

# Ventilation for Acceptable Indoor Air Quality

## Part 1 - Dilution Ventilation and IAQ

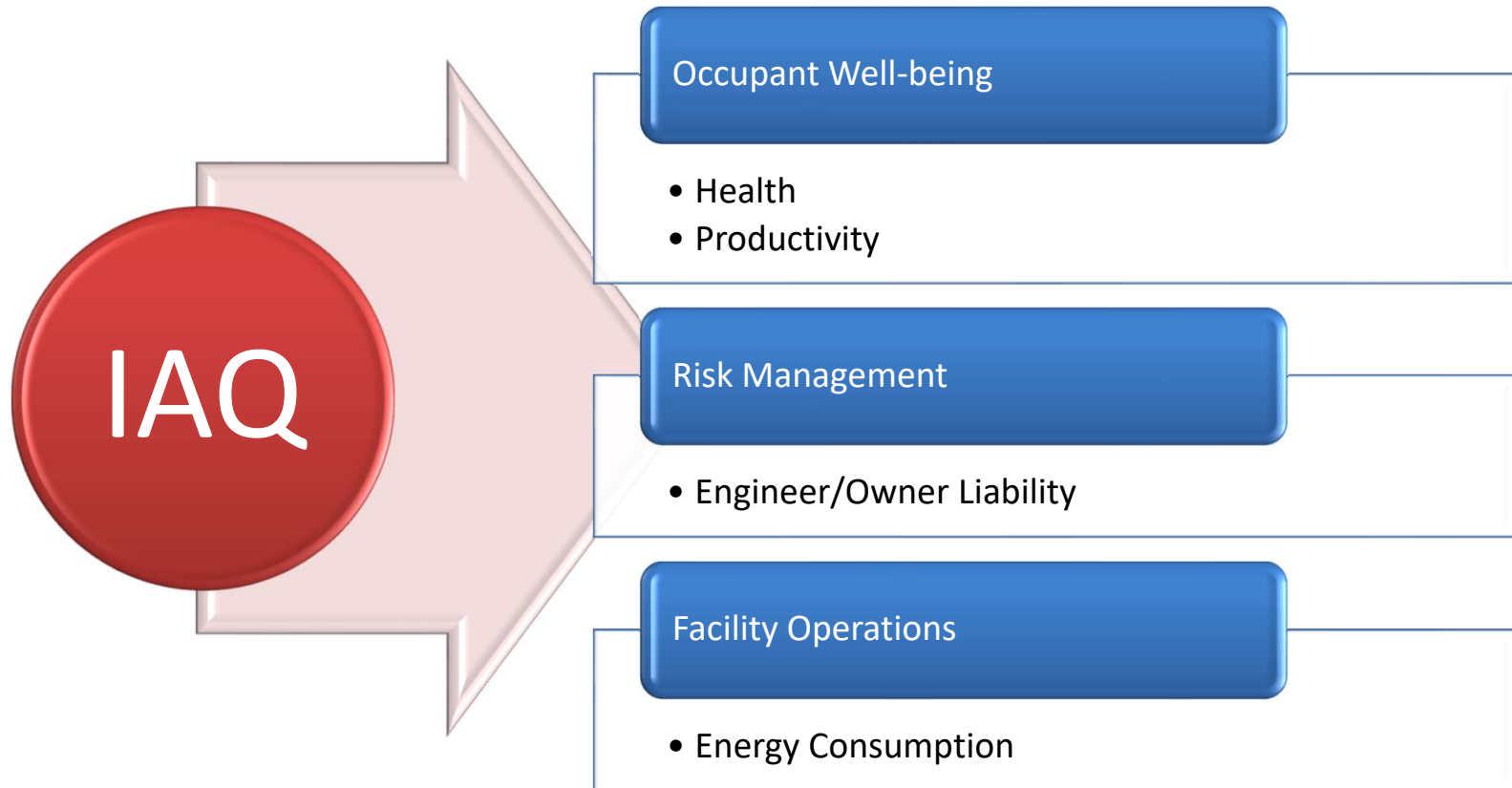
David S. Dougan, President



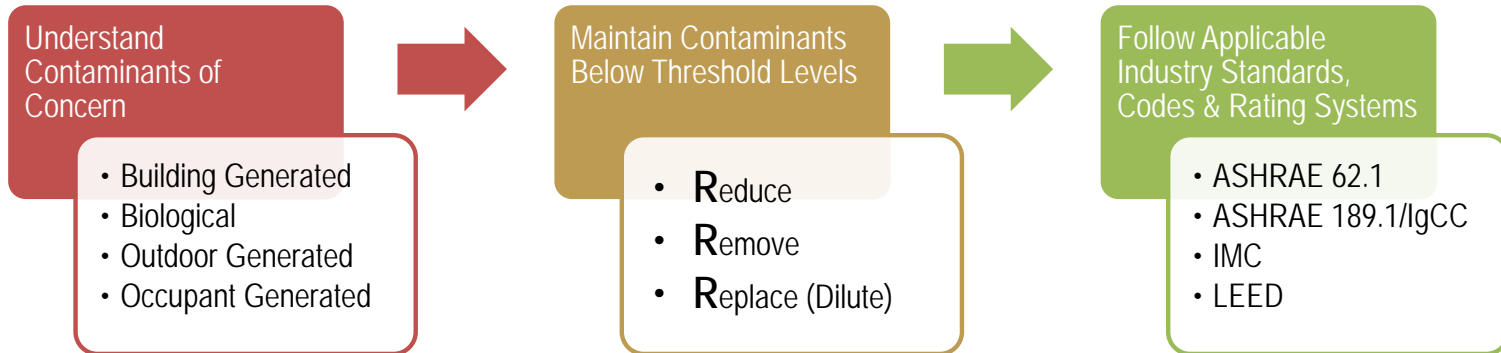
Loris, South Carolina



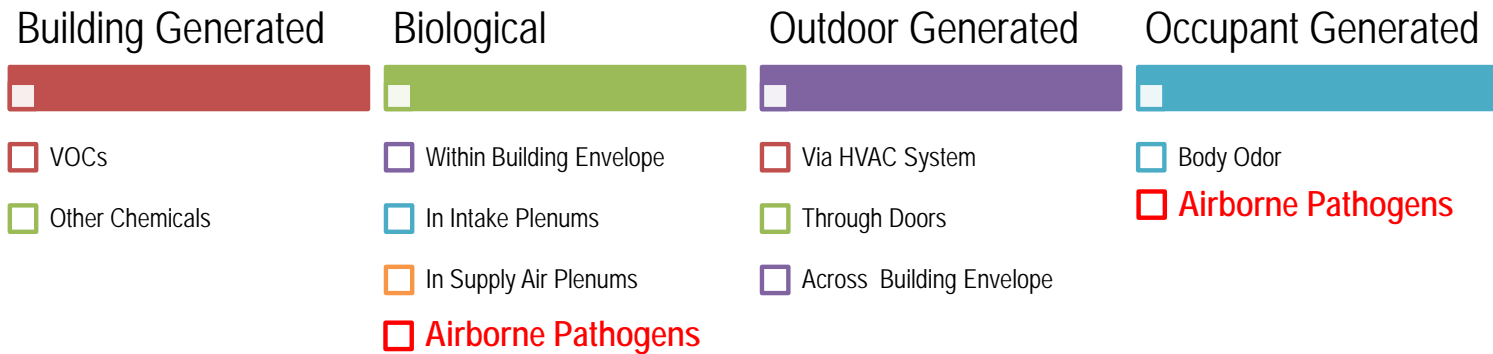
# Indoor Air Quality Affects ...



