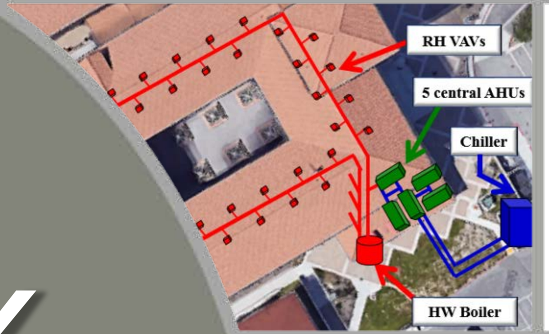
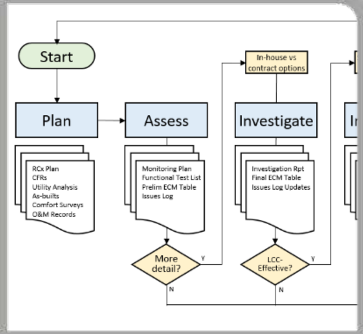
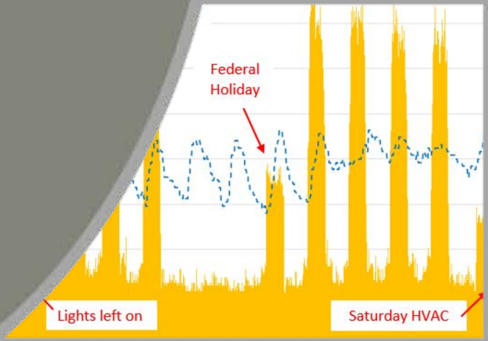
2020 RCx Academy

Week 4
Air-Side Systems

3 June 2020







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A Few References That Will Come Up

Information about COVID 19 and HVAC systems

https://av8rdas.wordpress.com/2020/05/30/taylor-engineerings-covid-19-white-paper/

Information about system effect

https://av8rdas.wordpress.com/2014/10/02/system-effectdealing-with-the-point-where-the-fan-meets-the-duct/

Information about filtration opportunities

https://www.av8rdas.com/ncbc.html#2015

Mixed air calculations spreadsheet

https://www.av8rdas.com/mixed-air-calculations.html

Economizer evaluation checklist

https://www.av8rdas.com/economizer-evaluation-checklist.html

A Few References That Will Come Up

Economizer Stratification Video

https://www.av8rdas.com/economizer-stratification.html

Economizer Stratification Blog Post

https://av8rdas.wordpress.com/2013/01/17/retrocommissioning-findings-economizer-mixed-air-plenum-stratificationoverview/

Pacific Energy Center Economizers; Design, Performance and Commissioning Issues Class Materials

https://www.av8rdas.com/pacific-energy-center-design-performance-and-commissioning-issues-classes.html#Economizers

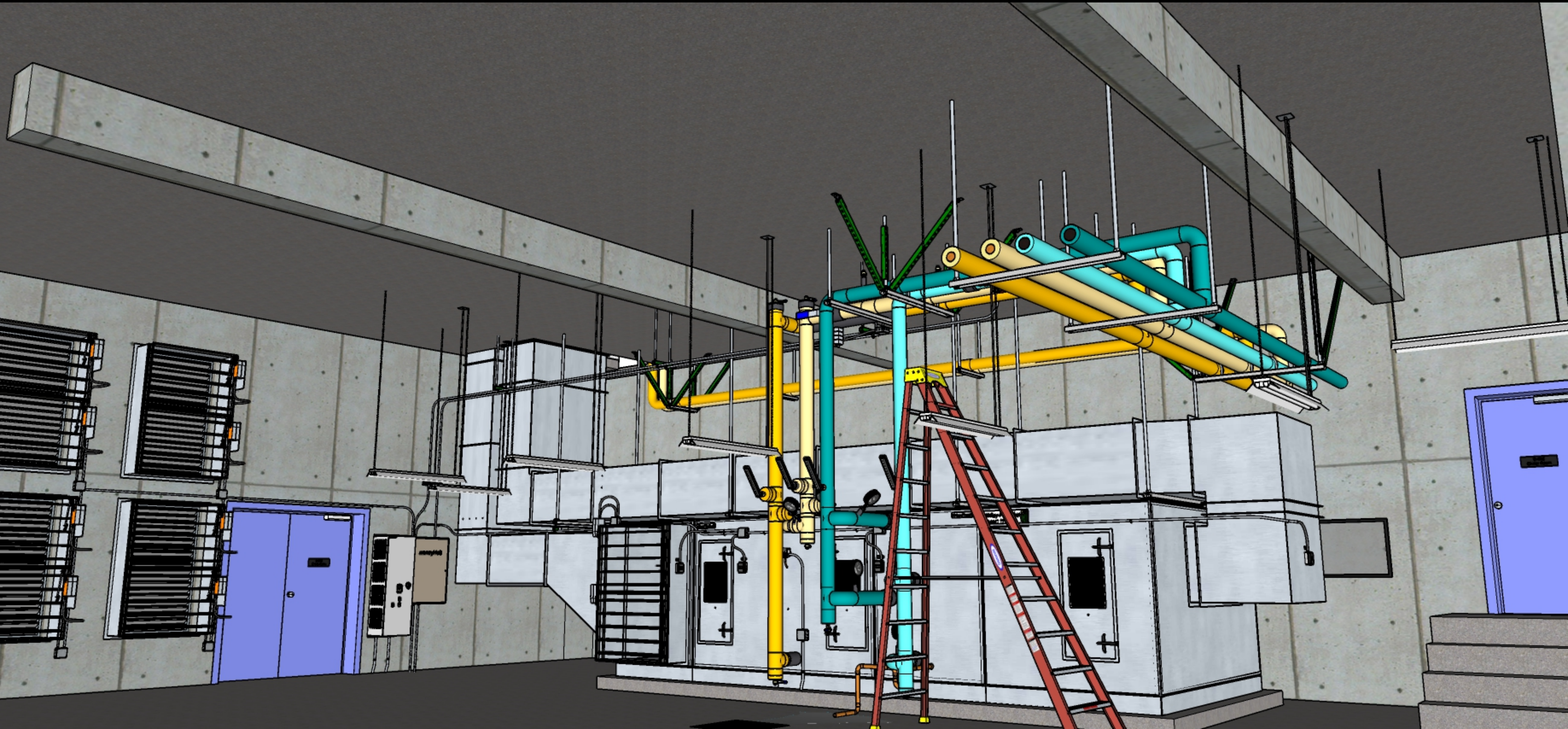
Pacific Energy Center Fans, Ducts and AHUs; Design, Performance and Commissioning Issues Class Materials

https://www.av8rdas.com/pacific-energy-center-design-performance-and-commissioning-issues-classes.html#Fans

