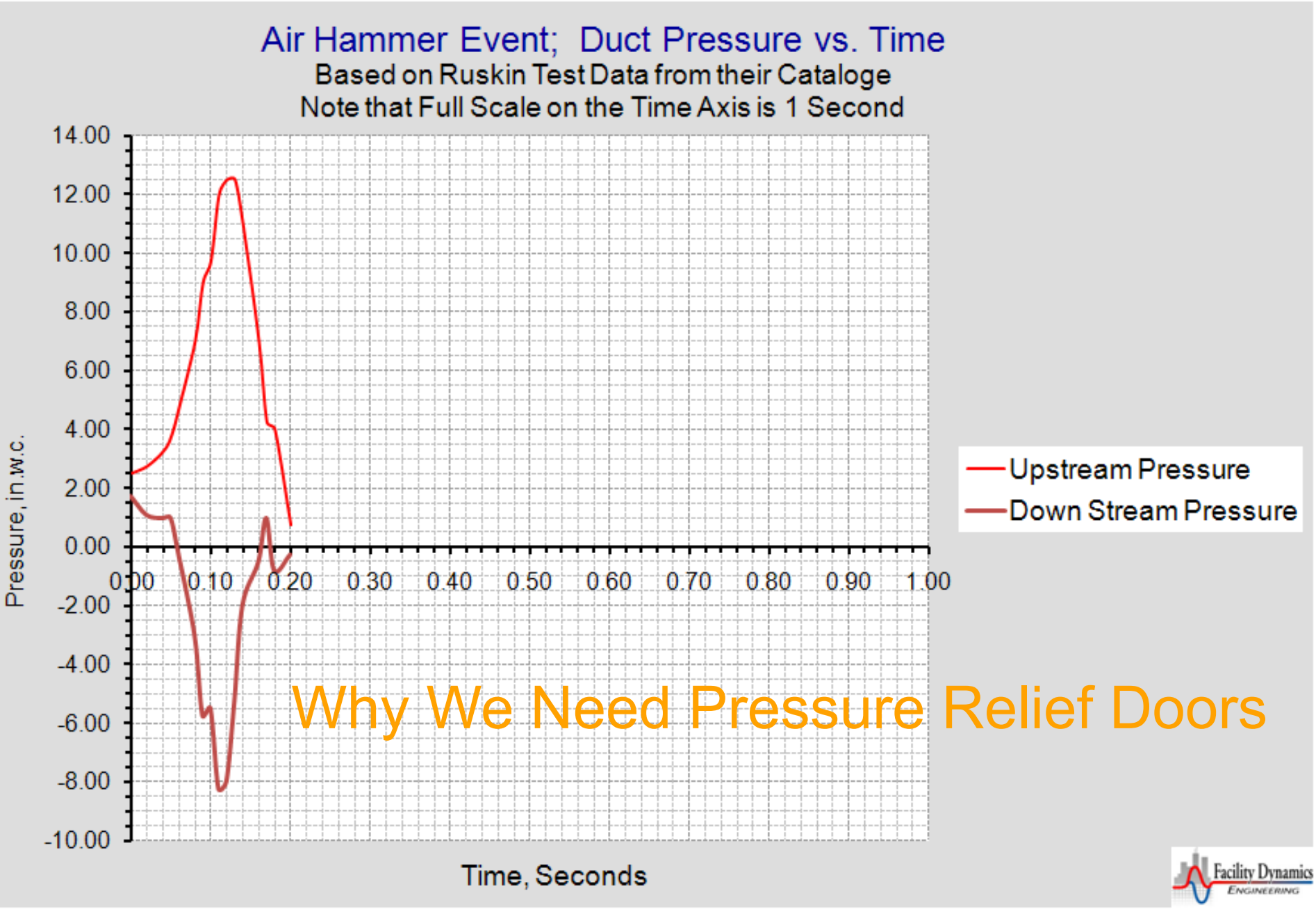
Temperature

- Economizer cycle
- Face and bypass control
- Zone temperature control

Pressure

- Building pressure control
- Pressure relief

Typical Pressure Relief Door Installation