# Steps to Acceptable IAQ

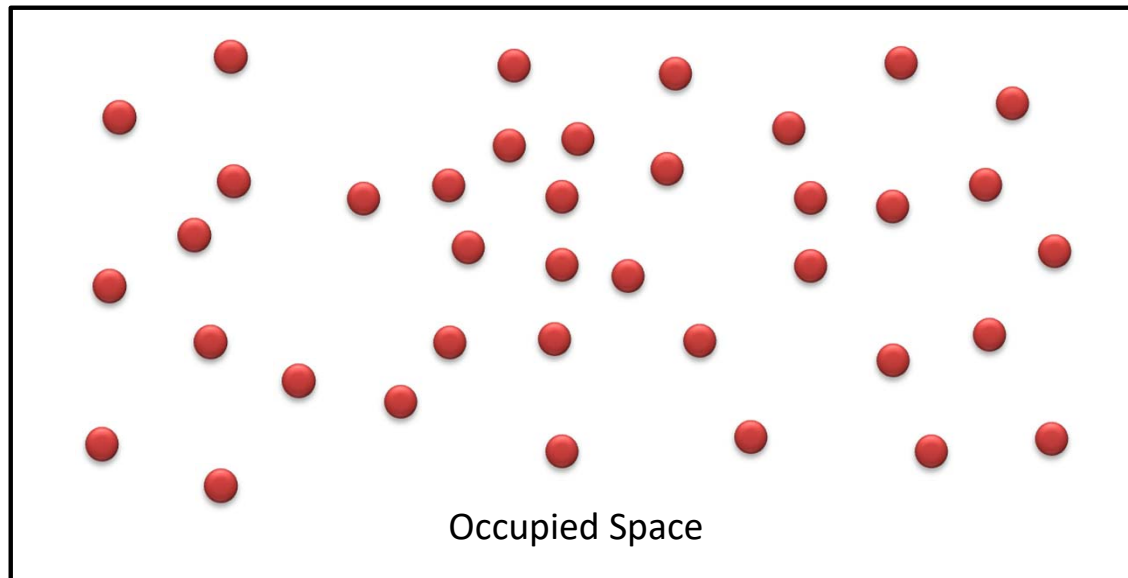


# Understand Contaminants of Concern



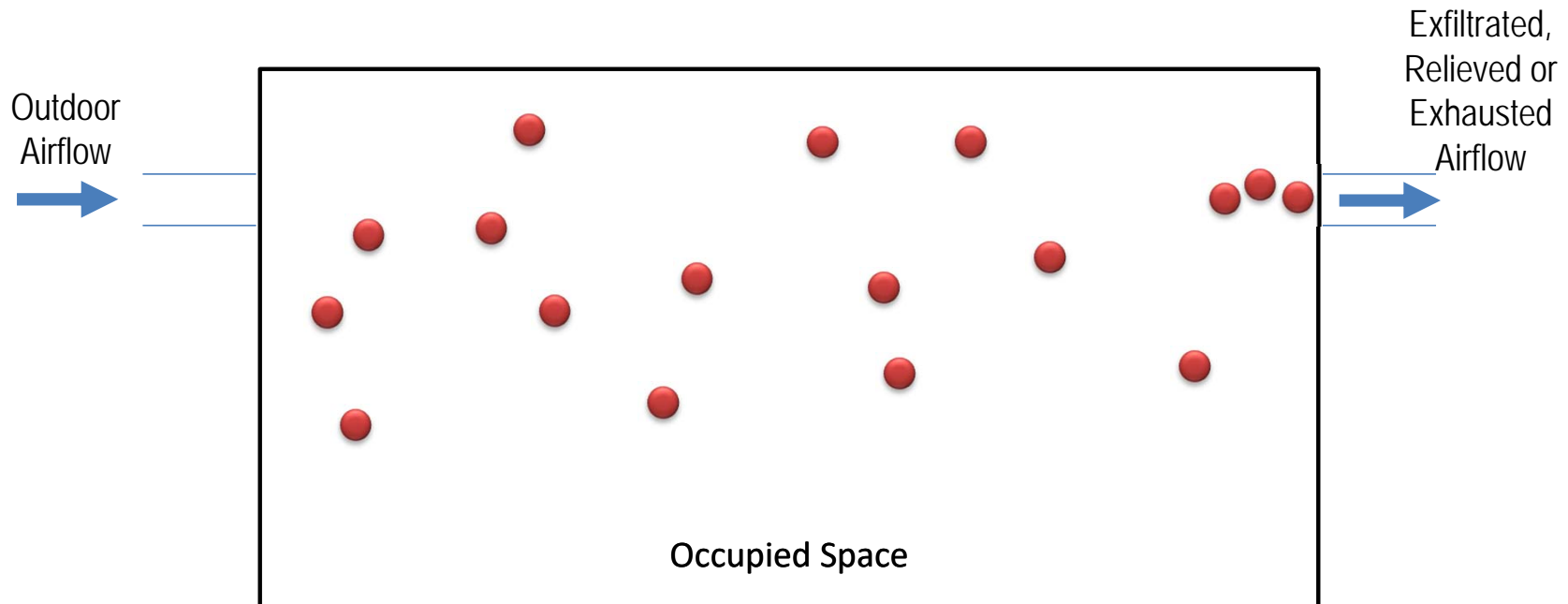
# Maintain Contaminants Below Threshold Levels

No Outdoor Air Dilution or Targeted High Level Filtration



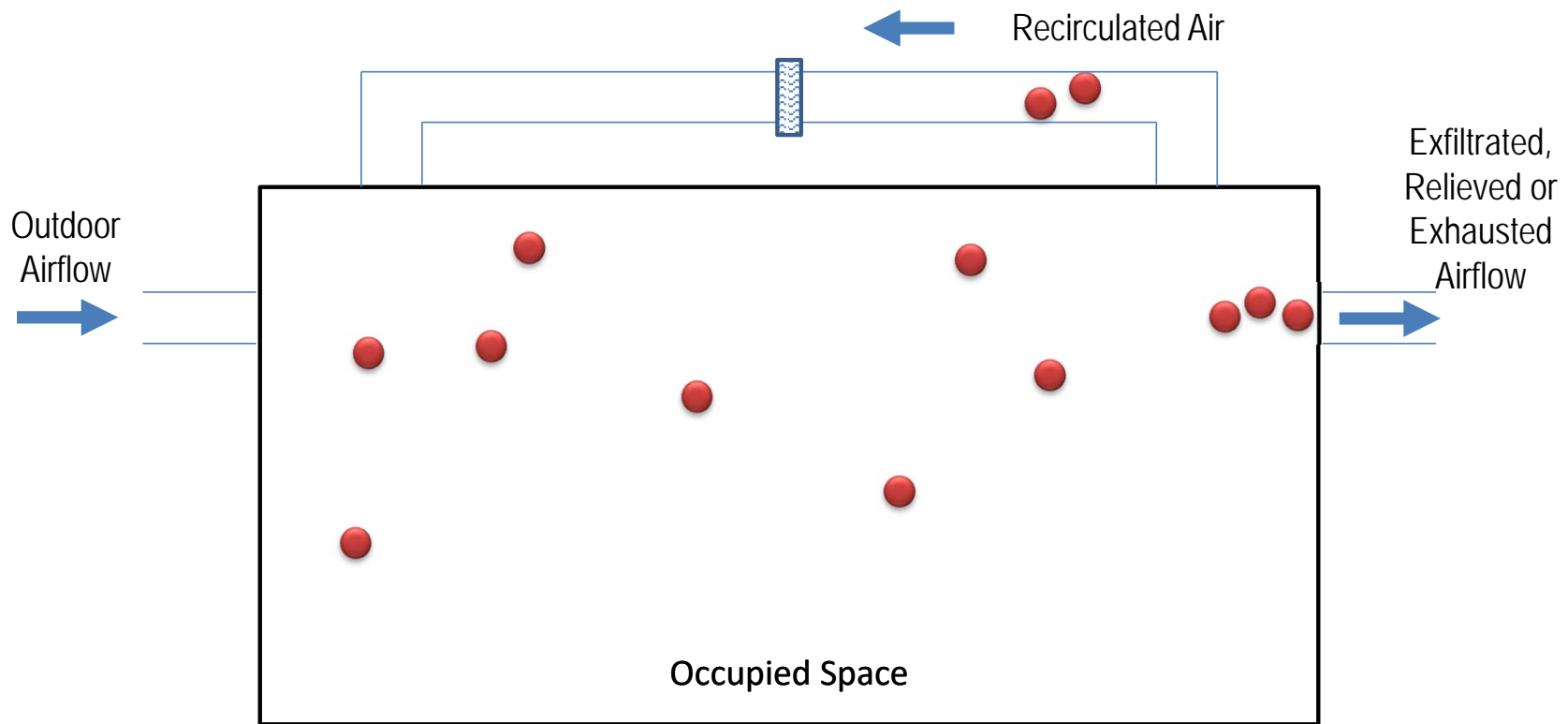
# Maintain Contaminants Below Threshold Levels