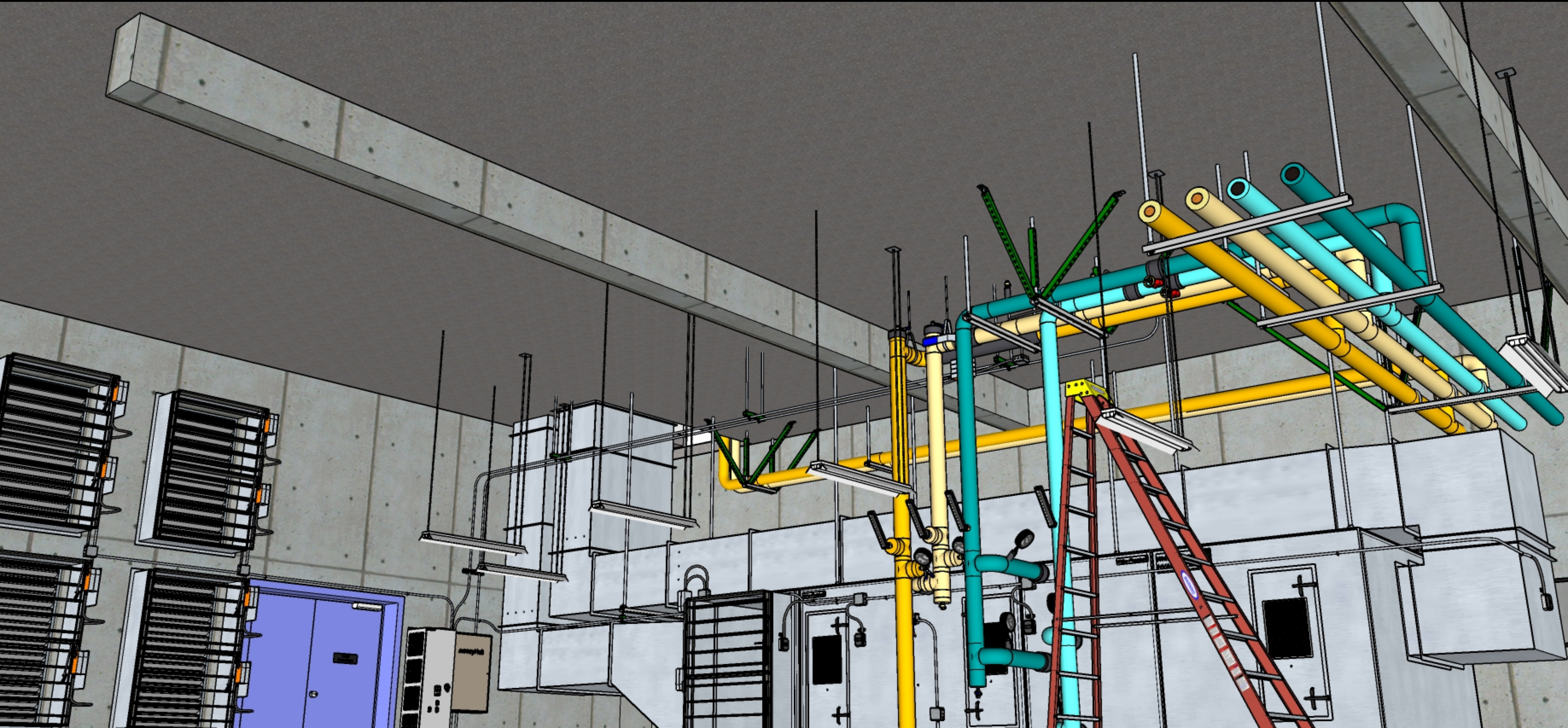
Taking a Closer Look at the Ball Room AHU