Why We Need Pressure Relief Doors

Critical Control and Life Safety Devices

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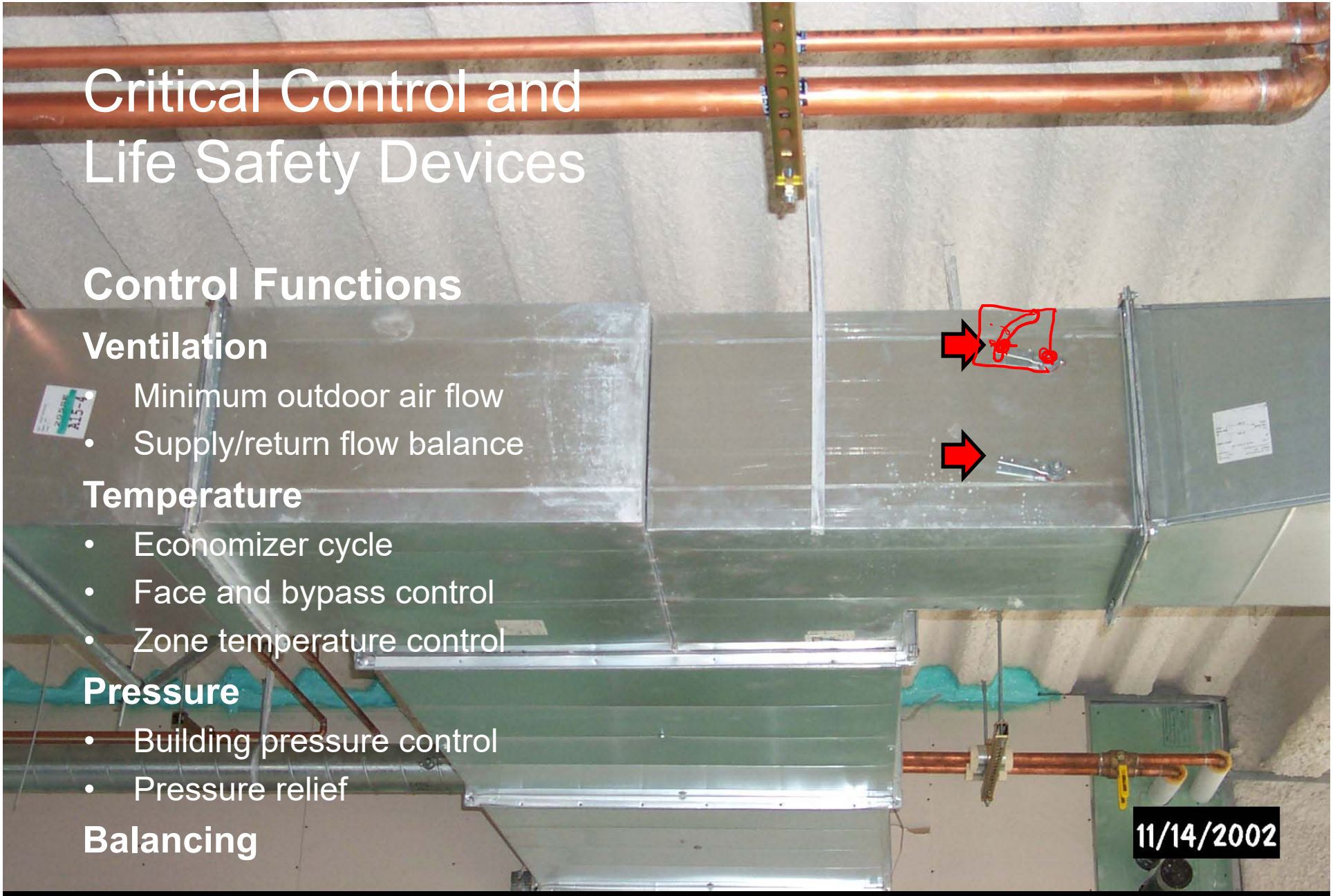
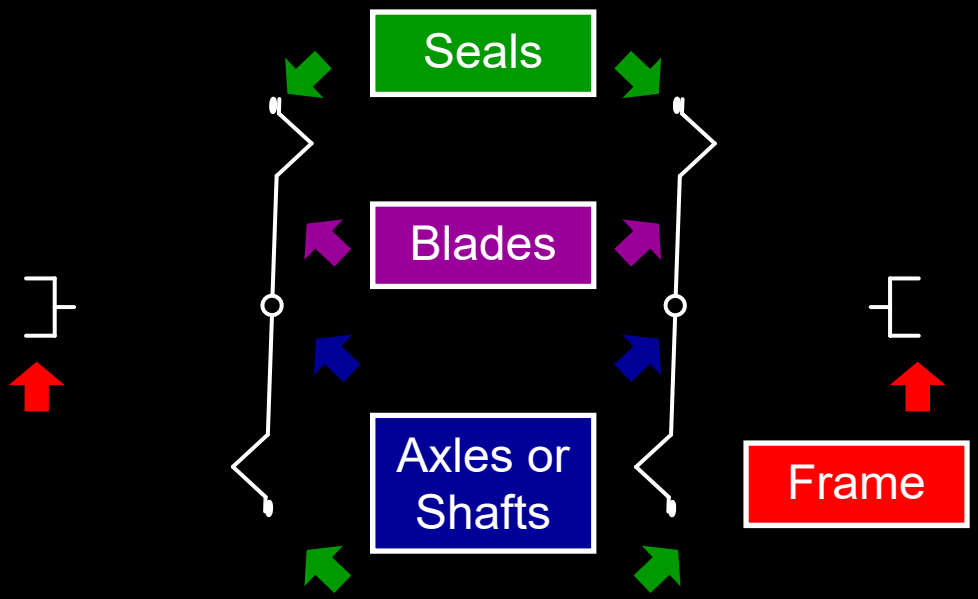
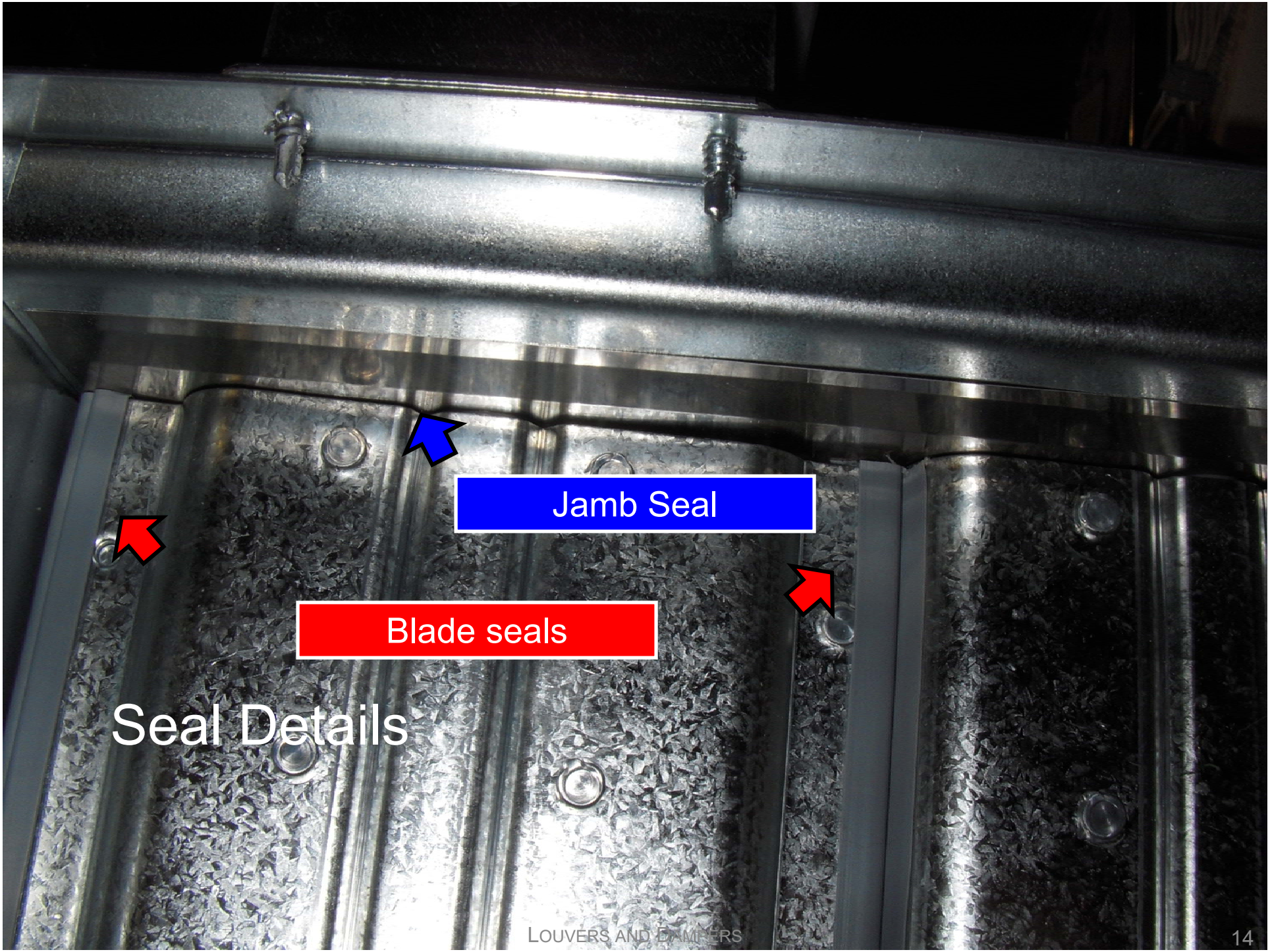