## OA Dilution Ventilation



# Maintain Contaminants Below Threshold Levels

OA Dilution with Targeted High Level Filtration



# Standards, Codes and Rating Systems ALL Require that Outdoor Air Ventilation Rates be Maintained for Compliance!



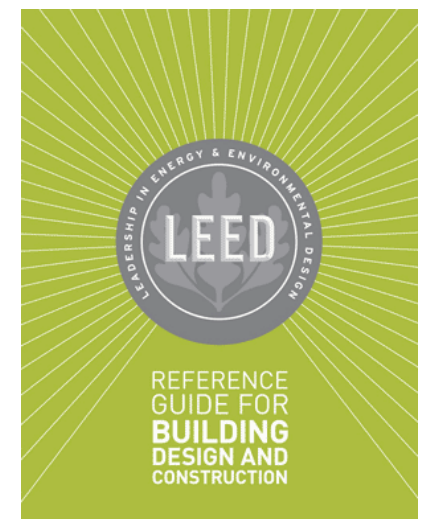
ASHRAE Standard 62.1



International Mechanical Code



International Green Construction Code/  
ASHRAE Standard 189.1

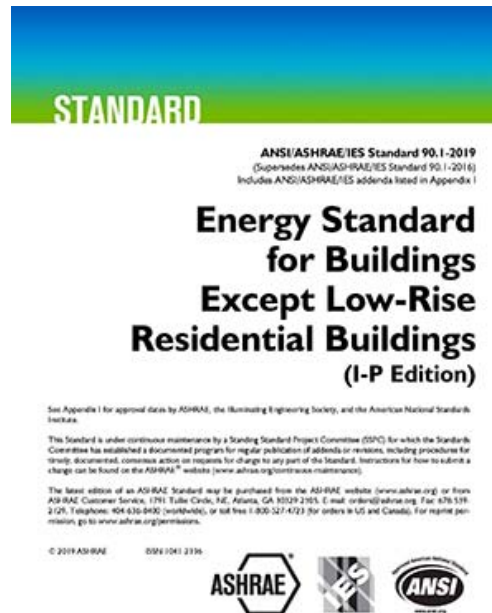


LEED 4.1





Our energy standard, ASHRAE 90.1, references ASHRAE 62.1 but often is conflicts with higher ventilation rates for occupant well-being



# ASHRAE Standard 62.1-2019

## Section 6 - Procedures (includes proposed addendum aa [2020] to IAQP)

**6.1.1 Ventilation Rate Procedure.** The prescriptive design procedure presented in Section 6.2, in which outdoor air intake rates are determined based on space type/application, occupancy level, and floor area, shall be permitted to be used for any zone or system.

**6.1.2 IAQ Procedure.** The IAQ Procedure (IAQP) is an alternate ventilation procedure that shall determine the necessary rate of outdoor air flow to maintain concentrations of Design Compounds (DCs) and PM<sub>2.5</sub> in the indoor environment at concentrations less than Design Targets, based on indoor and outdoor sources, air cleaning and other variables. Indoor concentrations and outdoor air requirements shall be calculated with mass balance equations. Verification of satisfaction shall be performed after the building is completed and occupied.



# IMC-2018

## Section 403 – Mechanical Ventilation

**403.2 Outdoor air required.** The minimum outdoor airflow rate shall be determined in accordance with Section 403.3.

*Comment: Section 403.3 is a strict interpretation of ASHRAE 62.1 Ventilation Rate Procedure (not the IAQ Procedure).*



# ASHRAE Standard 62.1-2019

## Section 5 - Systems and Equipment (approved addendum q)

**5.1.1.1 Designing for Varying Loads and Operating Conditions.** The ventilation air distribution system for VAV and multispeed CV applications shall be provided with means to adjust the system to achieve at least the minimum ventilation airflow as required by Section 6 under any load condition or dynamic reset condition.

*Comment: Some type of active control of outdoor air ventilation rates is required for most systems.*



# ASHRAE Standard 62.1-2019

## Section 5 - Systems and Equipment (approved addendum q)

**5.3.1** All systems shall be provided with manual or automatic controls to maintain not less than the outdoor air intake flow ( $V_{ot}$ ) required by Section 6 under all load conditions or dynamic reset conditions.

**5.3.2** Systems with fans supplying variable primary air ( $V_{ps}$ ), shall be provided with any combination of control equipment, methods, or devices to maintain no less than the outdoor air intake flow ( $V_{ot}$ ) required for compliance with Section 5.3.1.

*Comment: This applies to air handling units and fan coils, including DOAS to fan systems and/or fan coils.*



# ASHRAE Standard 90.1-2019

## Section 6 - HVAC

### 6.5.3.2.1 Supply Fan Airflow Control

Each cooling system listed in Table 6.5.3.2.1 shall be designed to vary the supply fan airflow as a function of load and shall comply with the following requirements:

- a. DX and chilled-water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have a minimum of two stages of fan control.
- b. All other units, including DX cooling units and chilled-water units that control the space temperature by modulating the airflow to the space, shall have modulating fan control.

*Comment: Standard 90.1 requires that most fan systems are VAV or multi-speed.*



# IMC-2018

## Section 405 - Systems Control

**405.1 General.** Mechanical ventilation systems shall be provided with manual or automatic controls that will operate such systems whenever the spaces are occupied. Air-conditioning systems that supply required ventilation air shall be provided with controls designed to automatically maintain the required outdoor air supply rate during occupancy.

**403.3.1.4 Variable air volume system control.** Variable air volume air distribution systems, other than those designed to supply only 100-percent outdoor air, shall be provided with controls to regulate the flow of outdoor air. Such control system shall be designed to maintain the flow rate of outdoor air at a rate of not less than that required by Section 403.3 over the entire range of supply air operating rates.



# Measurement for the control of fresh air intake

*The Standard 62-1989 recommendations for measuring and documenting outdoor air intake flow are discussed*

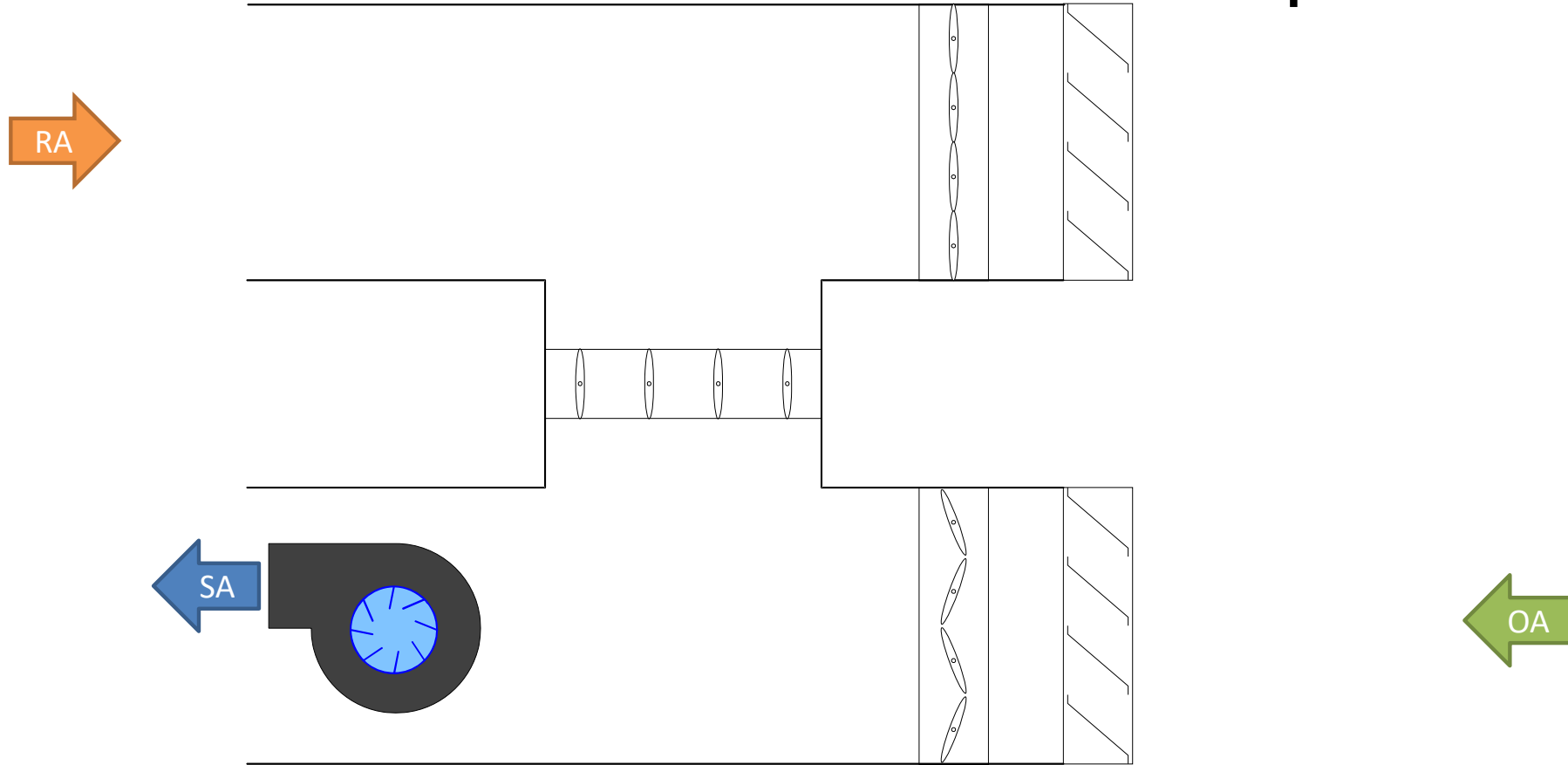
By **David W. Solberg, P.E., David S. Dougan and Leonard A. Damiano**  
*Member ASHRAE*