Some Floor Plans to Help You Stay Oriented

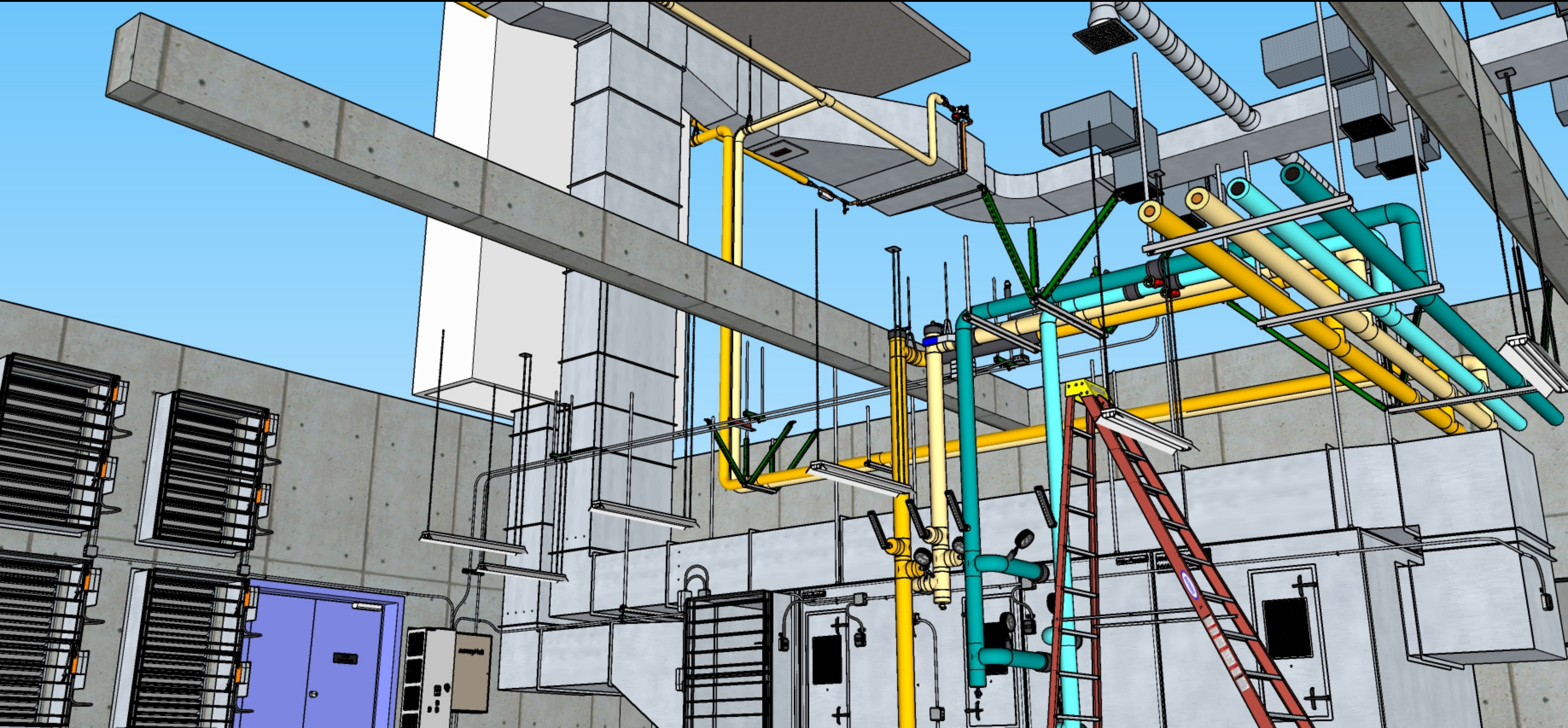
AHU Overview



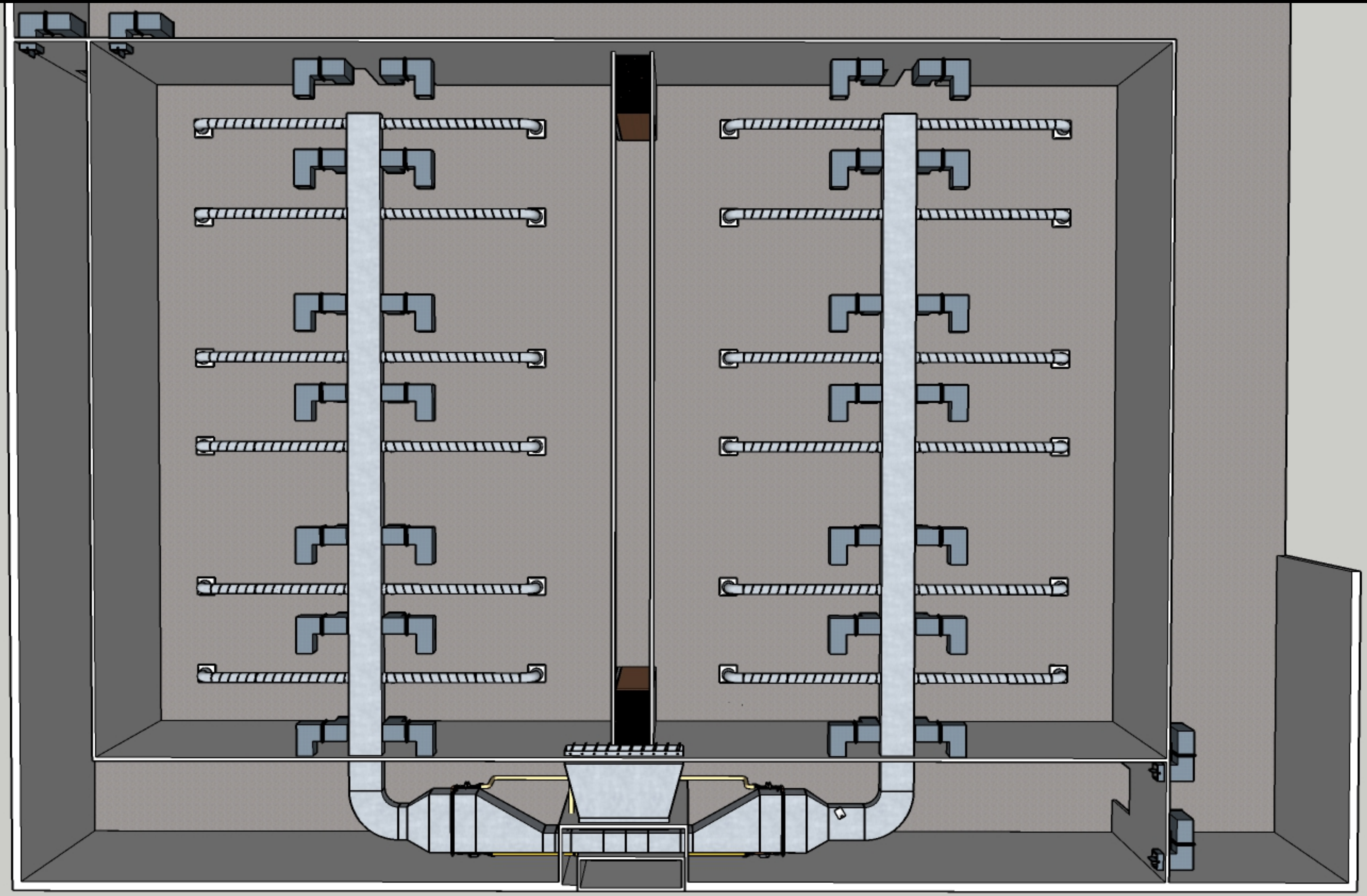
AHU System Overview



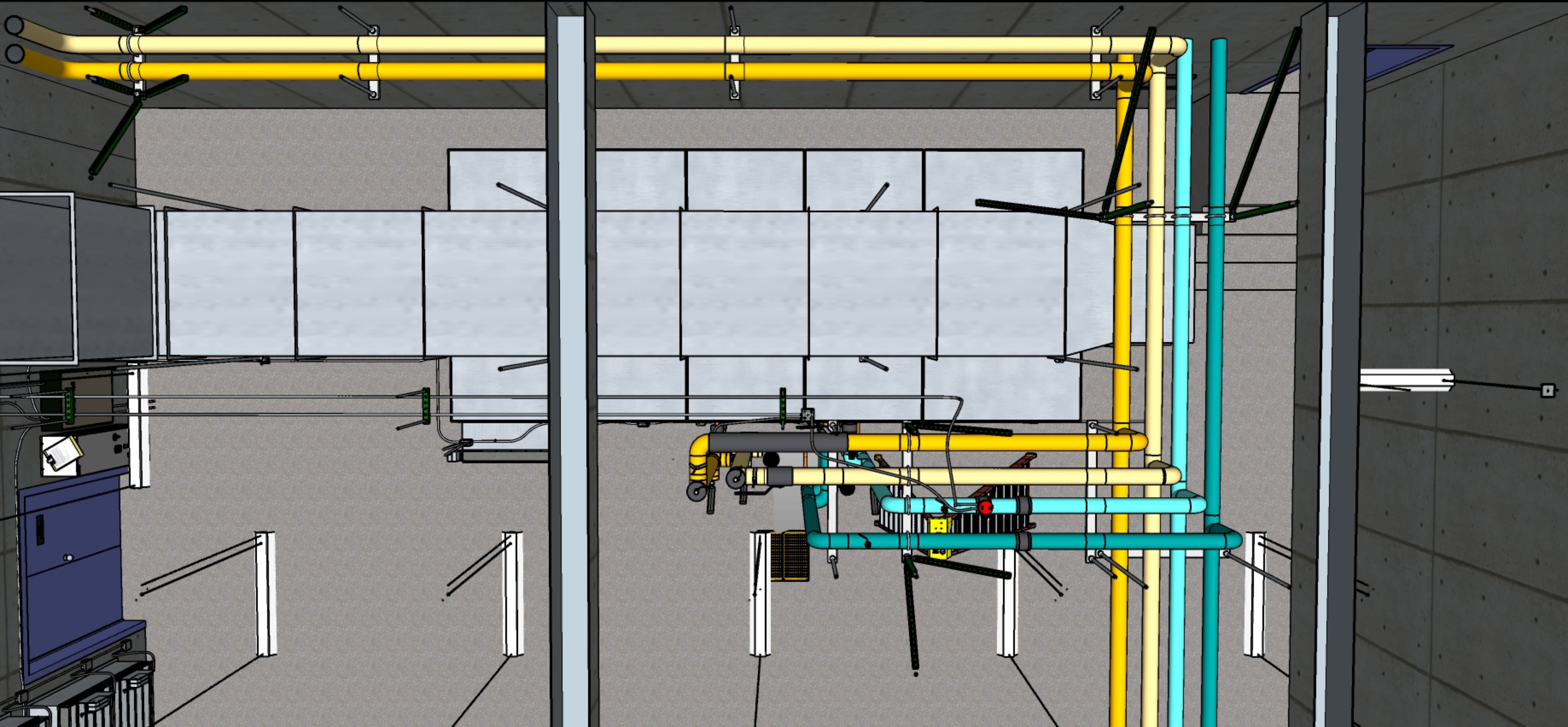