Damper Parts



A Conventional, Flat Plate Blade Cross-Section

Greenheck's Airfoil Blade Cross-Section

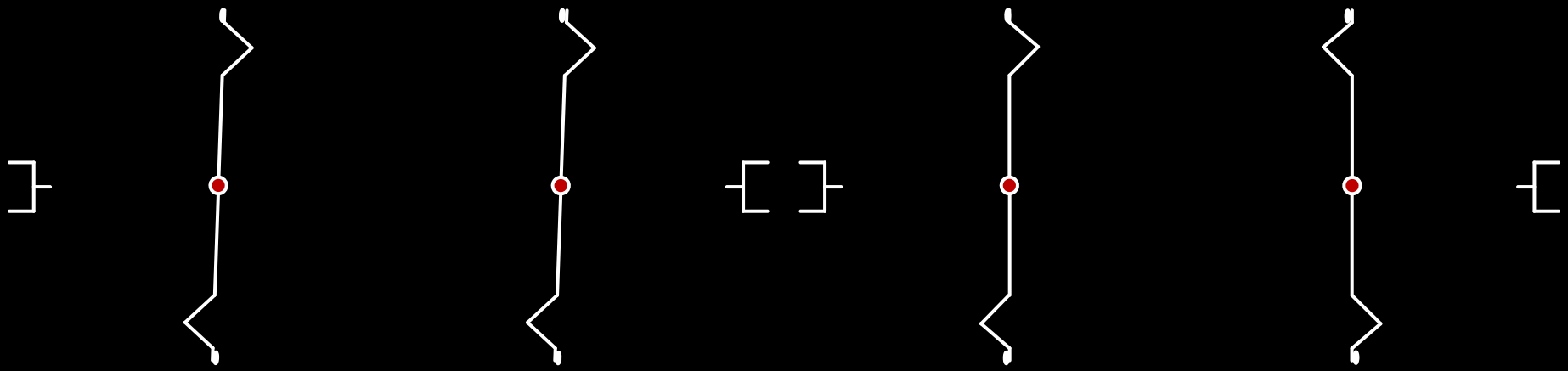


Seal Details

Parallel vs. Opposed Blade Dampers

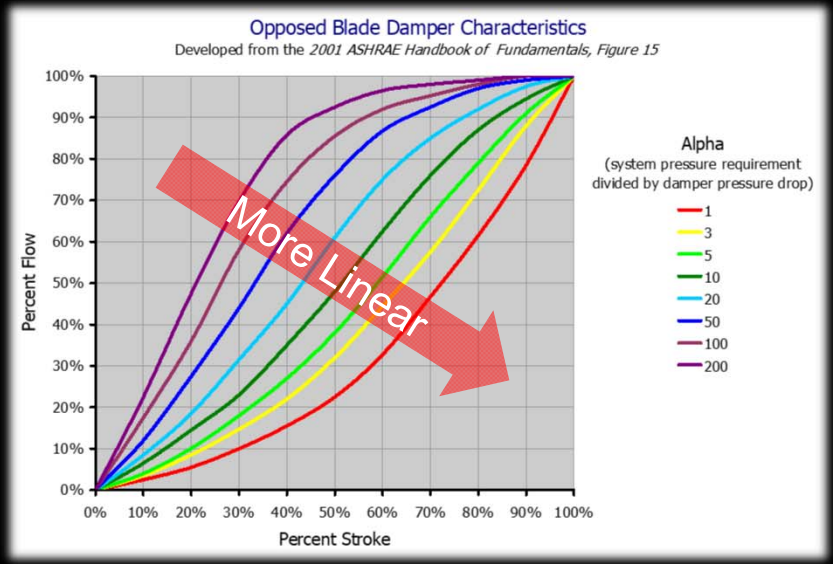
Parallel Blade Damper

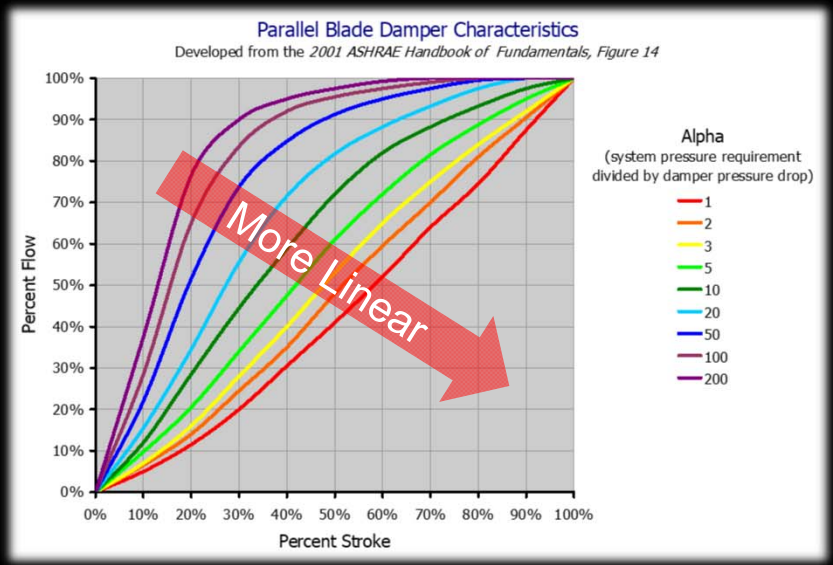
Opposed Blade Damper



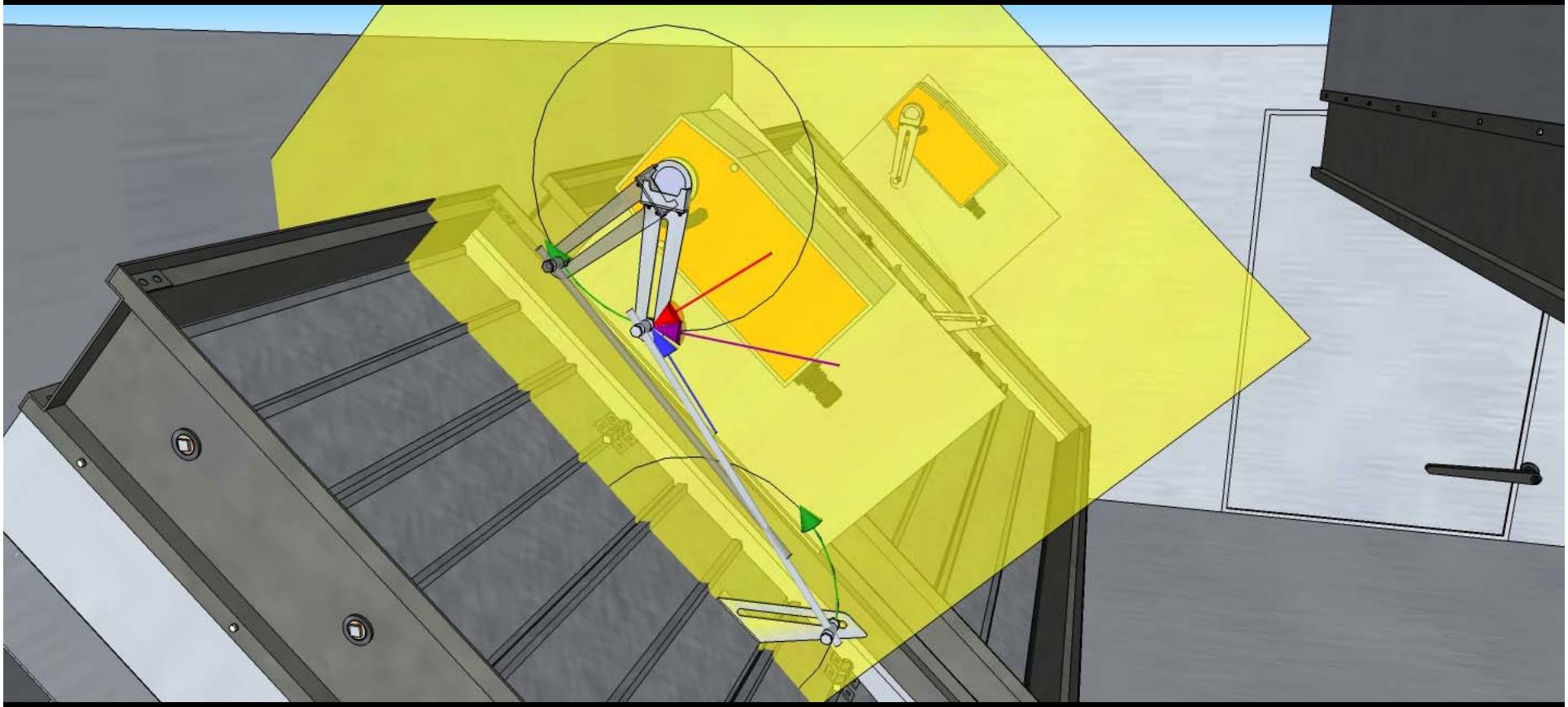
Dampers Use Pressure Drop to Control Flow

- **Opposed and parallel blade characteristics curves are different**
- **The damper's pressure drop needs to be significant relative to the system**
- **The more significant the pressure drop, the more linear the flow vs. stroke response**





Linkage Kinematics Can Be Critical



See *Economizers – The Physics of Linkage Systems* on my blog for more information