Published January, 1990 in ASHRAE Journal



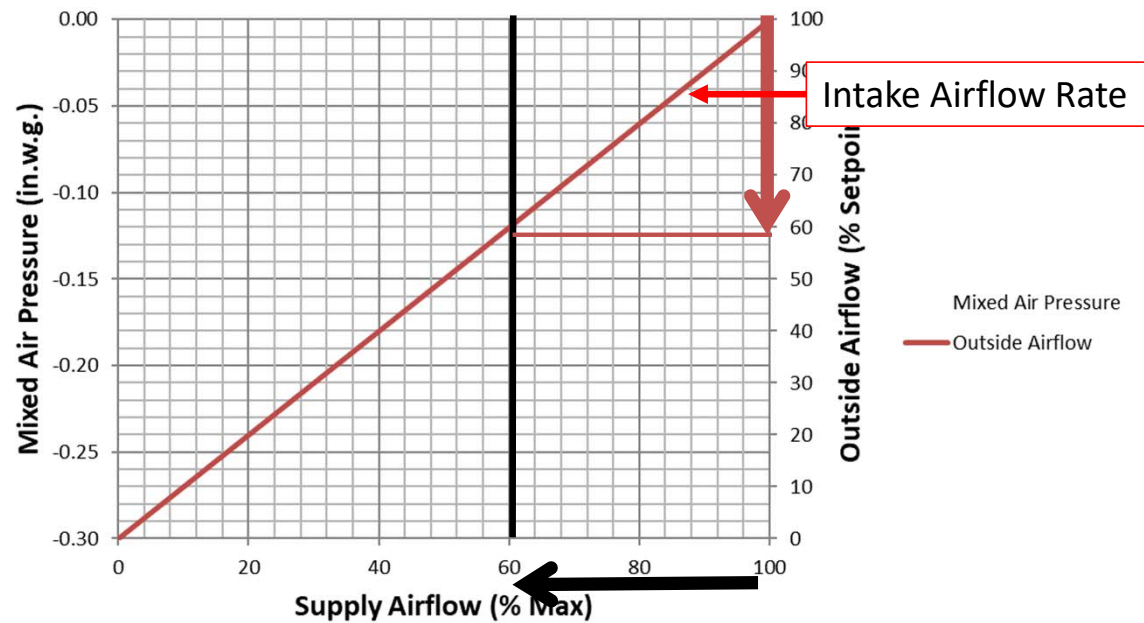


# Fixed Minimum Position Intake Damper



# Fixed Minimum Position Intake Damper

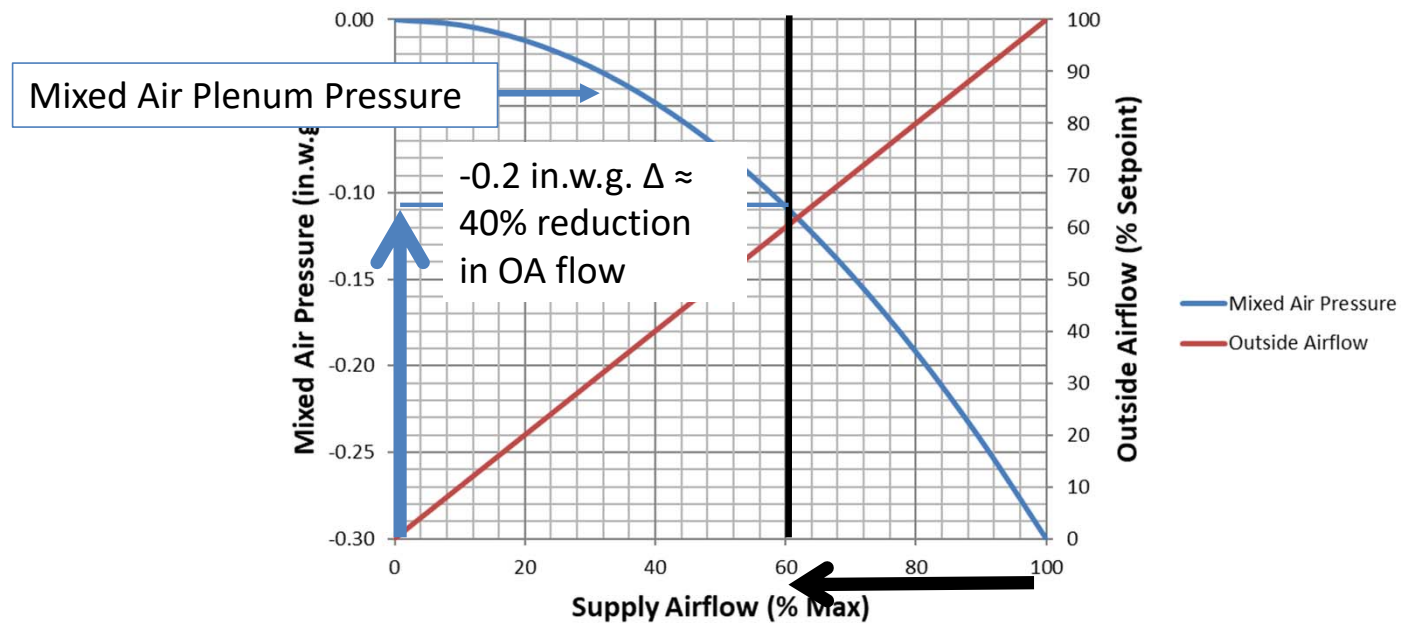
Intake Flow and Mixed Air Plenum Pressure Variations on Multi-speed Fan Systems  
Fixed Minimum Position Intake Damper