AHU System Overview



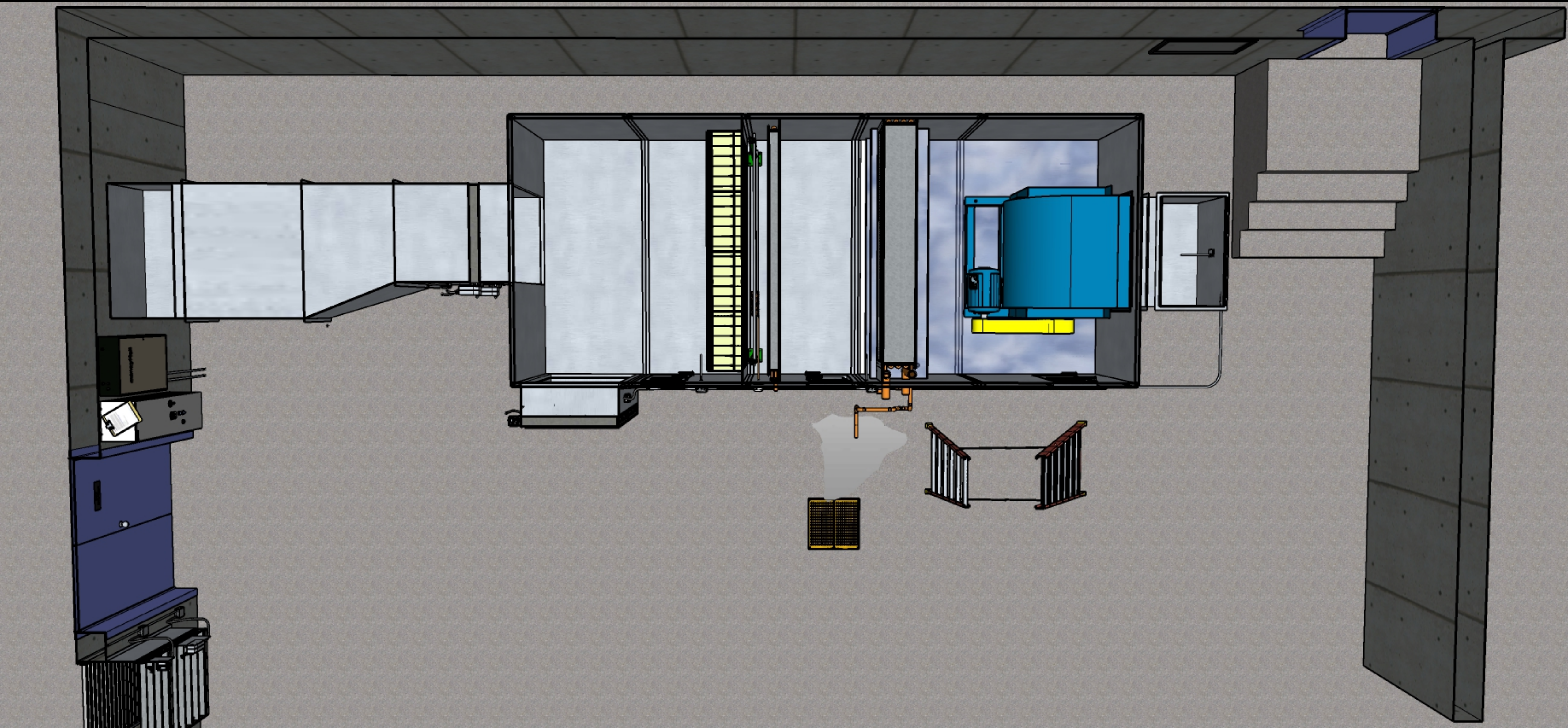
Ball Room Overview



Mechanical Room Plan View

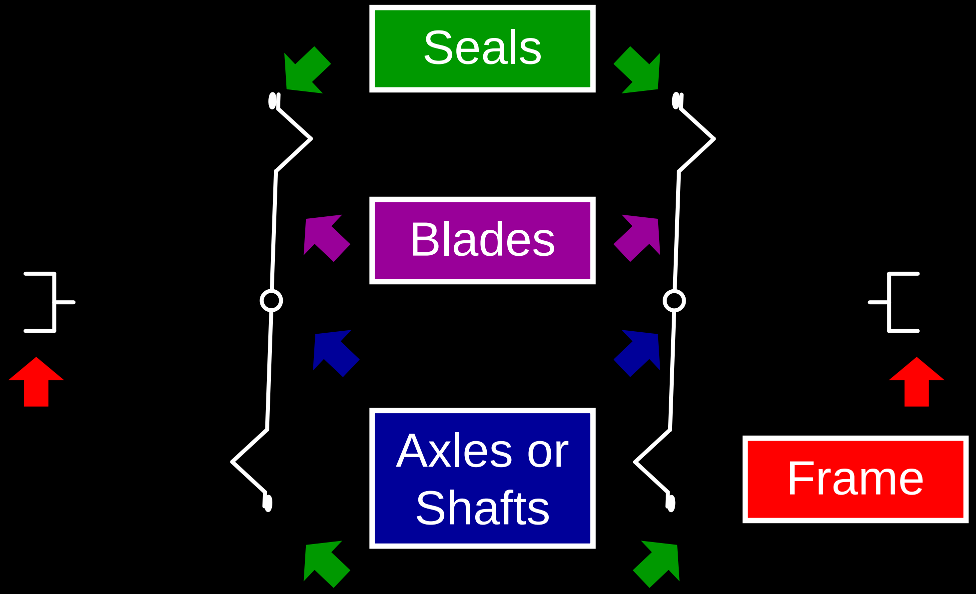


Mechanical Room Plan View – AHU Interior Exposed