Critical Control and Life Safety Devices

Life Safety Functions

Ventilation

Pressure Relief

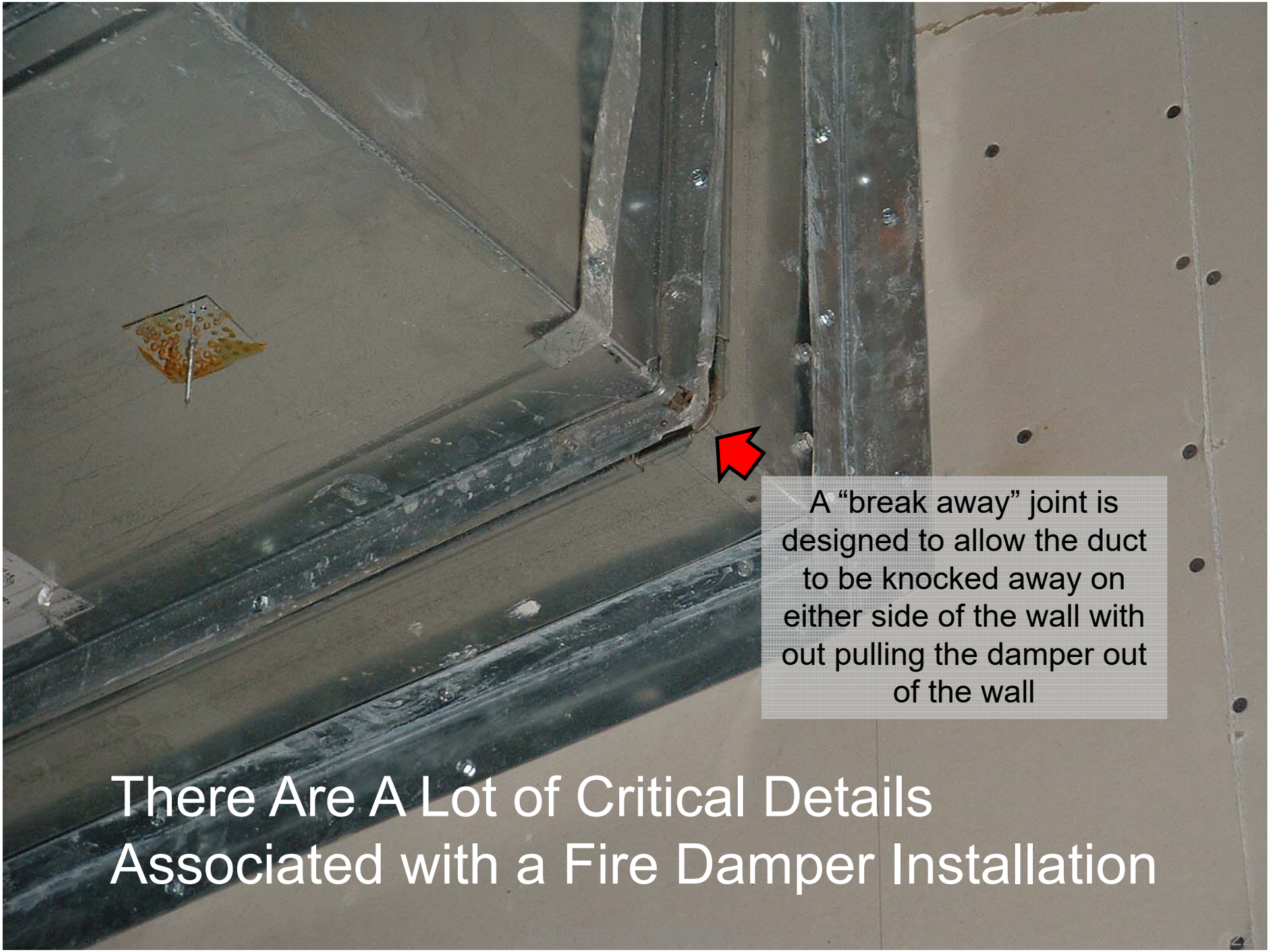
- Explosion vents
- Pressure differential control

Fire Separation

Fusible Links are Typically U.L. Labeled …

Fusible Links are Typically U.L. Labeled… But Not Always

There Are A Lot of Critical Details Associated with a Fire Damper Installation



There Are A Lot of Critical Details Associated with a Fire Damper Installation

Critical Control and Life Safety Devices

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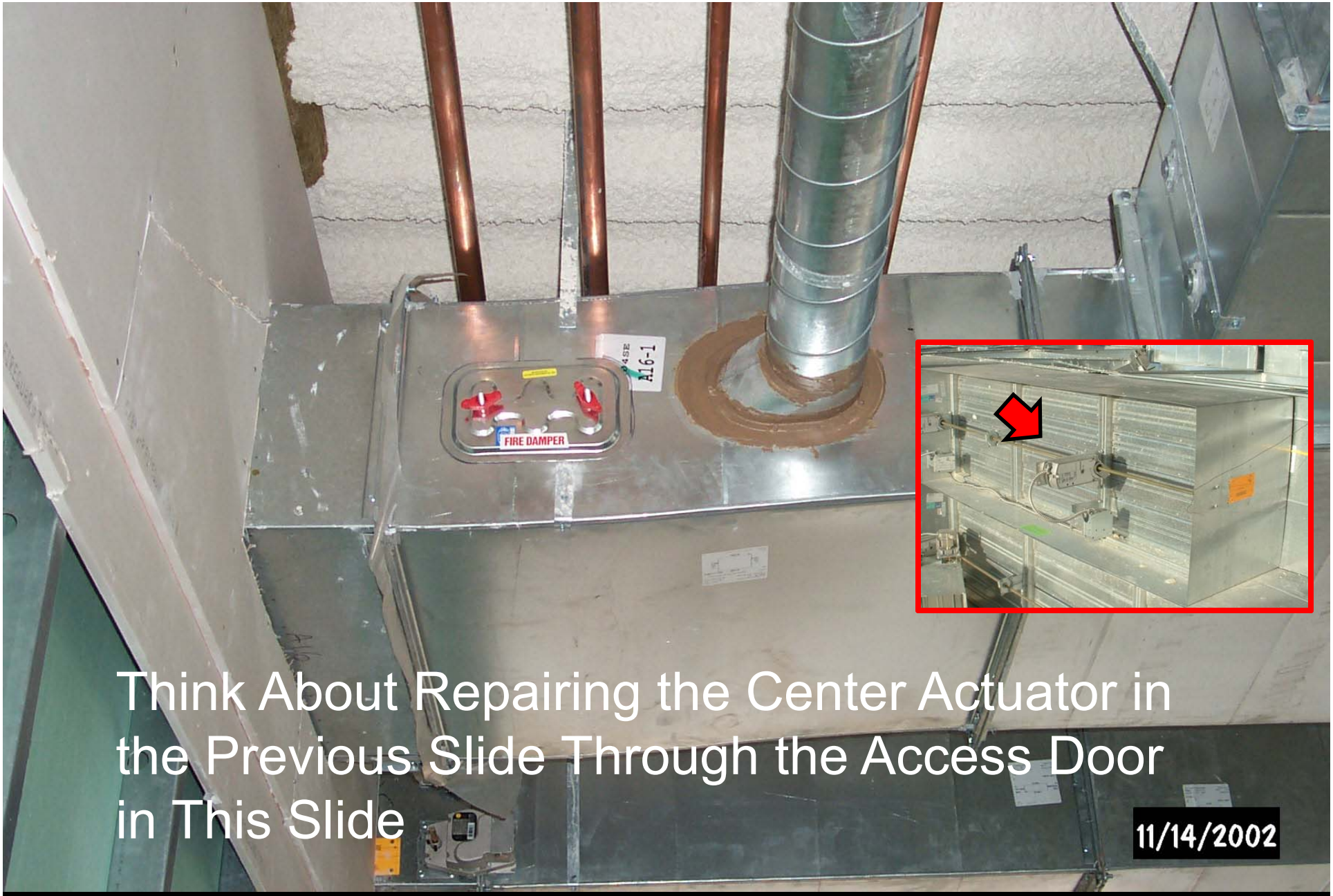
Fire Separation

Smoke Management



Think About Repairing the Center Actuator in the Previous Slide Through the Access Door in This Slide