# Fixed Minimum Position Intake Damper

## Intake Flow and Mixed Air Plenum Pressure Variations on Multi-speed Fan Systems

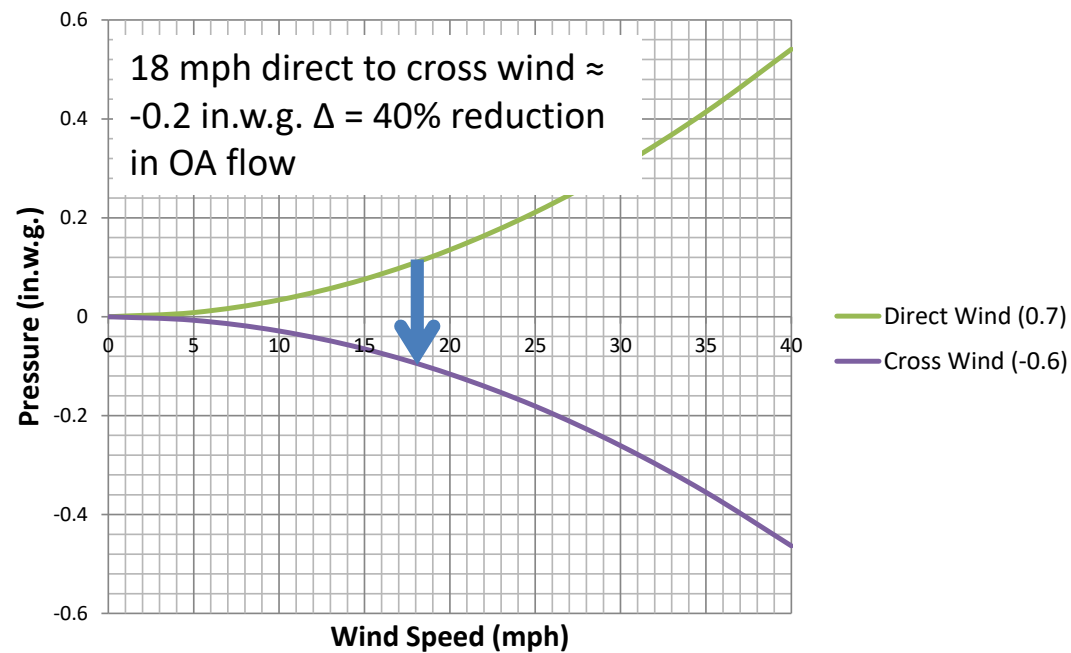
Fixed Minimum Position Intake Damper



# Wind Pressure Variations

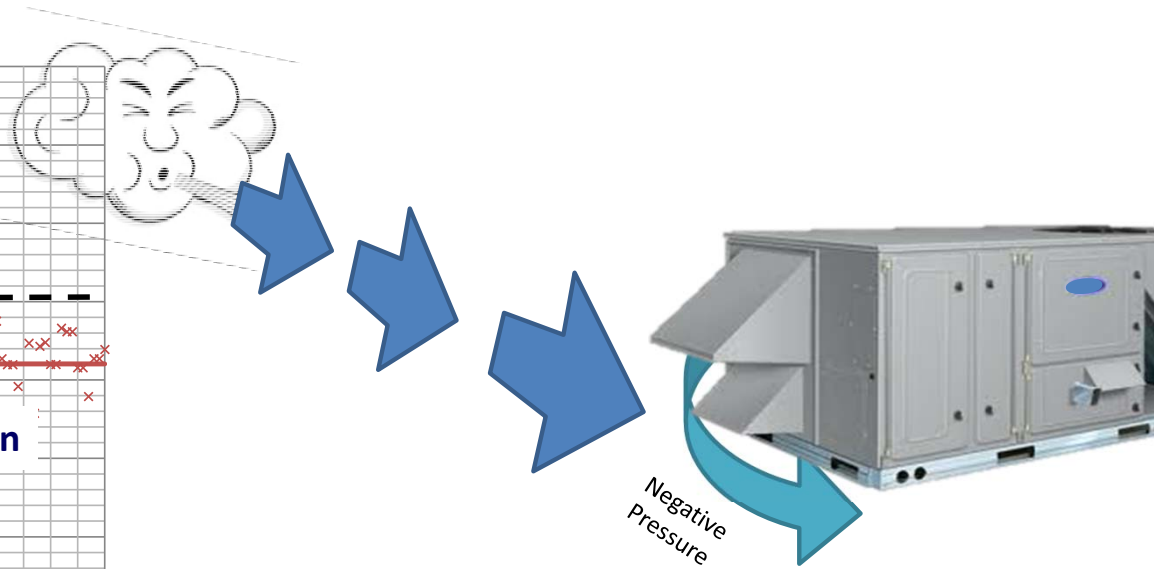
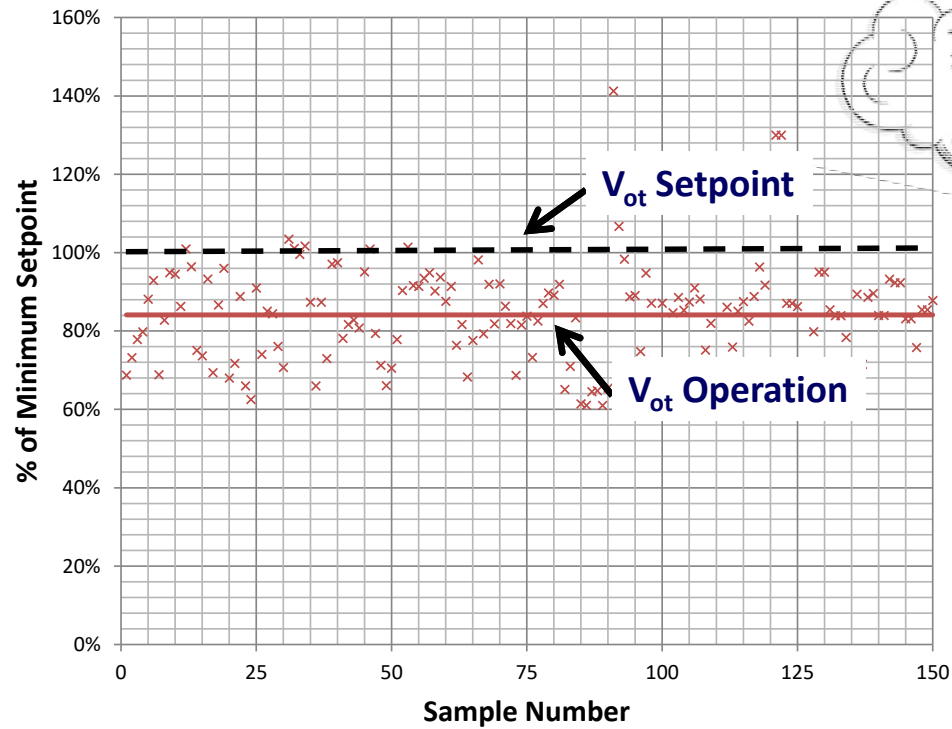
Additional motivation to control all outdoor air intakes!