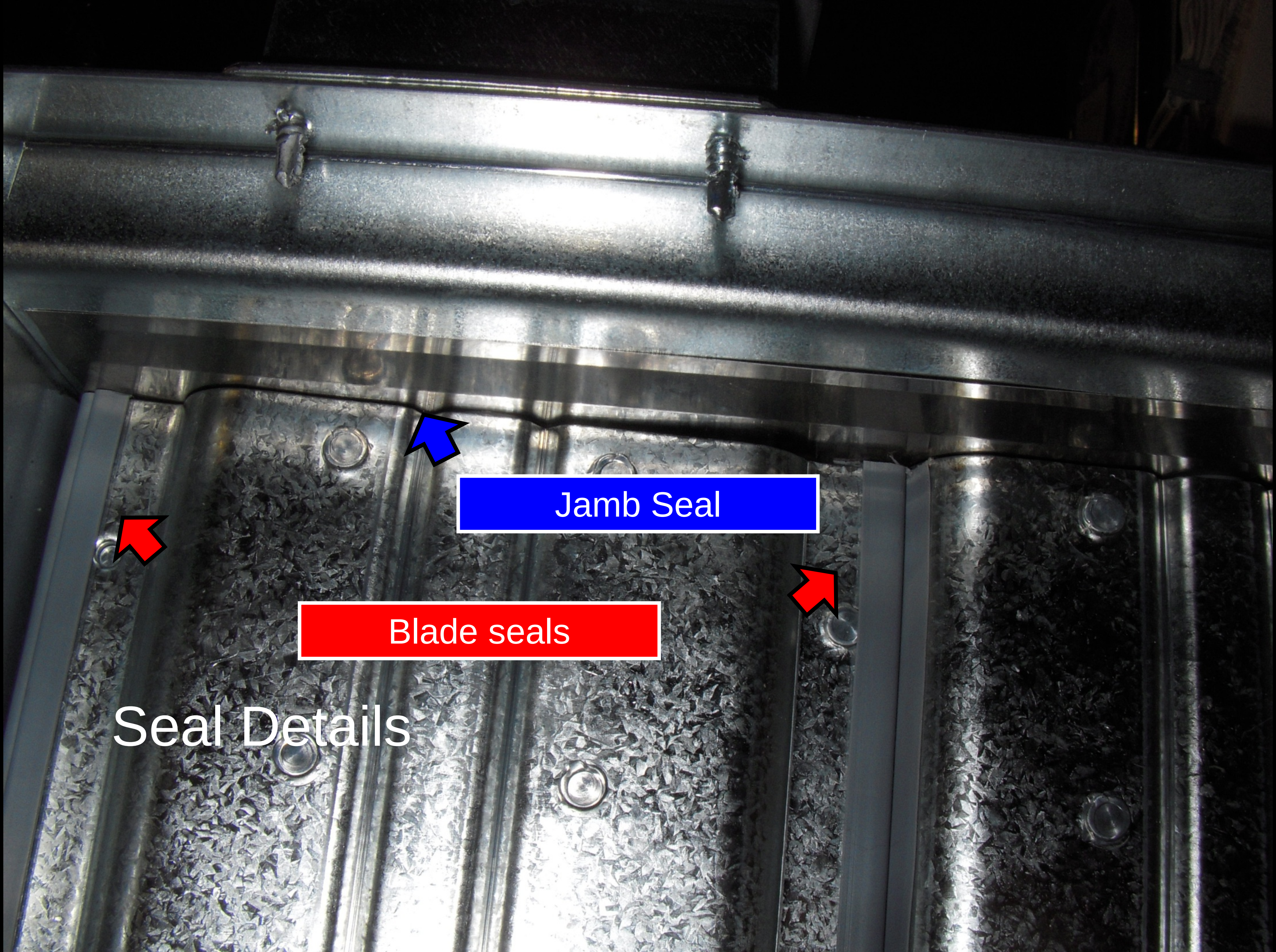
Damper Parts

Parallel Blade Damper



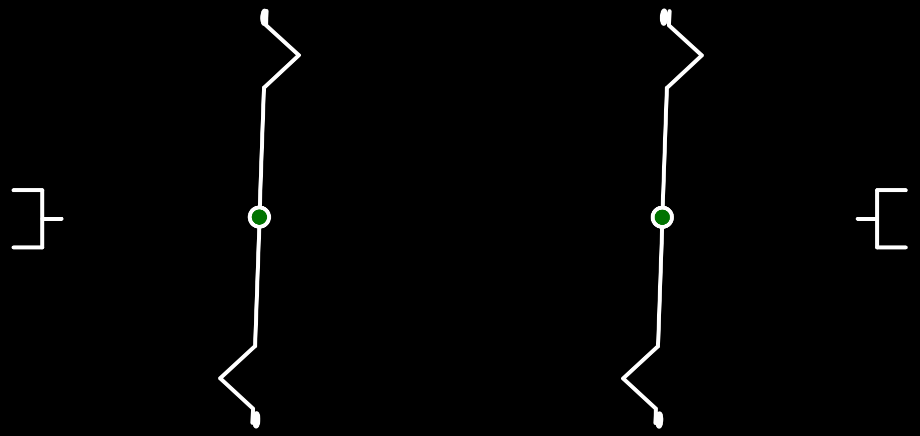
A Conventional, Flat Plate Blade Cross-Section