Fire/Smoke/Control Damper Access is Critical

Preferably, it should not involve tearing down a wall

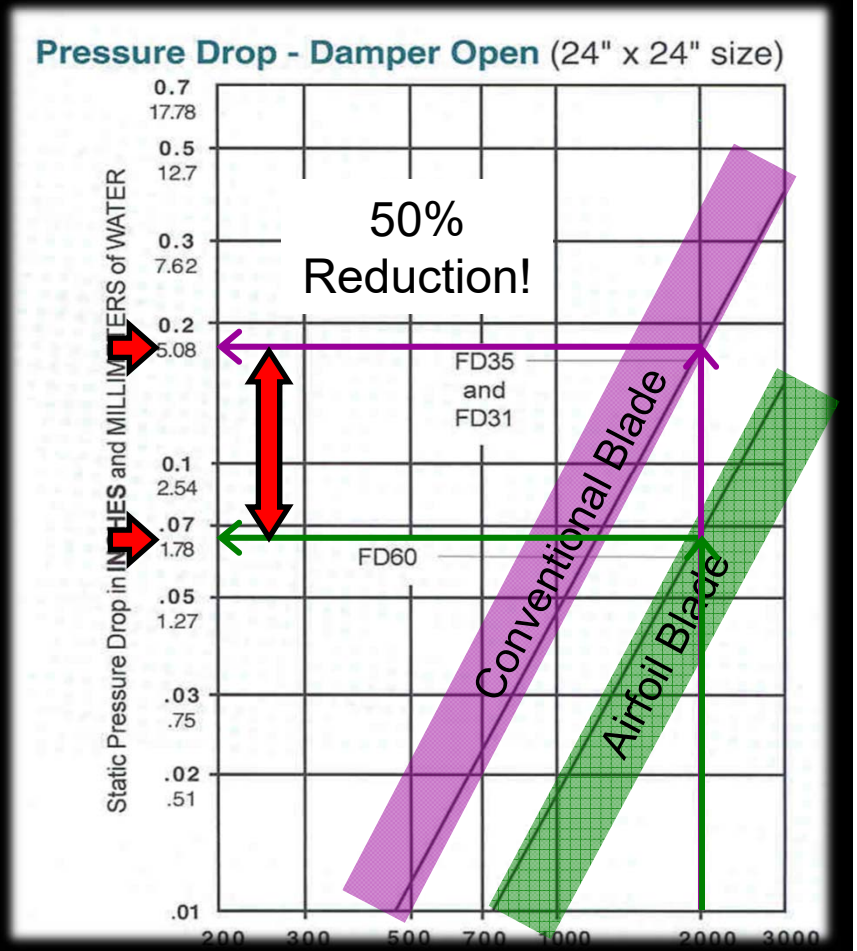
Commissioning and Preventive Maintenance are Critical

System	Number of HVAC System Fans	Number of Other Components	Reliability of New System Before Cx	Mean Life of Commissioned System (months)
1	3	0	0.97	116
2	0	3	0.83	46
3	3	9	0.56	14
4	5	18	0.31	8
5	5	54	0.03	3

1. Data derived from the ASHRAE's Design of Smoke Management Systems
2. HVAC fan reliability assumed to be .99 and other components assumed to be .94
3. HVAC fan fan failure rates were assumed to be 10^{-6} per hour and other components assumed to be10^{-5} per hour

Minimizing Pressure Drop to Capture Savings

- Upgrade smoke dampers to airfoil blade design
- Savings potential = 50%+ reduction in pressure drop for every hour of operation



Fans, Ductwork, & Air Handling Components:

Supplemental Information

More on Linkage Systems

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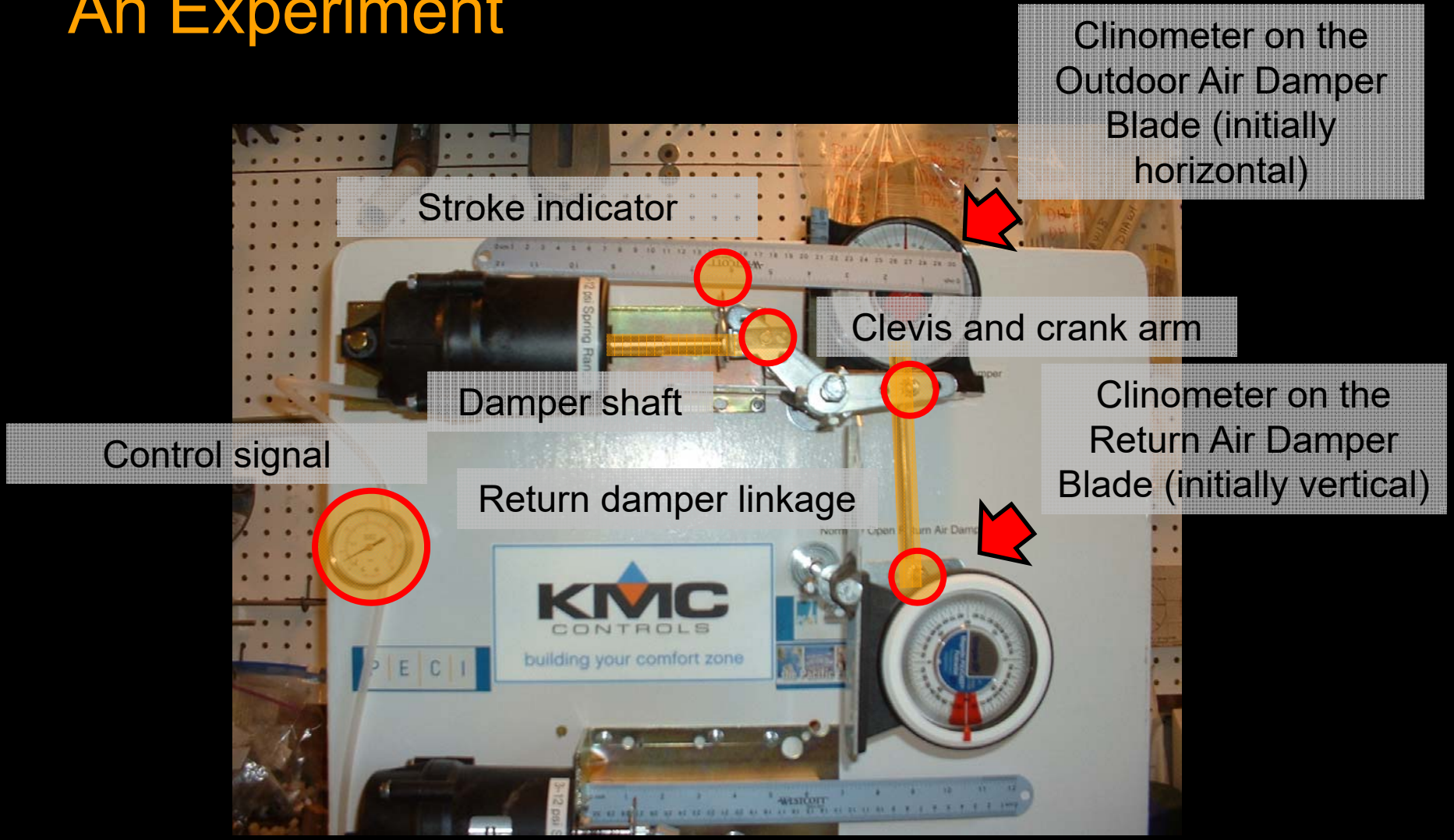
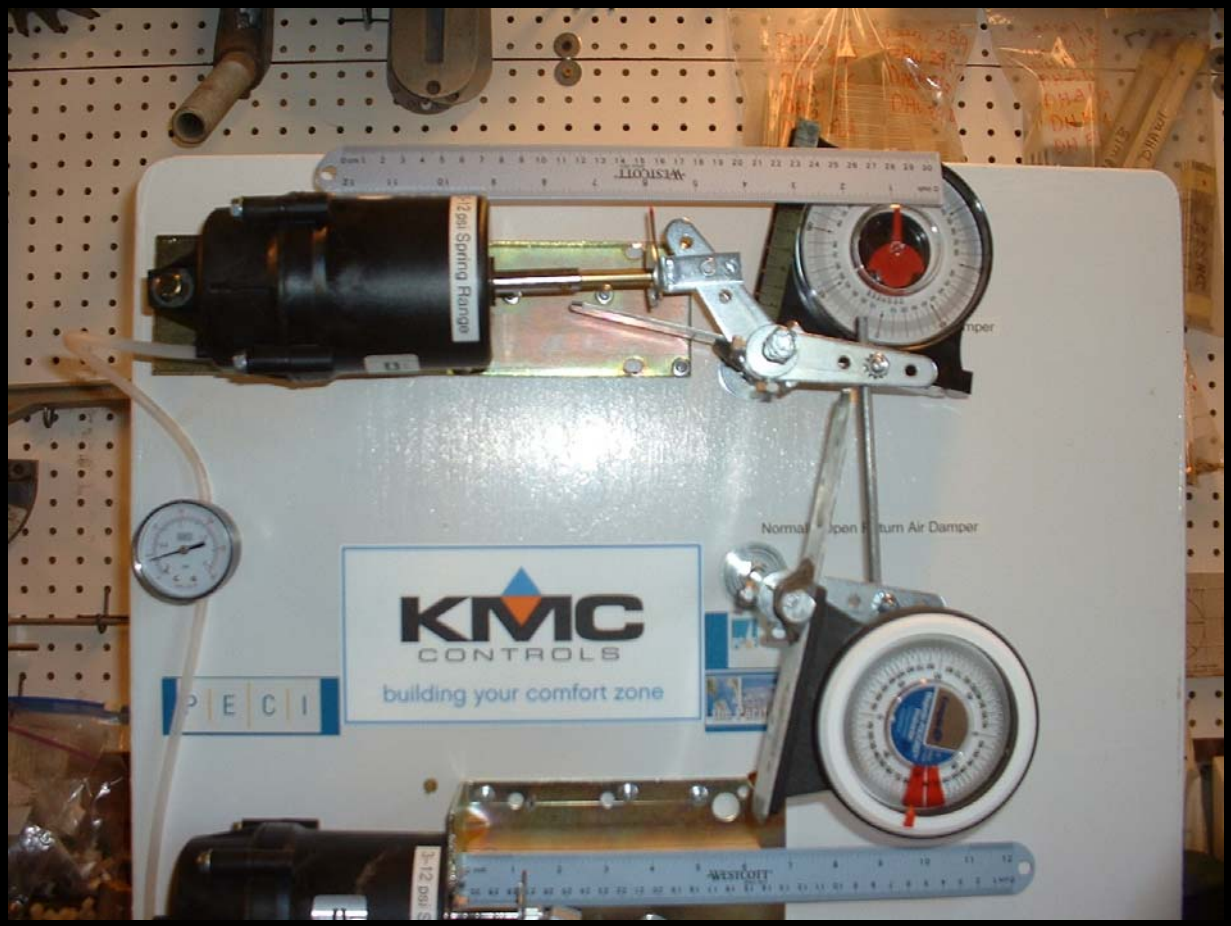
An Experiment



