

SMART AIRFLOW™

A ventilation airflow virtual sensor

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Outline

- Background
 - Ventilation rules as applied to RTUs
 - Setting ventilation rates with economizers
- Describe the Smart Airflow concept
- Engineering behind it
- Summarize benefits of virtual sensors

Factors Impacting Ventilation Rate

OUTDOOR AIR PERCENTAGE VS. FRESH AIR DAMPER ANGLE - Less ERW

Fresh Air Damper Opening Angle	Percentage of Outdoor Air Available at Various Return Duct Static Pressures - In. w.g.			
	0.2	0.4	0.6	0.8
10°	5%	11%	16%	21%
20°	19%	25%	30%	36%
30°	34%	39%	44%	50%
40°	48%	53%	59%	64%
50°	62%	68%	73%	79%
60°	77%	82%	87%	93%
70°	91%	96%	100%	100%
80°	100%	100%	100%	100%

NOTE - Outdoor air percentage will vary when a variable frequency drive (VFD) drive is used on the supply air blower.

- Damper position
- Return duct design
- Supply airflow rate

Ventilation Background

- Building codes require ventilation in commercial buildings.
 - Amount required based on:
 - Floor Area
 - Number of occupants
 - Typically 10 – 30% of supply airflow
- Two common implementations
 - Fixed ventilation
 - Demand control ventilation

Controls Configuration for Ventilation

- Single speed fan
 - Min damper position
- Variable speed fan
 - Min damper position at low airflow
 - Min damper position at high airflow
- Demand control ventilation
 - Min damper position min CO2 & low airflow
 - Min damper position at max CO2 & high airflow

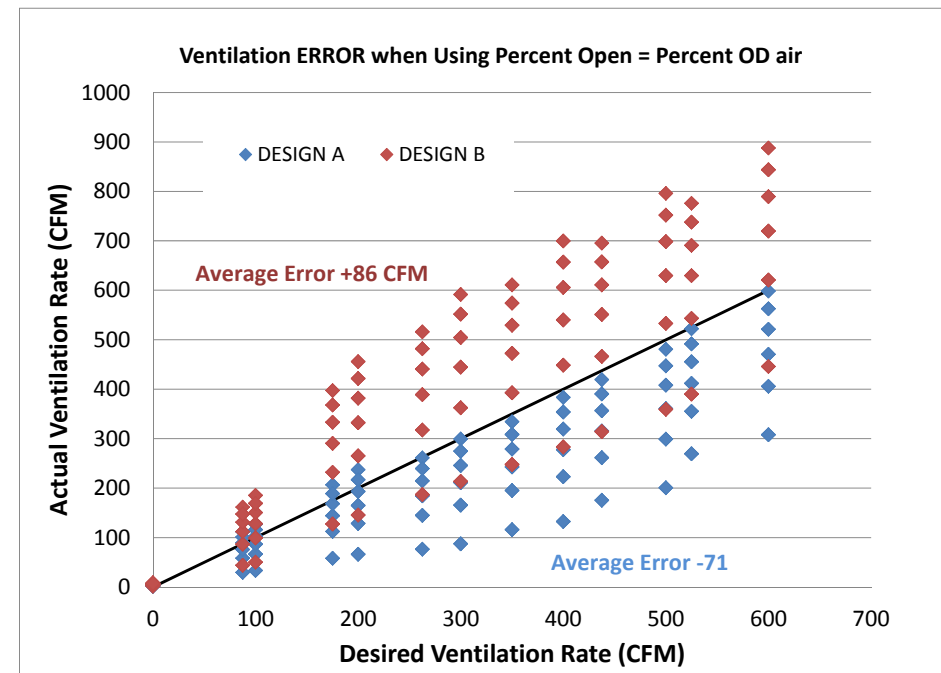


Setting Minimum Damper Positions

- Test and Balance Contractor
 - Iterative
 - Low velocity potentially inaccurate
15% OD air = 61 fpm = 0.7mph