Greenheck’s Airfoil Blade Cross-Section

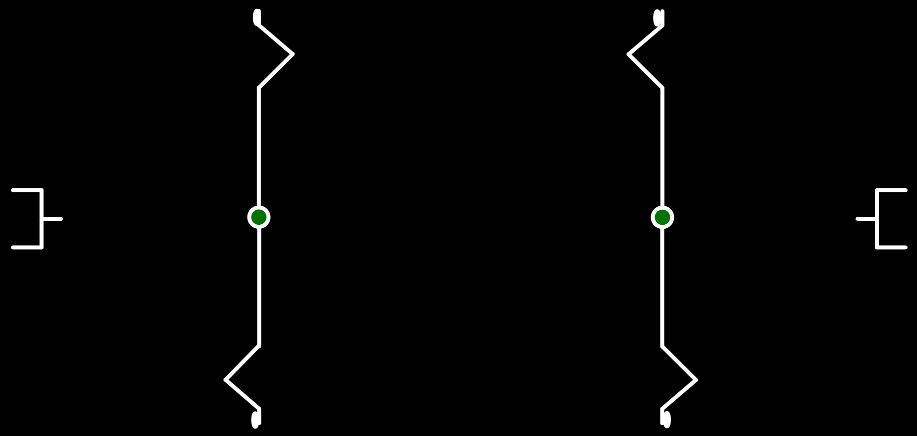

Jamb Seal
Blade seals
Seal Details

Parallel vs. Opposed Blade Dampers

Parallel Blade Damper



Opposed Blade Damper

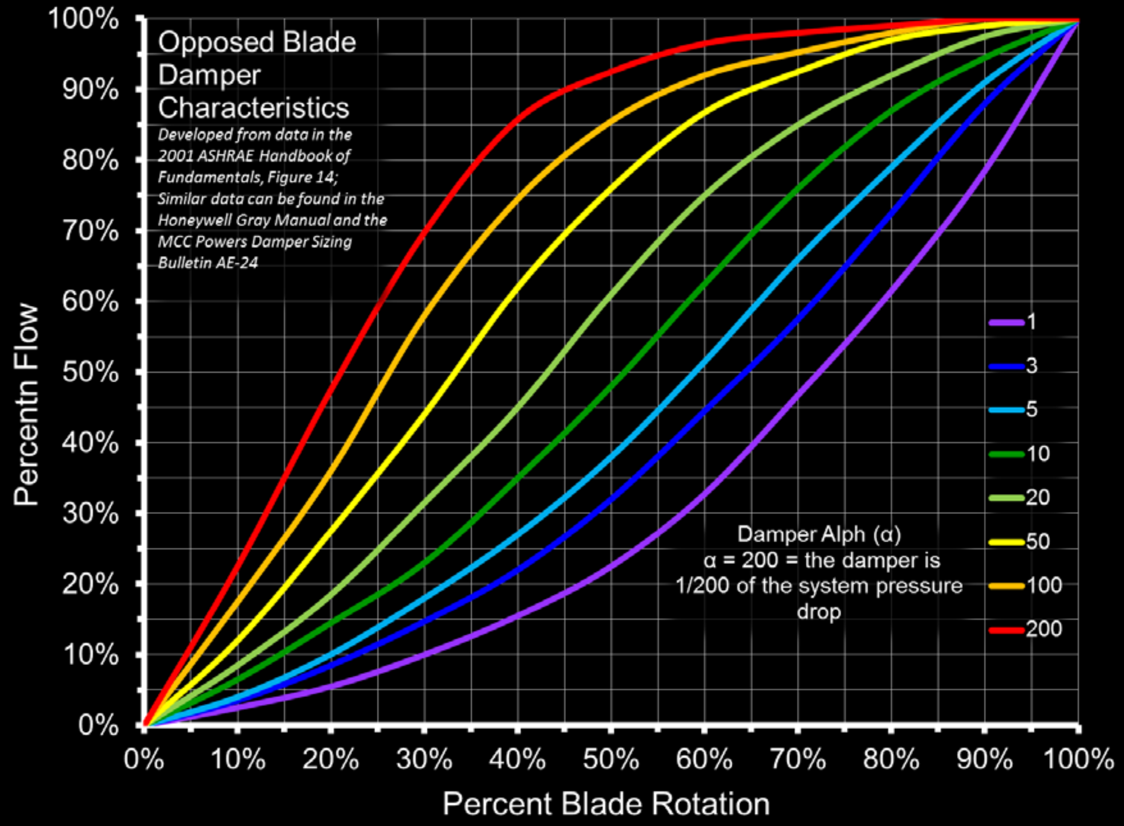


Dampers Need to be Sized for Modulating Control

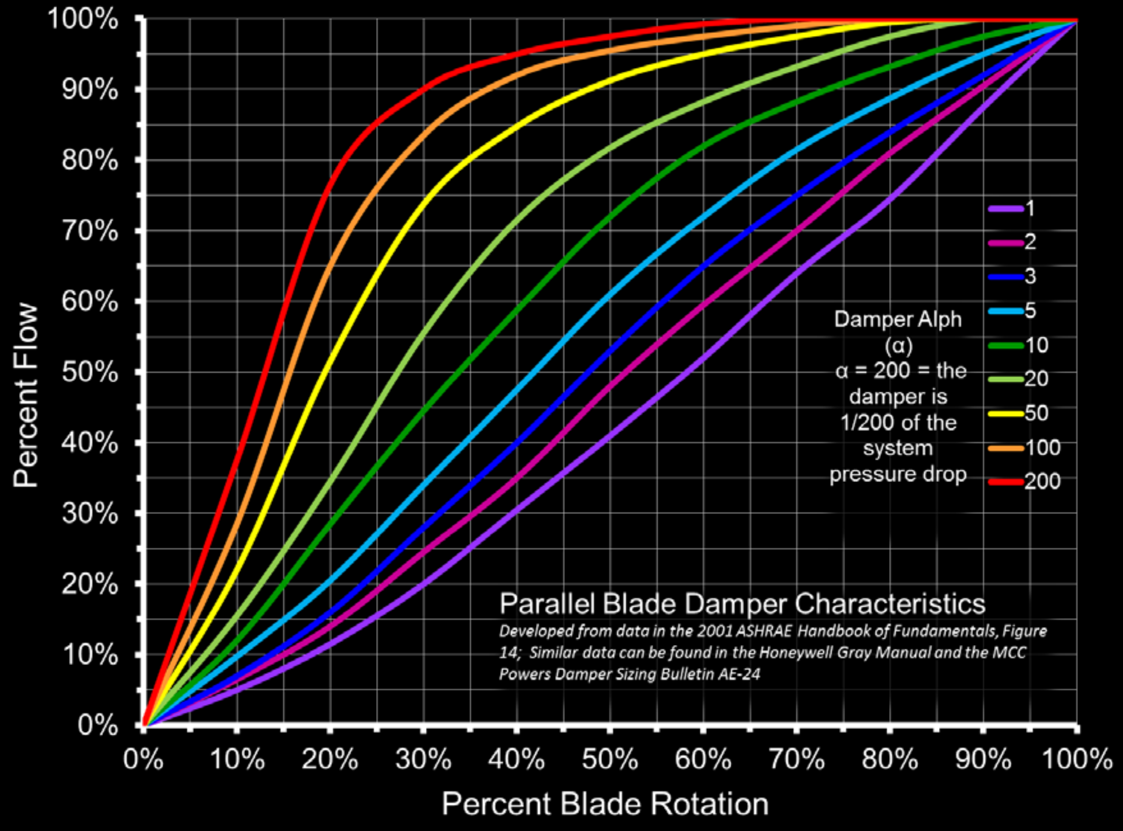
Characteristics vary with damper design

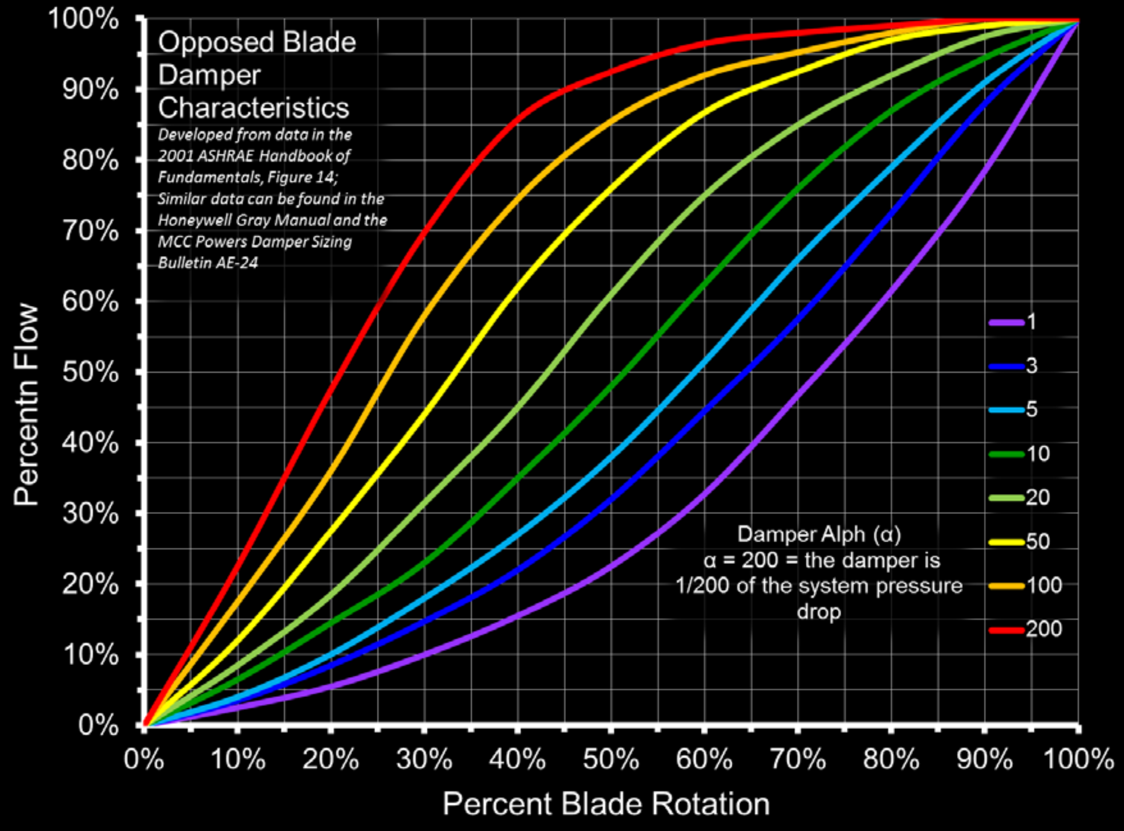
Rules of thumb

- Pressure significant relative to the system
- Target face velocity of 1,500 to 2,500 fpm will usually work
- Air flow velocity conversions count in the over-all pressure loss