Start

4 psig



5 psig

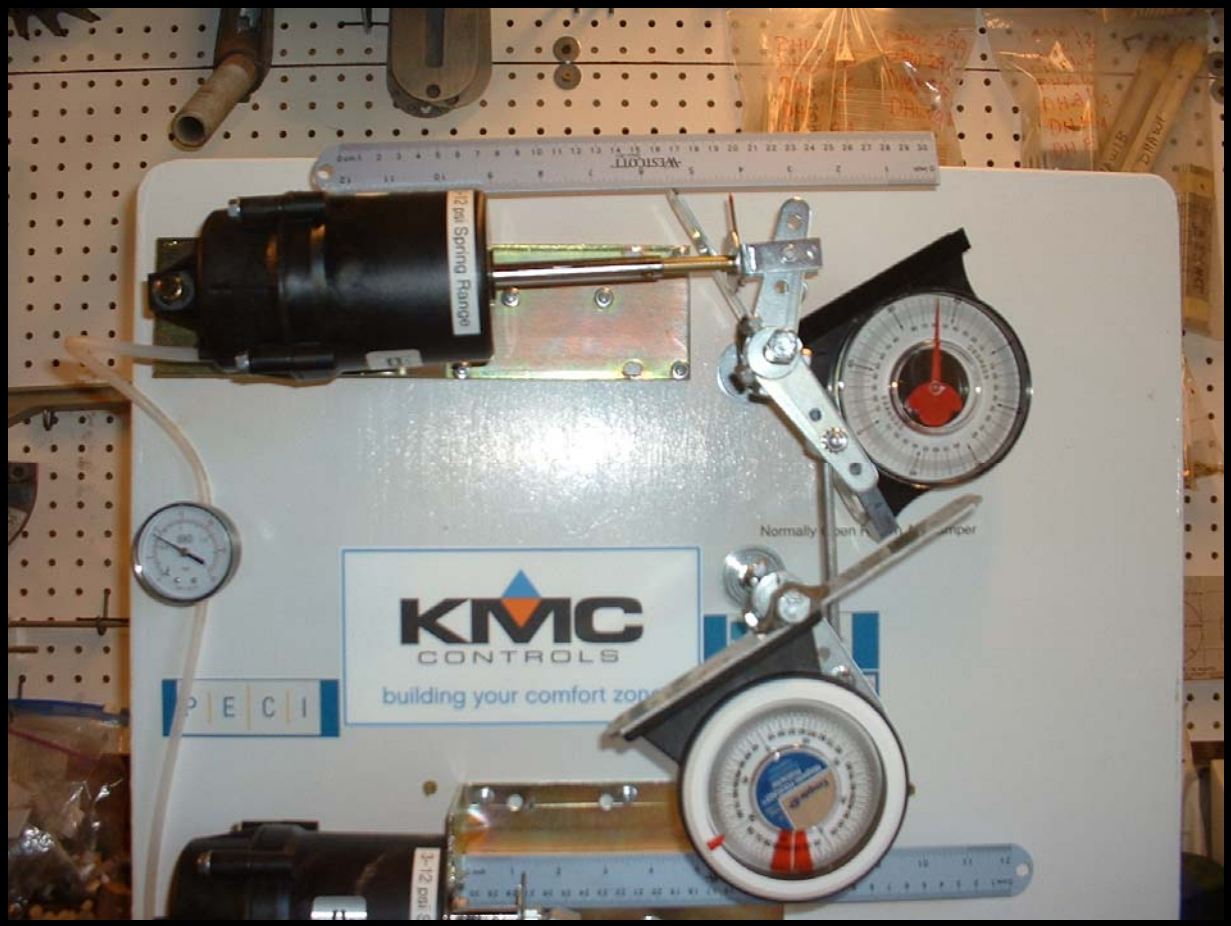
6 psig

7 psig

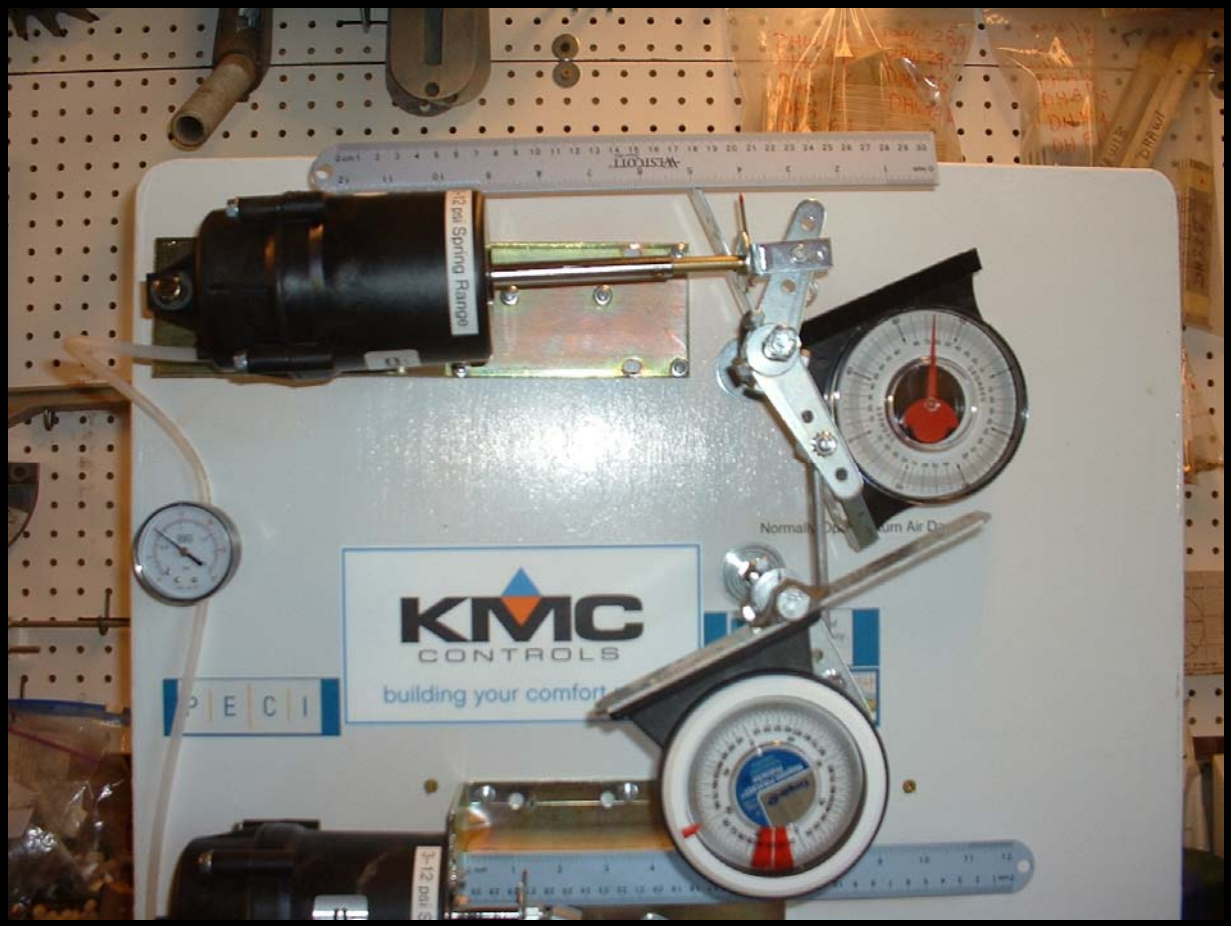
7-1/2 psig (50% stroke)