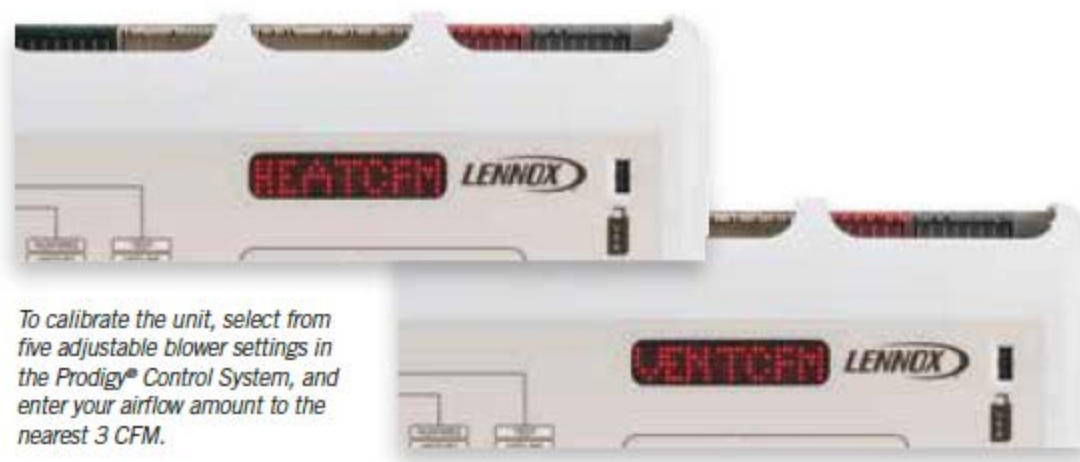


- Guess
 - 15% open = 15% outdoor
 - Function of damper design
 - Very inaccurate
 - Average error 46%
 - Max error 127%

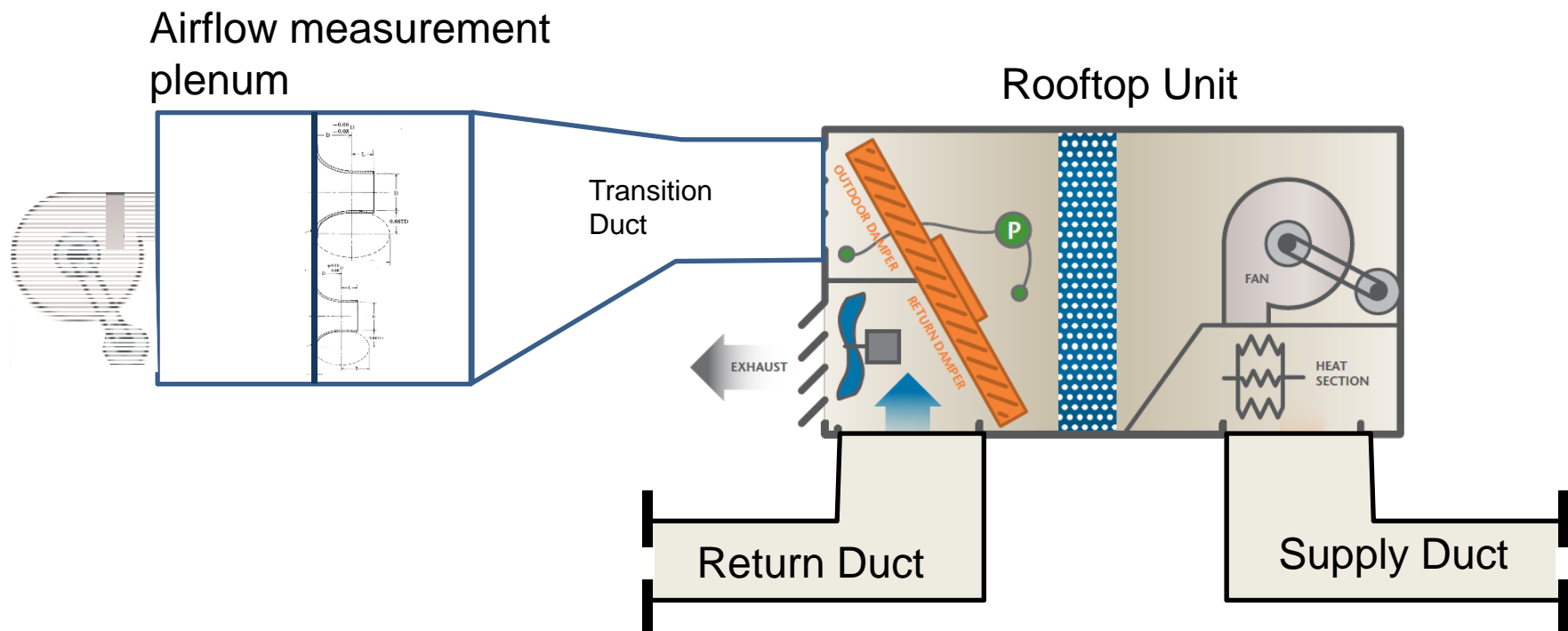


Smart Airflow Concept

- Ventilation
 - Develop a low cost virtual ventilation airflow sensor
 - Installer to configure system based on ventilation airflow
 - Add economizer diagnostics
- Supply Airflow
 - Same features, but out of scope