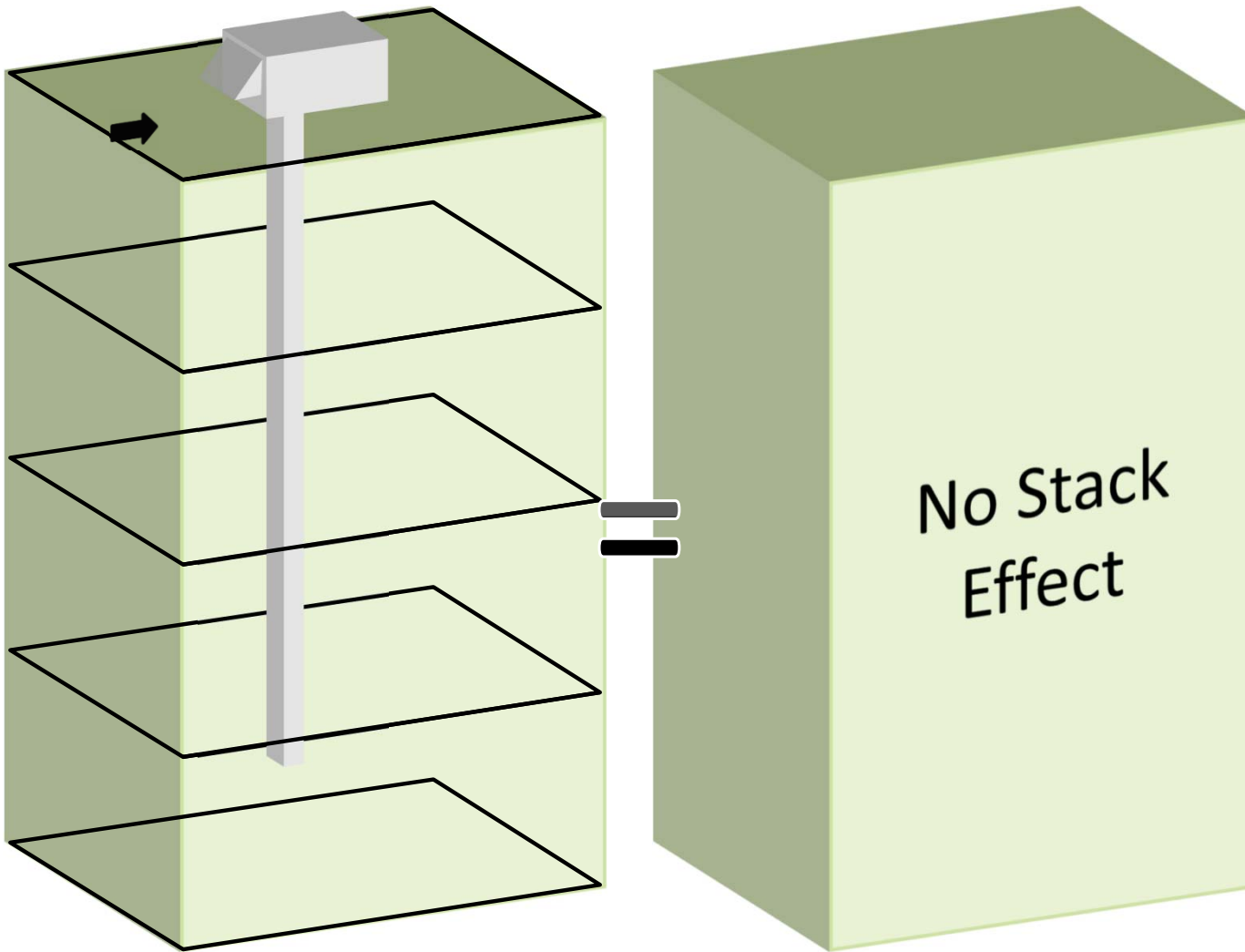
Wind Pressure on Intake System

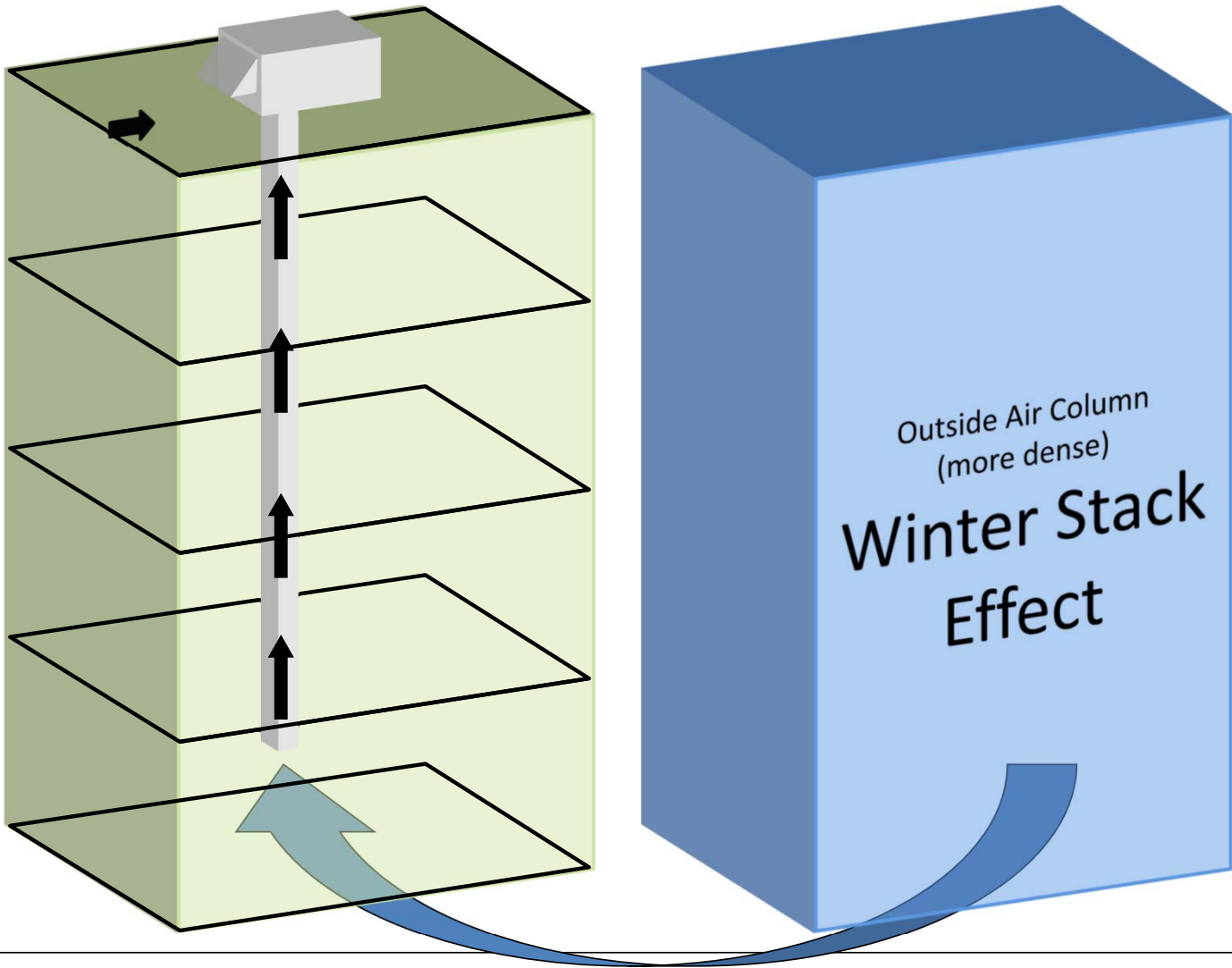


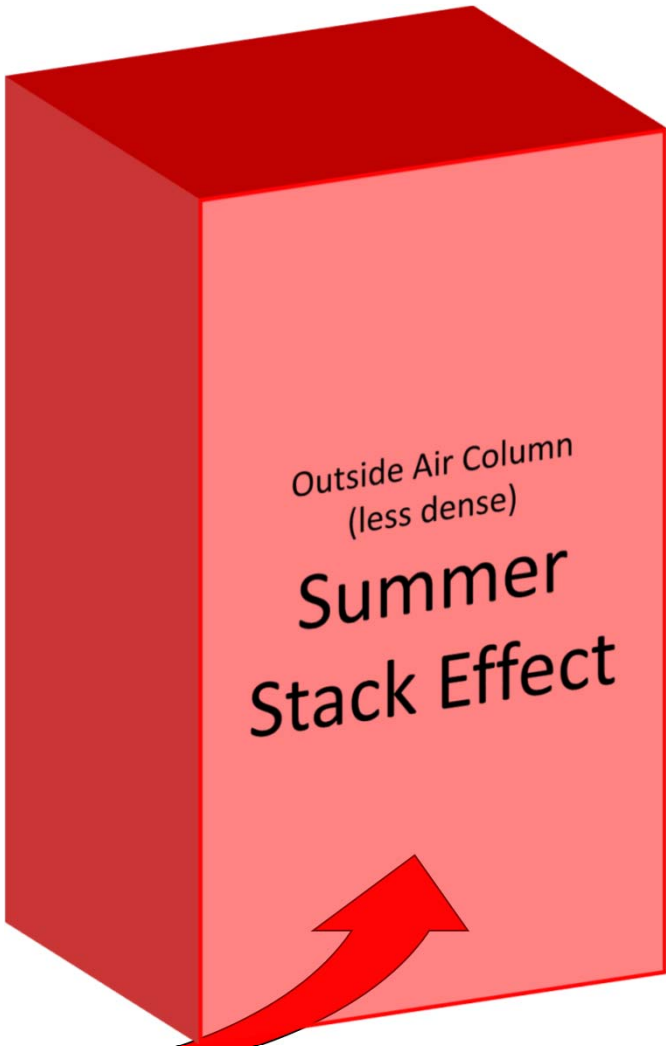
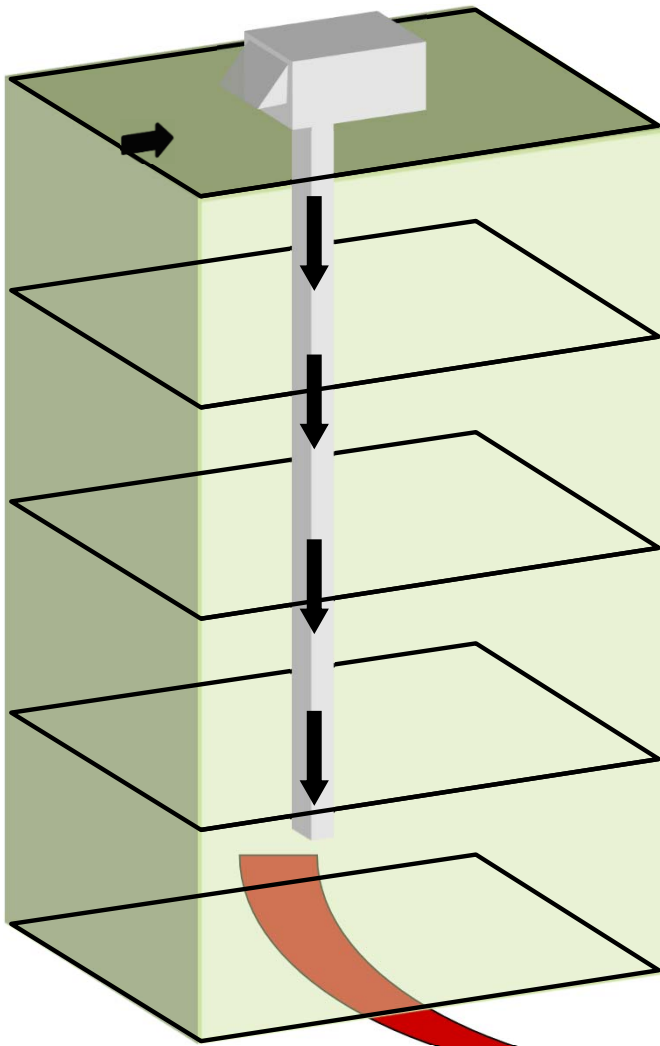
# Wind Effect

15 mph Cross Wind w/Gusts  