8 psig

9 psig



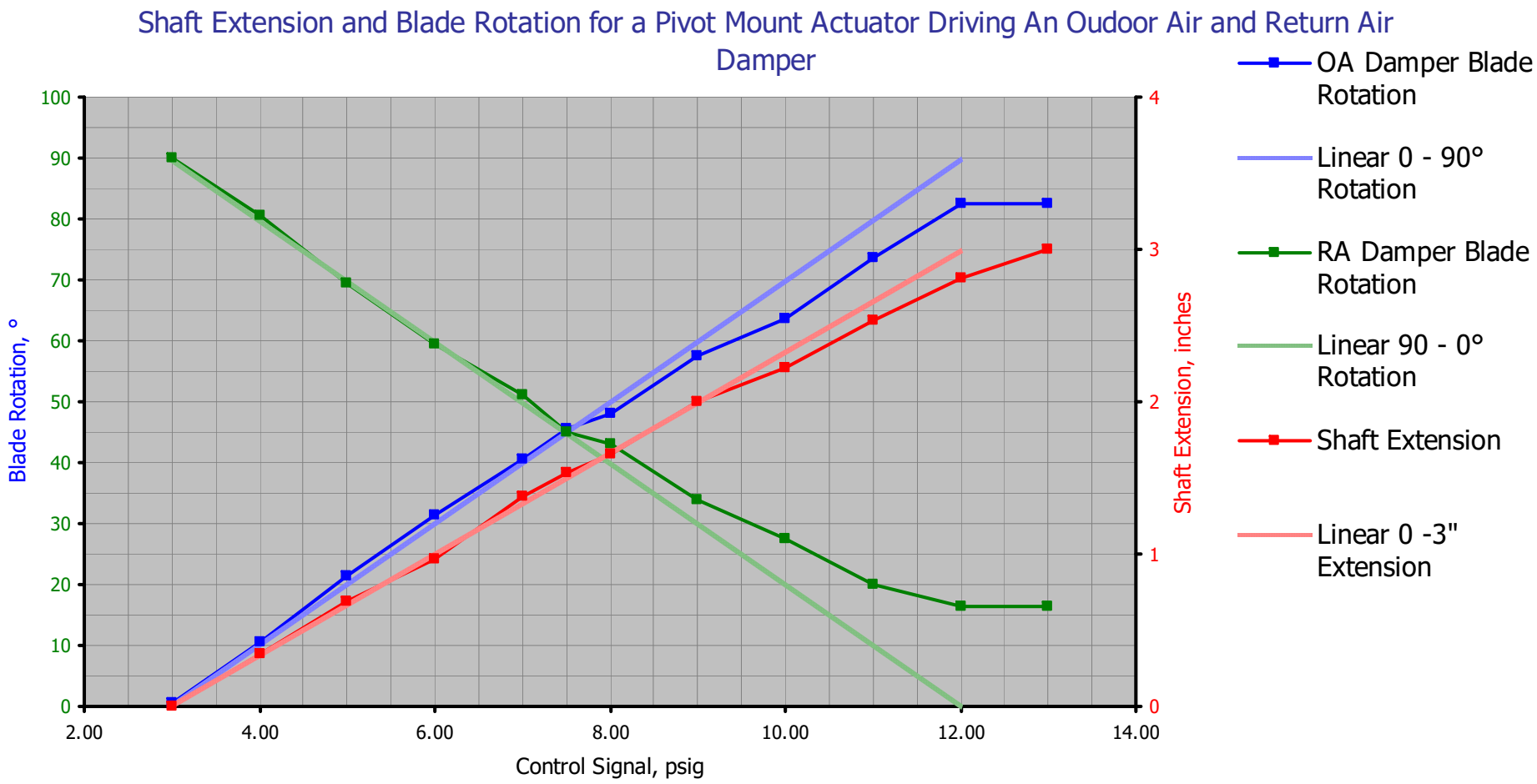
10 psig



11 psig

12 psig (Should be full stroke, but it wasn't)