Lab Setup



Development Methodology

Supply Airflow



Outdoor Damper DP



Damper Position



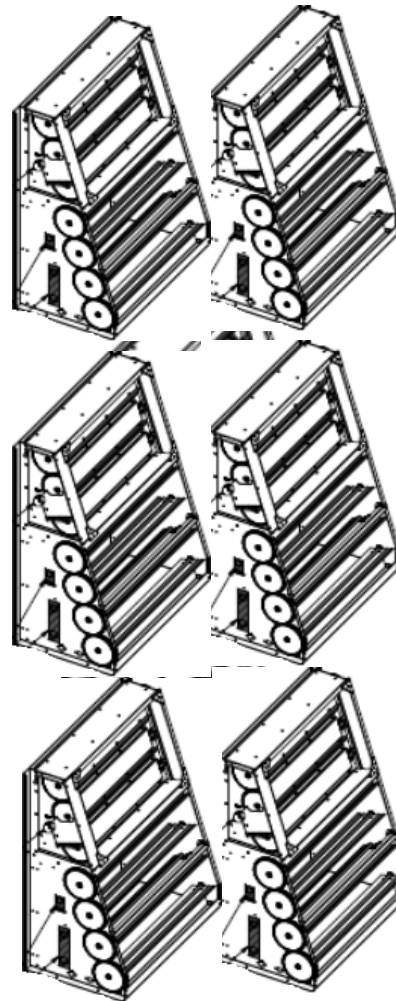
Wind



Inlet filter DP



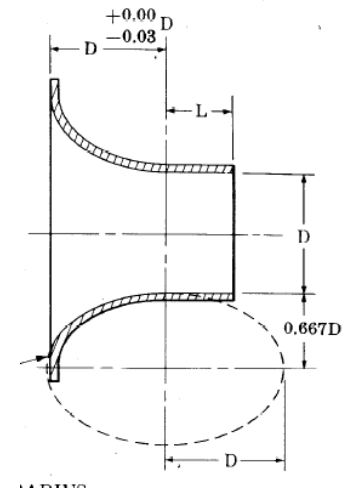
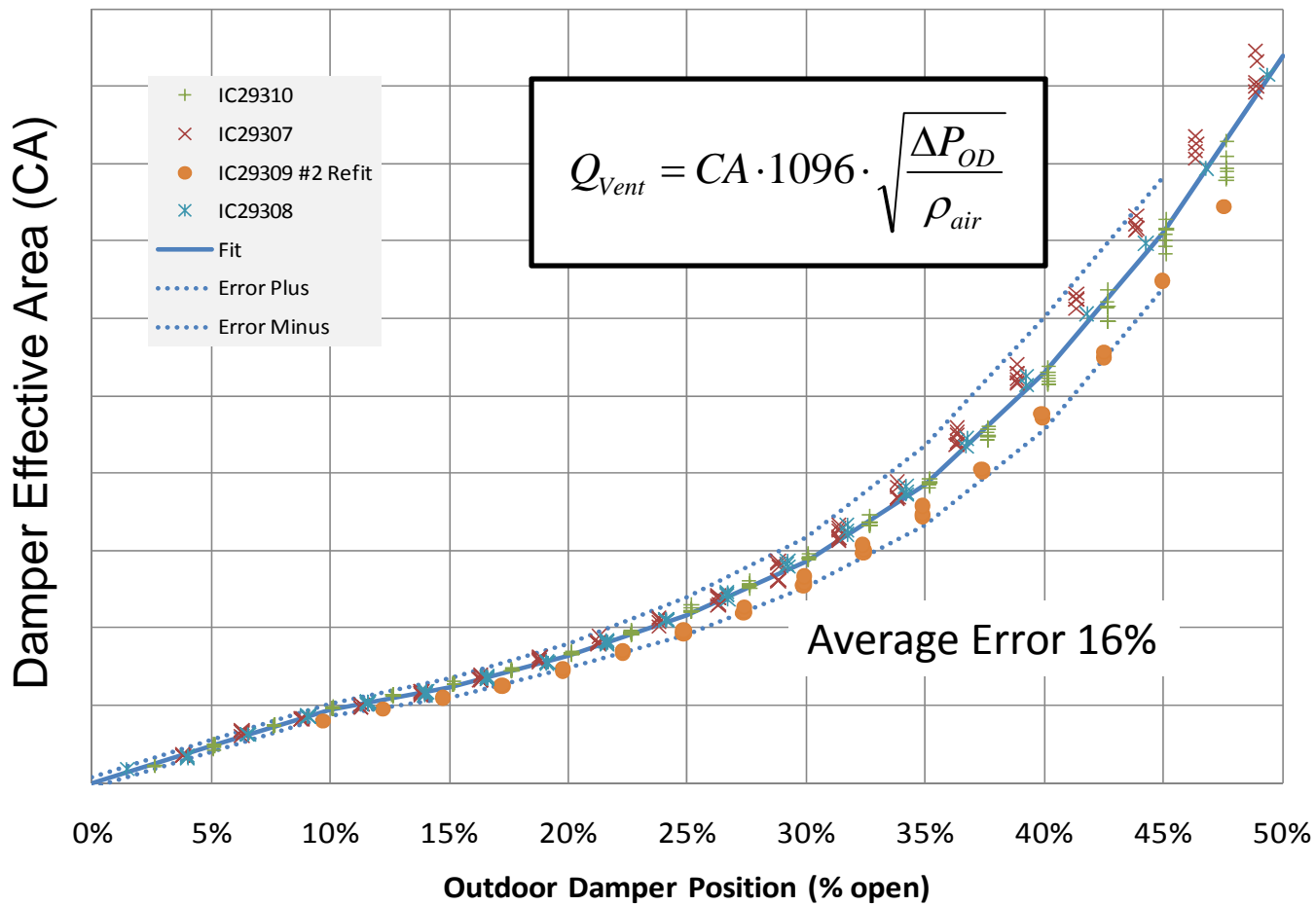
Barometric Relief