15% Damper Open







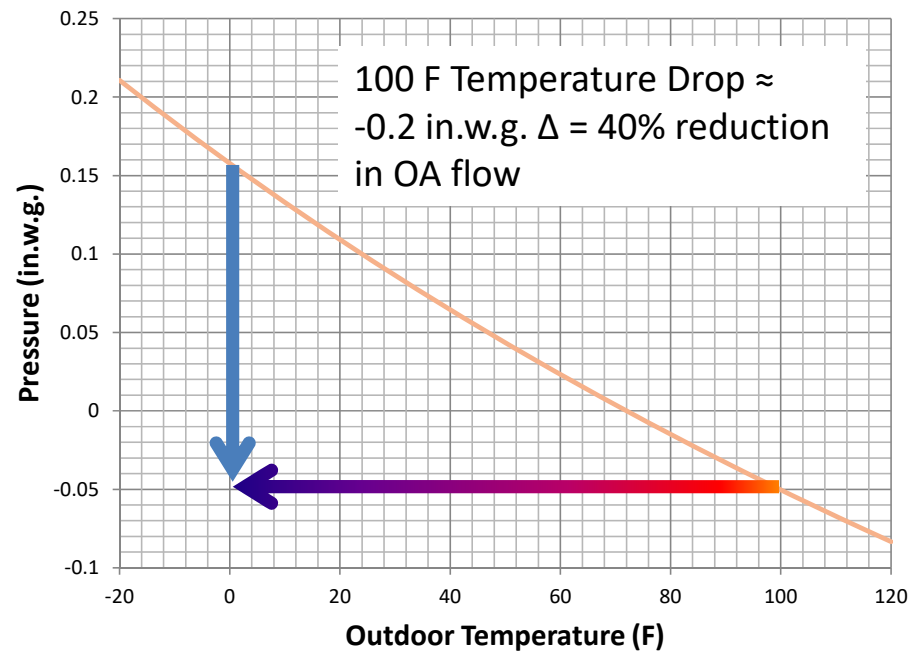




# Stack Pressure Variations

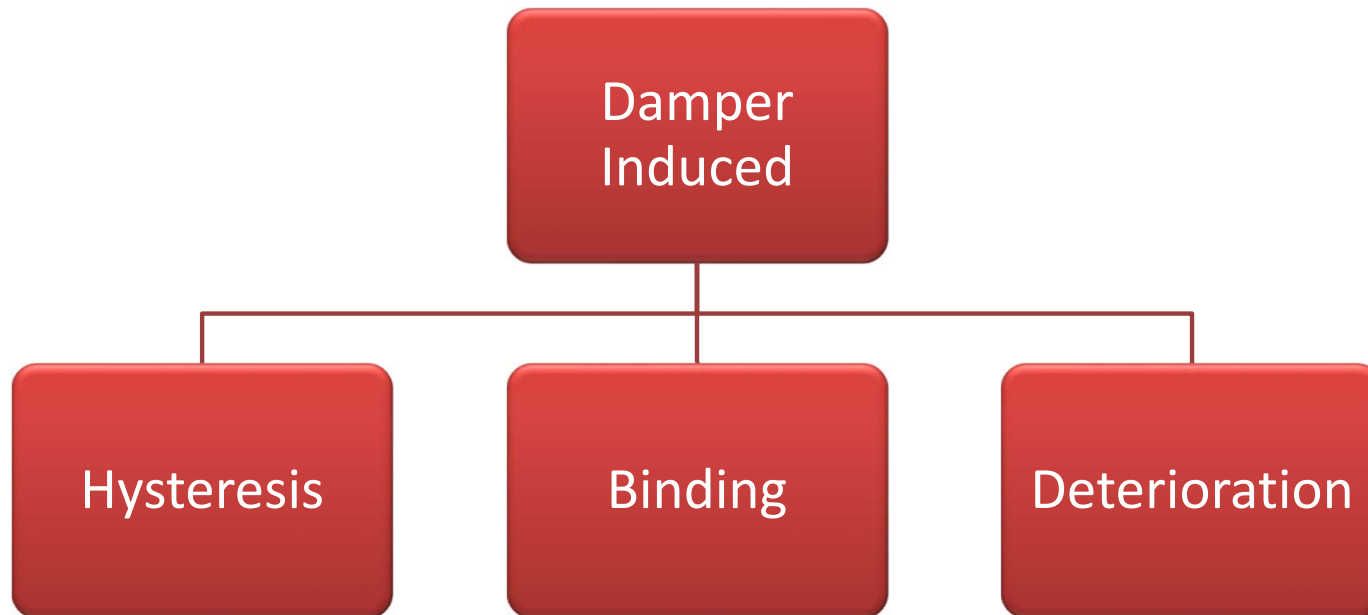
## Stack Pressure on Intake System

70 ft. (First Floor to Roof)