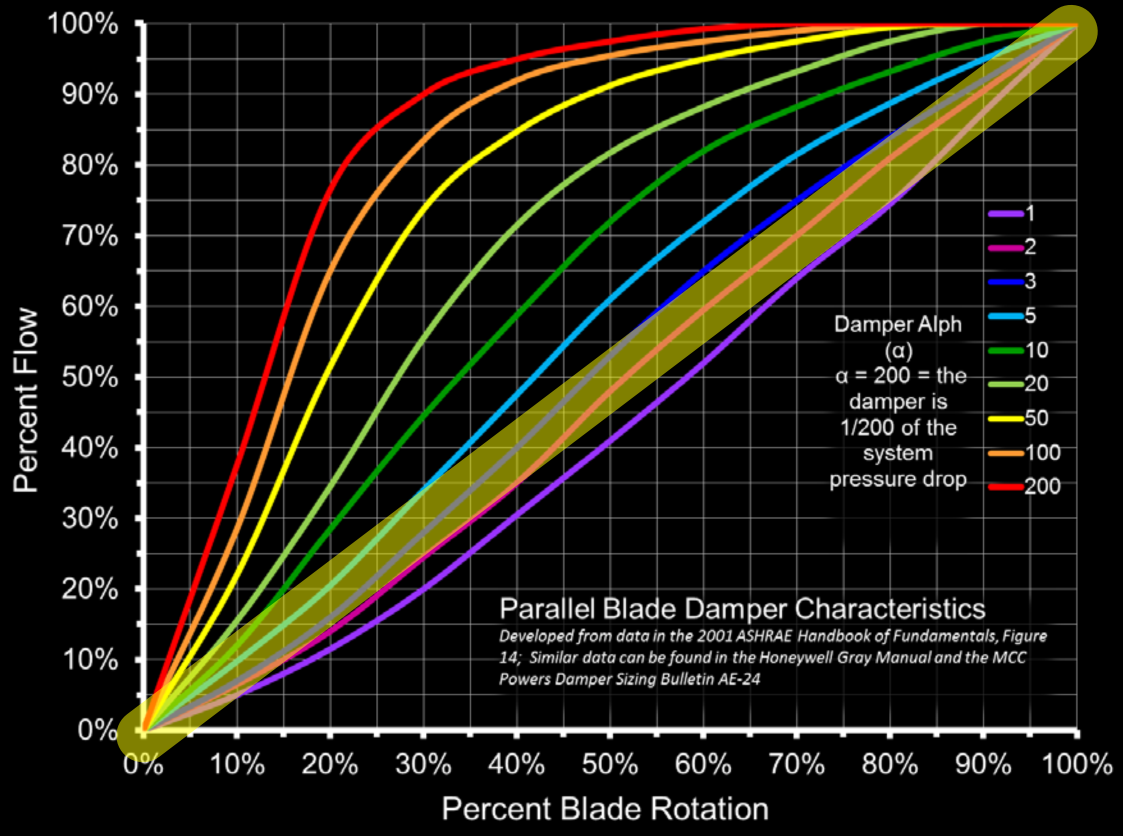


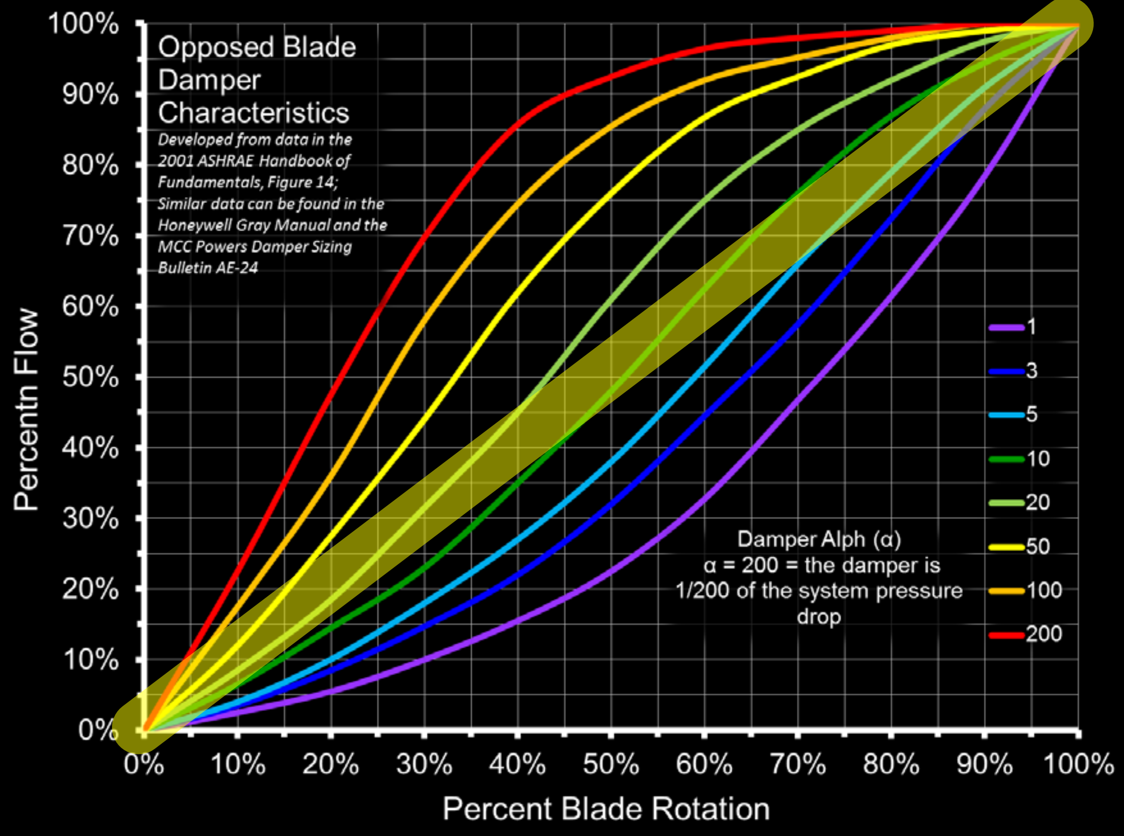
Opposed Blade Characteristics are Different from Parallel Blade Characteristics





Face Velocities of 1,500 – 2,500 fpm Will Generally Get You in the Range of a Linear Flow vs. Bade Rotation Curve