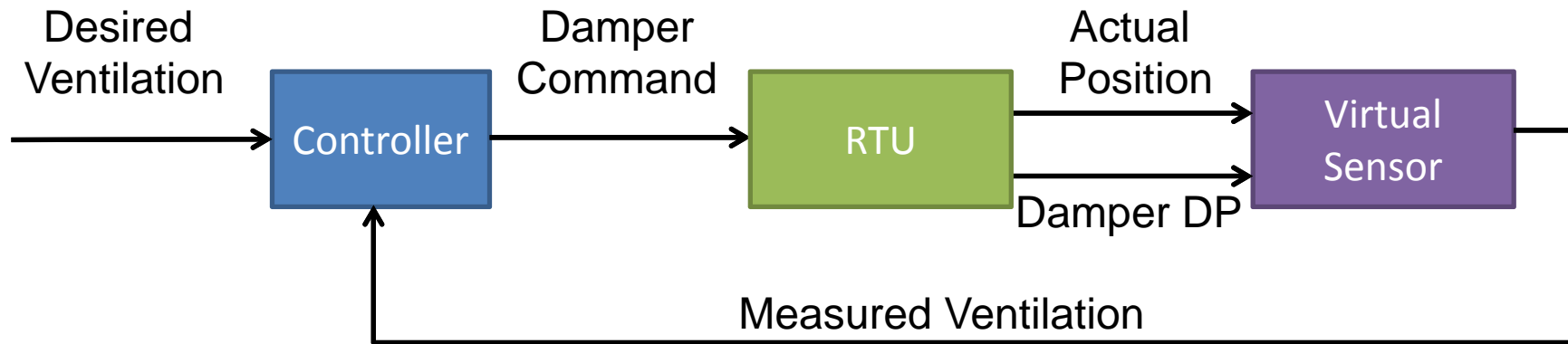
Ventilation Airflow Rate



Damper Calibration Curve



Feedback Control Loop

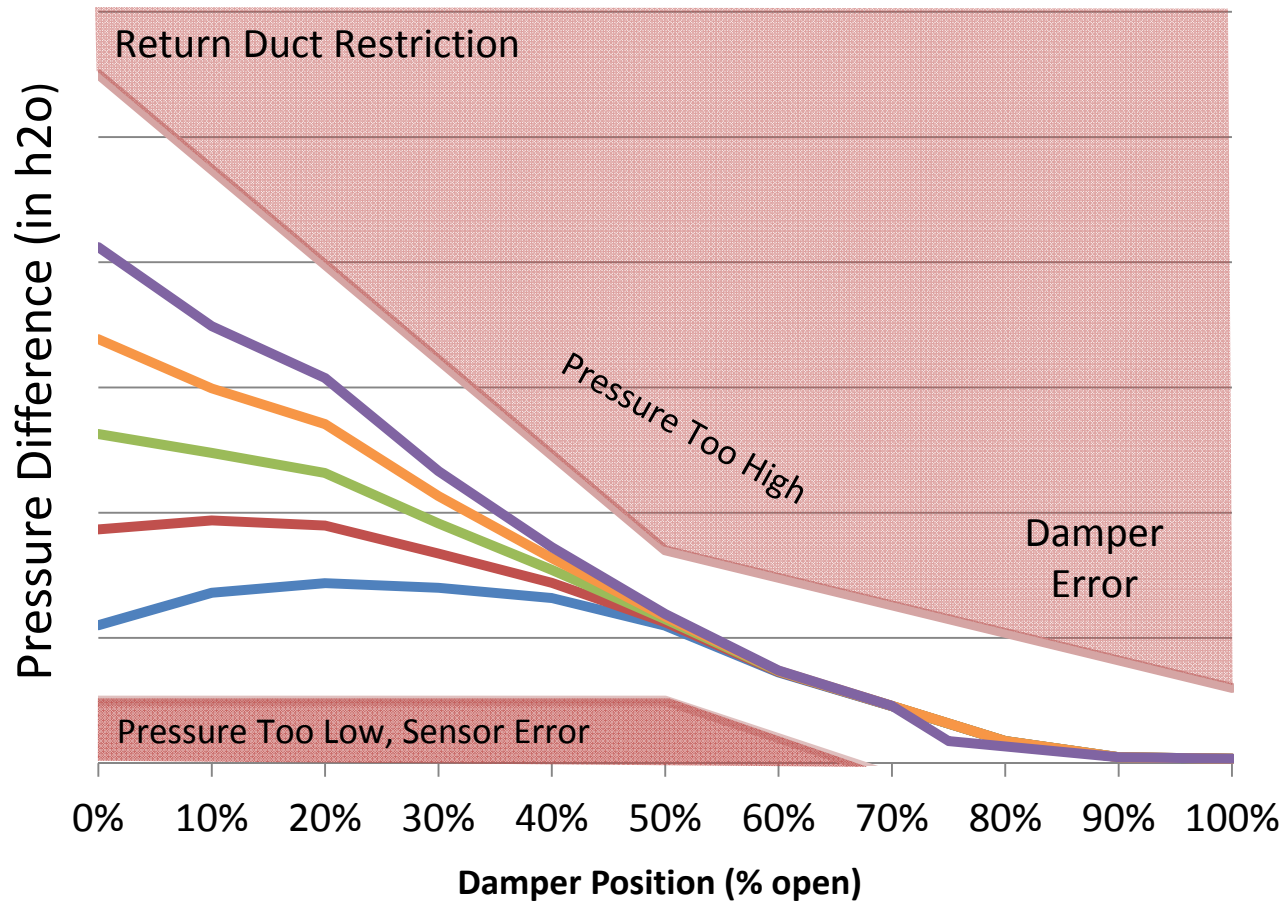


- Control design challenges
 - Slow actuator: 30-90 seconds between closed to open
 - Actuator resolution: Typically 1-2%
 - Actuator life: Move actuator every 10 minutes

Solid Control Design = Good Fault Detection

- Properly handle “Edge Conditions”
 - Bad inputs
 - Out of range DP = Bad pressure sensor
 - No feedback signal = Bad cable or failed actuator
 - Controller output at limit
 - 100% open = Over ventilation
 - 0% open = Under ventilation
- FMEA on system
 - Pressure sensor tube falls off.
 - Actuator disconnects from damper

Damper Diagnostic Using Differential Pressure



Benefits of Control with Virtual Sensors

- Customer
 - Interact with systems in engineering units.
 - Better performance
 - Natural diagnostics
- Company
 - Better understanding of products
 - Improved consistency of products

Questions?

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