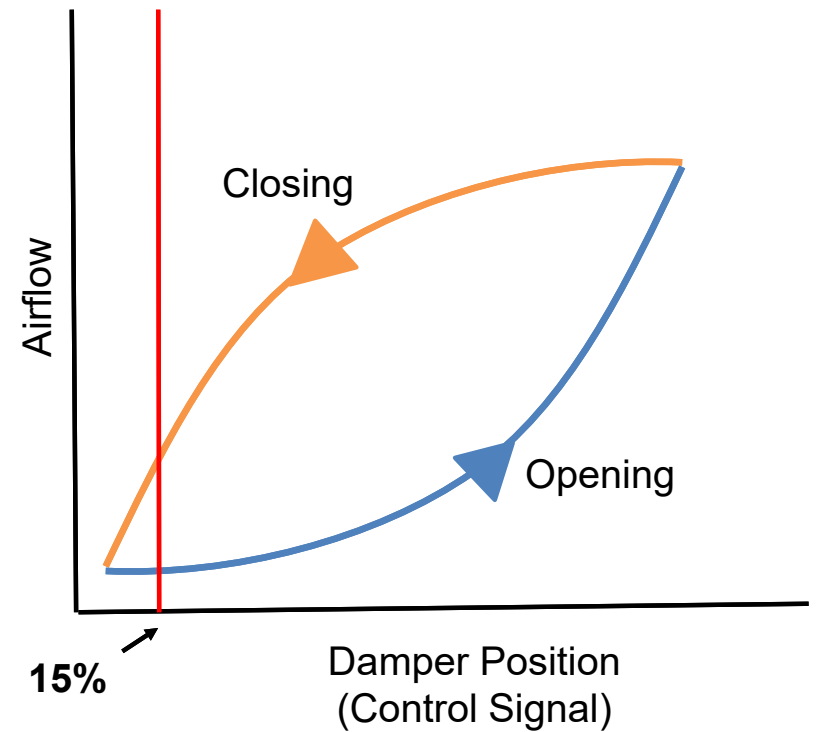
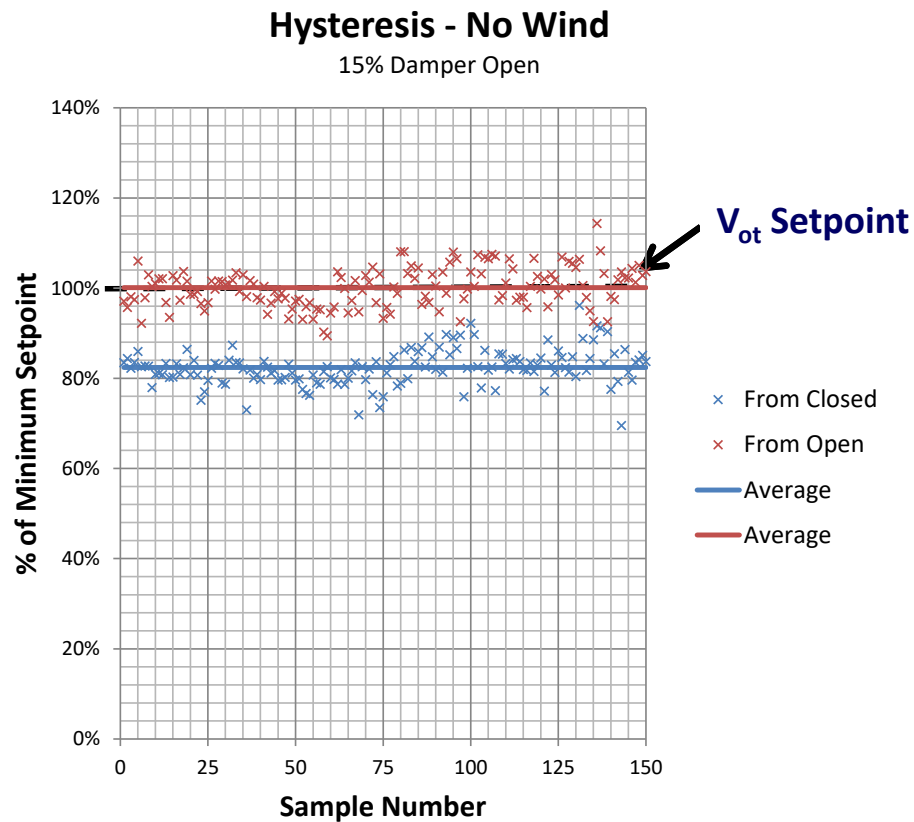


# Intake Airflow Variations

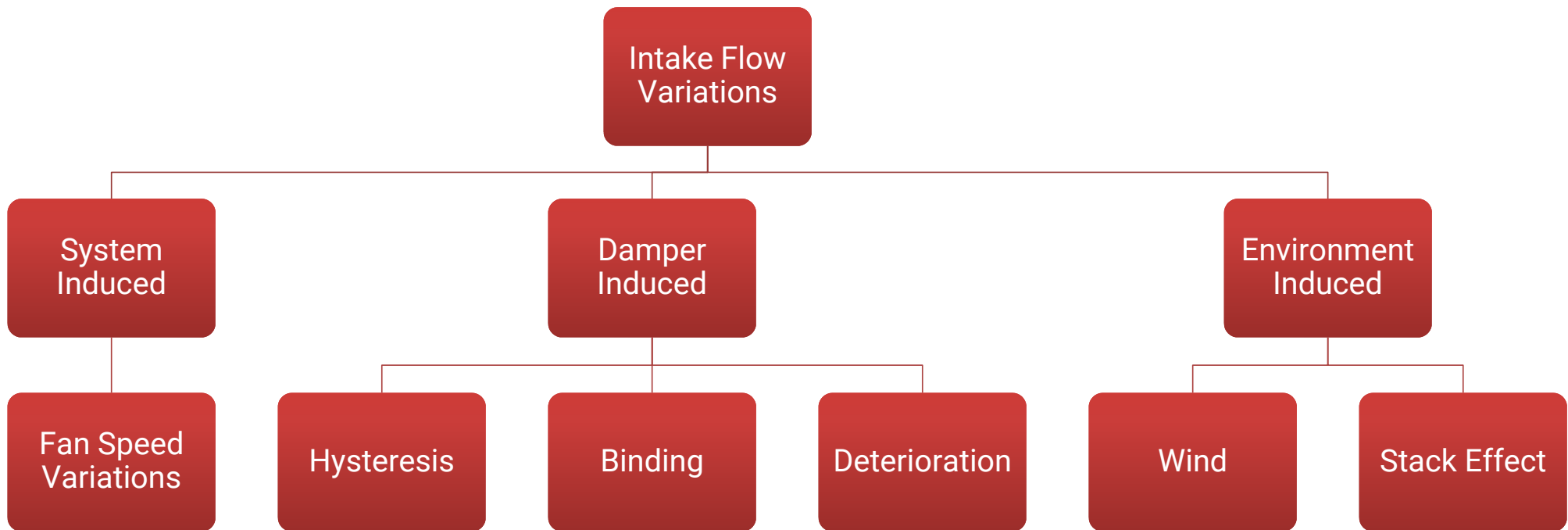
Additional motivation to control all outdoor air intakes!



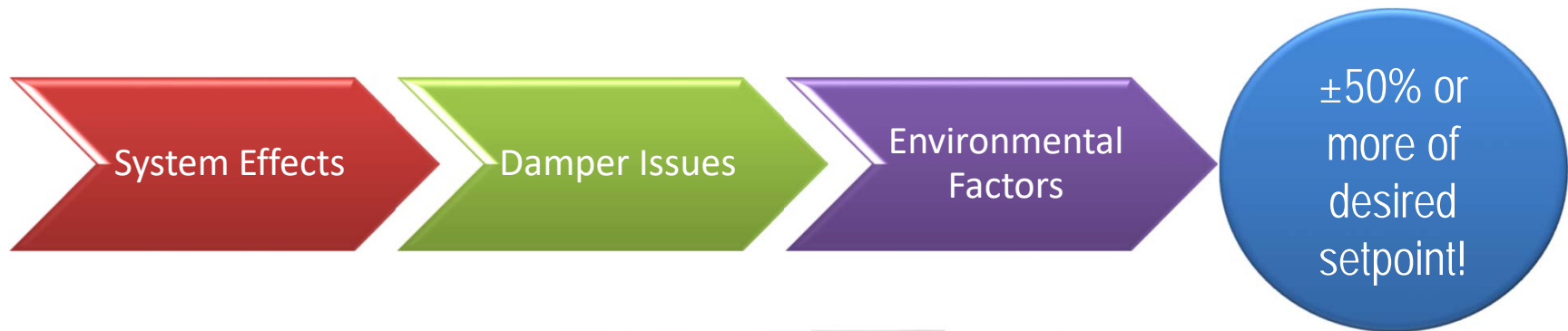
# Damper Hysteresis



# Factors that Influence Intake Flow Rates



# Uncontrolled OA Intake Uncertainty



# The Logical Conclusion ...



## On ALL OA Intakes



# Thank You!

Questions? More information?

[AskDave@EngineeredSalesCorp.com](mailto:AskDave@EngineeredSalesCorp.com)