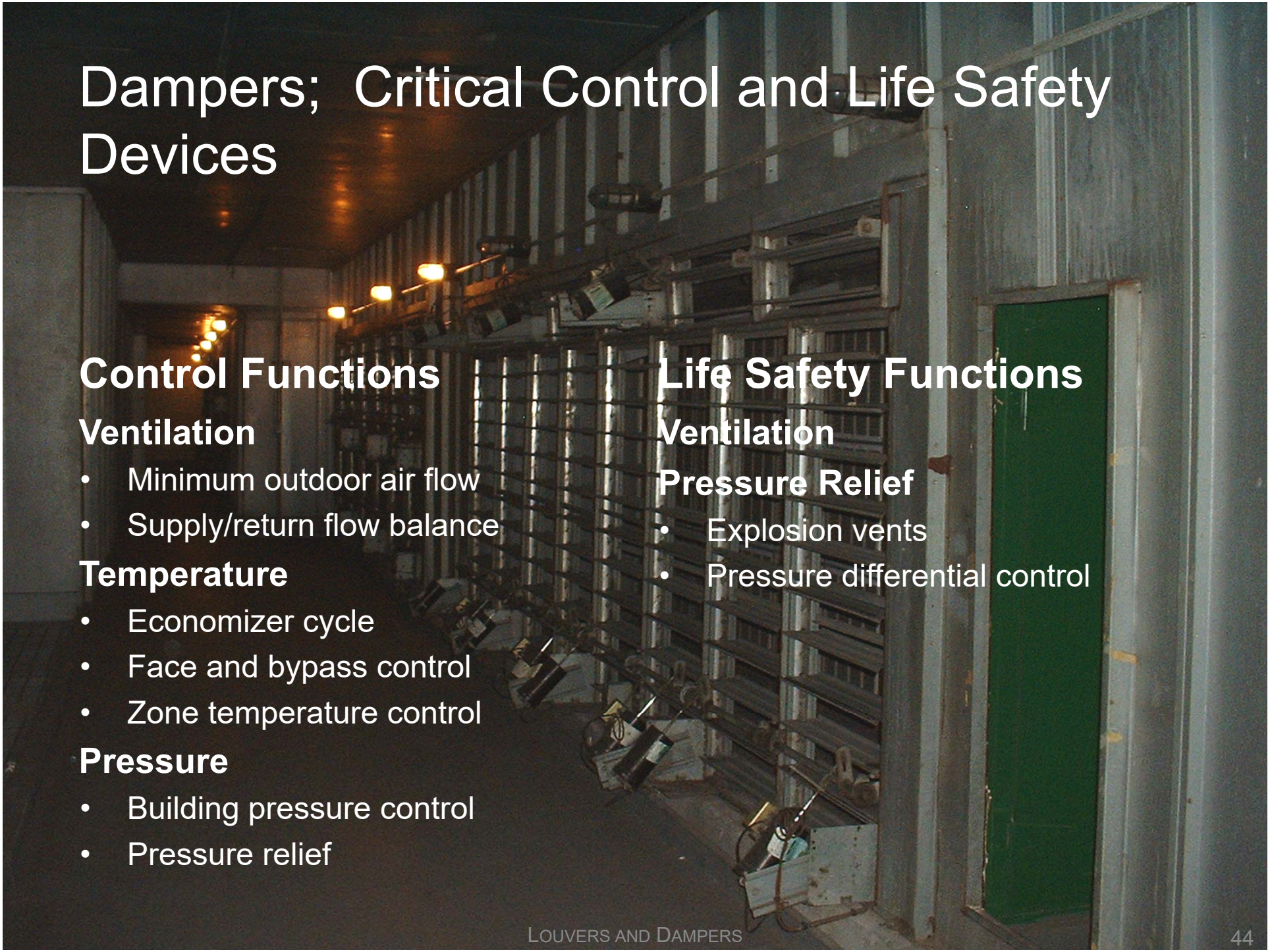
Experimental Results



Fortunately, Centerline Drive Actuators Solve the Linearity Problems

Fortunately, Centerline Drive Actuators Solve the Linearity Problems; Or Not

Dampers; Critical Control and Life Safety Devices



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Savings via a blade design change

Horse power = (Flow in cfm) x (Fan static pressure in in.w.c.)/(Coversion constant x Fan efficiency x Motor efficiency)

Flow rate = 46,687 cfm

Static pressure eliminated = 0.23in.w.c. (Ruskin data for an FD60 at 3,000 fpm)

Assumed fan efficiency = 80%

Assumed motor efficiency = 85%

Fan horse power = 2.43hp.

Kw = 1.81

Operating hours per year = 2,600

Annual kWh savings potential = 4,714 kWh per year

Assumed electrical cost = $0.0750 $/kWh

Annual savings potential for AHU9 = $354 per year

The Simple Payback at Design

Damper area = 15.82 sq.ft.

Conventional blade cost per square foot = $88

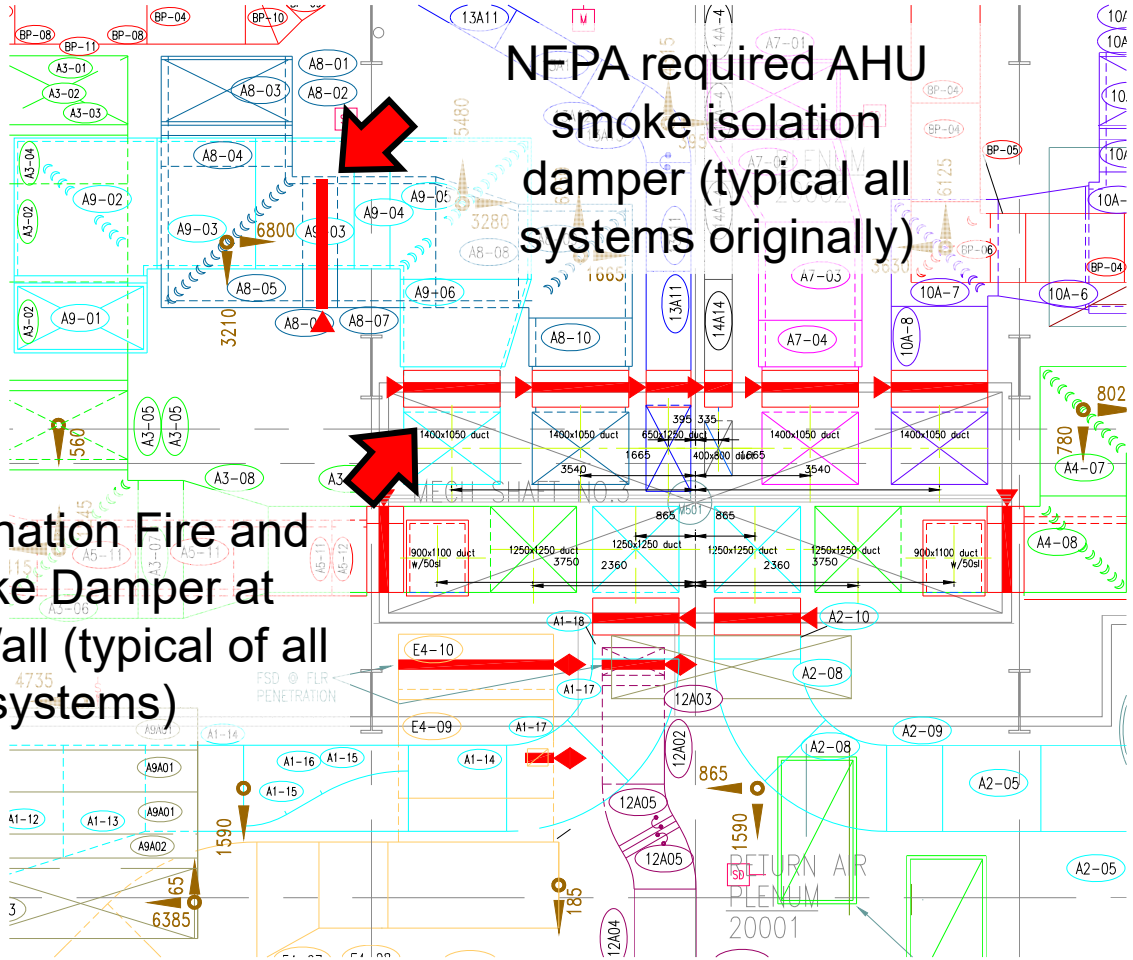
Airfoil blade cost per square foot = $104

Cost difference for this damper = $257

Simple payback = 0.73 years

The payback decays rapidly if the change is not made until after the damper is purchased or installed!

Thinking Outside the Box to Capture Savings



Operating Cost Savings

Horse power = (Flow in cfm) x (Fan static pressure in in.w.c.)/(Coversion constant x Fan efficiency x Motor efficiency)

Flow rate = 46,687 cfm

Static pressure eliminated = 0.18in.w.c. (Ruskin data for an FD60 at 3,000 fpm)

Assumed fan efficiency = 80%

Assumed motor efficiency = 85%

Fan horse power = 1.89 hp.

Kw = 1.41

Operating hours per year = 2,600

Annual kWh savings potential = 3,666 kWh per year

Assumed electrical cost = $0.0750 $/kWh

Annual savings potential for AHU9 = $275 per year

For 16 air handling units = $4,400 per year

First Cost Savings

Supply damper area =	15.82	sq.ft.
Damper first cost =	$104	$/sq.ft.

	One Unit	All Units
Supply damper savings	$1,642	$26,266
Return damper savings	$3,283	$52,532
Total savings	$4,925	$78,798

- This does not include the installation costs and wiring, so the actual savings could easily be twice this much!

Early Discovery = Better

Detail improved fitting at design

- May lower first cost
  - Less sheet metal
- Capture life time savings with a wiser and/or lower first cost expenditure
  - Less static = Smaller fan
    Smaller drive
    Smaller wire
    Smaller service

Early Discovery = Better

Discover a problem during installation

- May take money to correct
  - Reconfigure
  - Design issue vs. contractor issue
- Capture operational savings
- Loose first cost savings

Early Discovery = Better

Discover a problem after installation

- Correction may be financially unviable unless driven by a performance requirement
- Operational penalty for the life of the system
- First cost savings opportunity lost