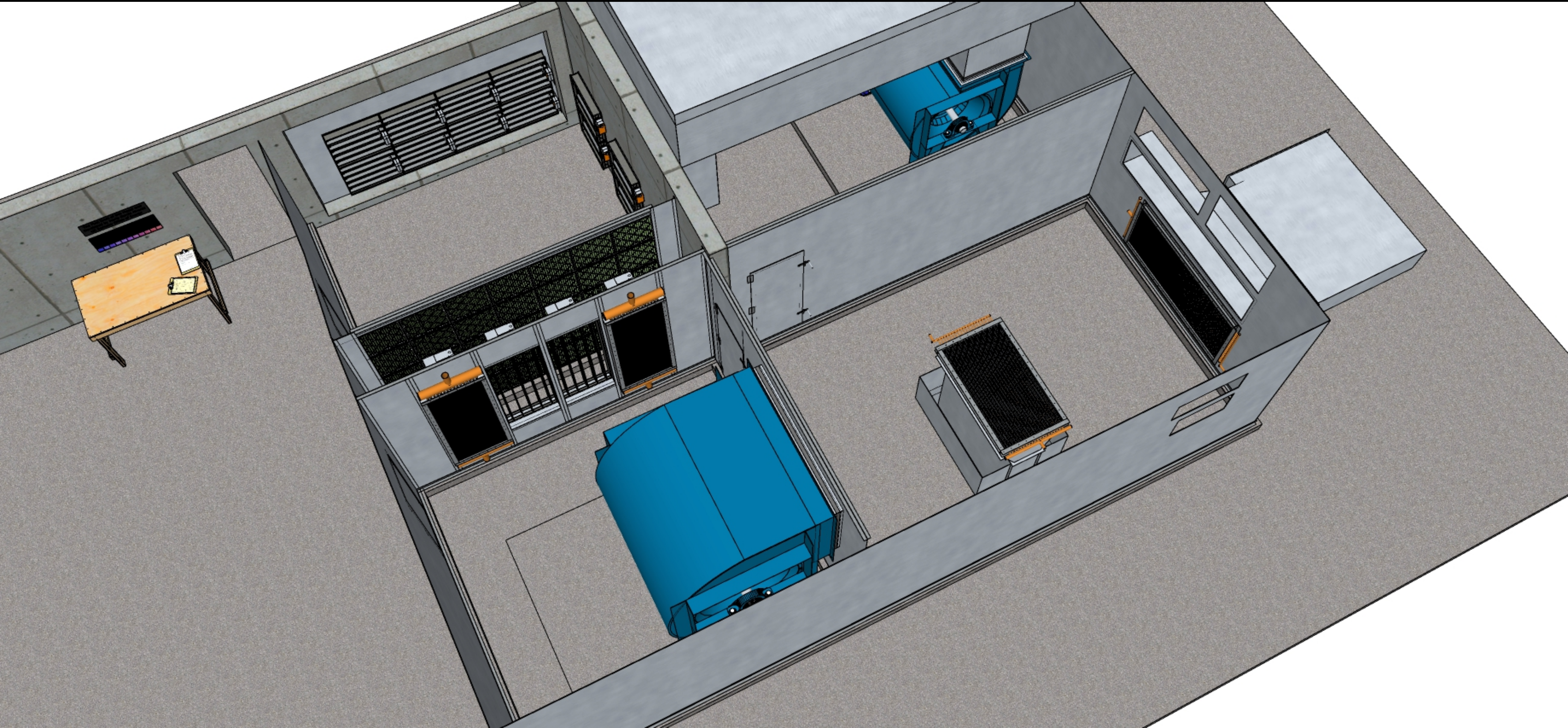



Thanks For Watching!
The End

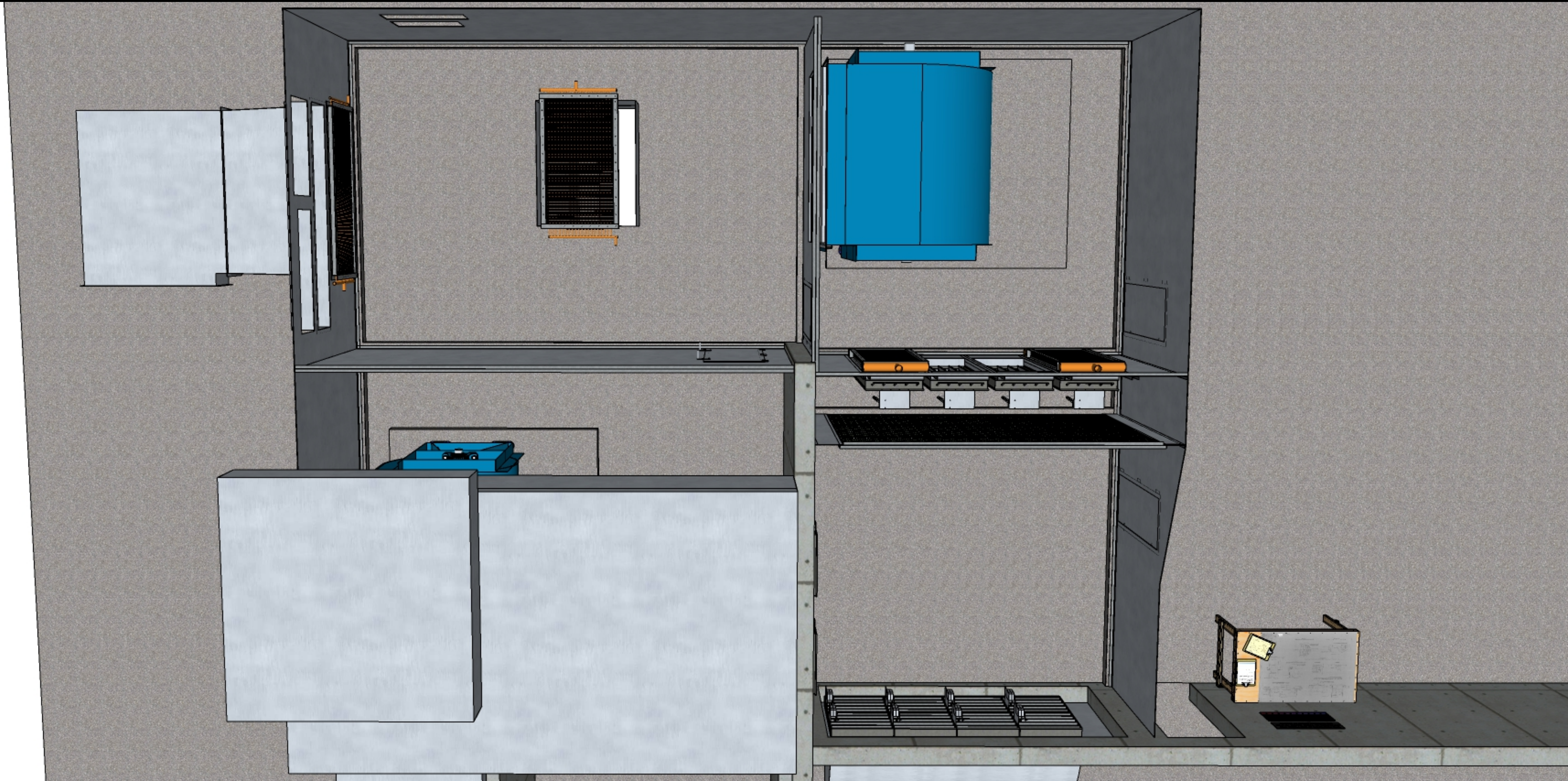
Taking a Closer Look at an Economizer

Some Floor Plans to Help You Stay Oriented

Overview



Plan View



A Break and an Exercise

Given:

1. The economizer evaluation checklist
2. The images that follow
3. The maximum face velocity rule of thumb;

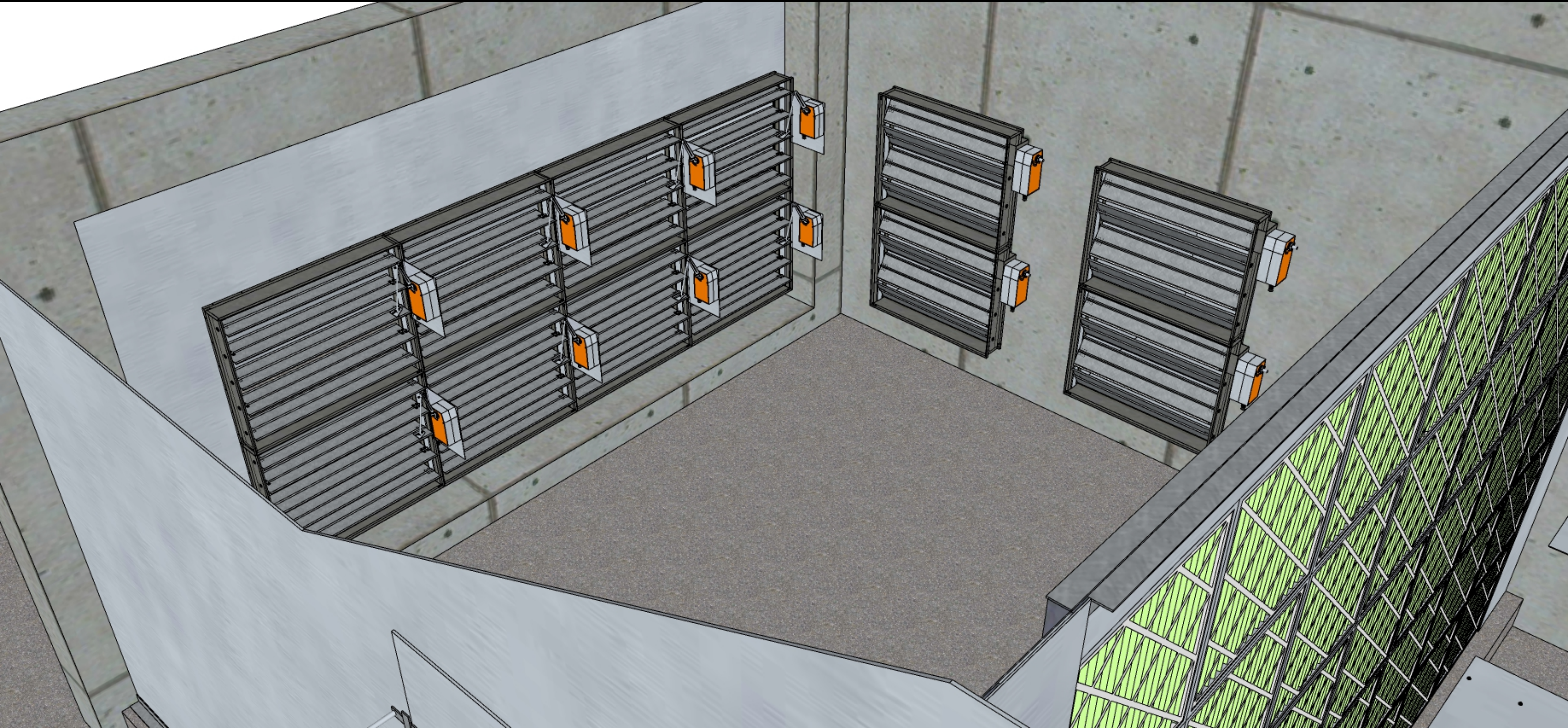
   Face velocities through filters and coils are generally held between 350 and 500 feet per minute to minimize the potential for blowing water off a condensing cooling coil and to manage fan energy
4. The damper face velocity rule of thumb:

   Damper face velocities probably need to be in the 1,500 to 2,500 fpm range at design flow to provide a semi-linear control characteristic

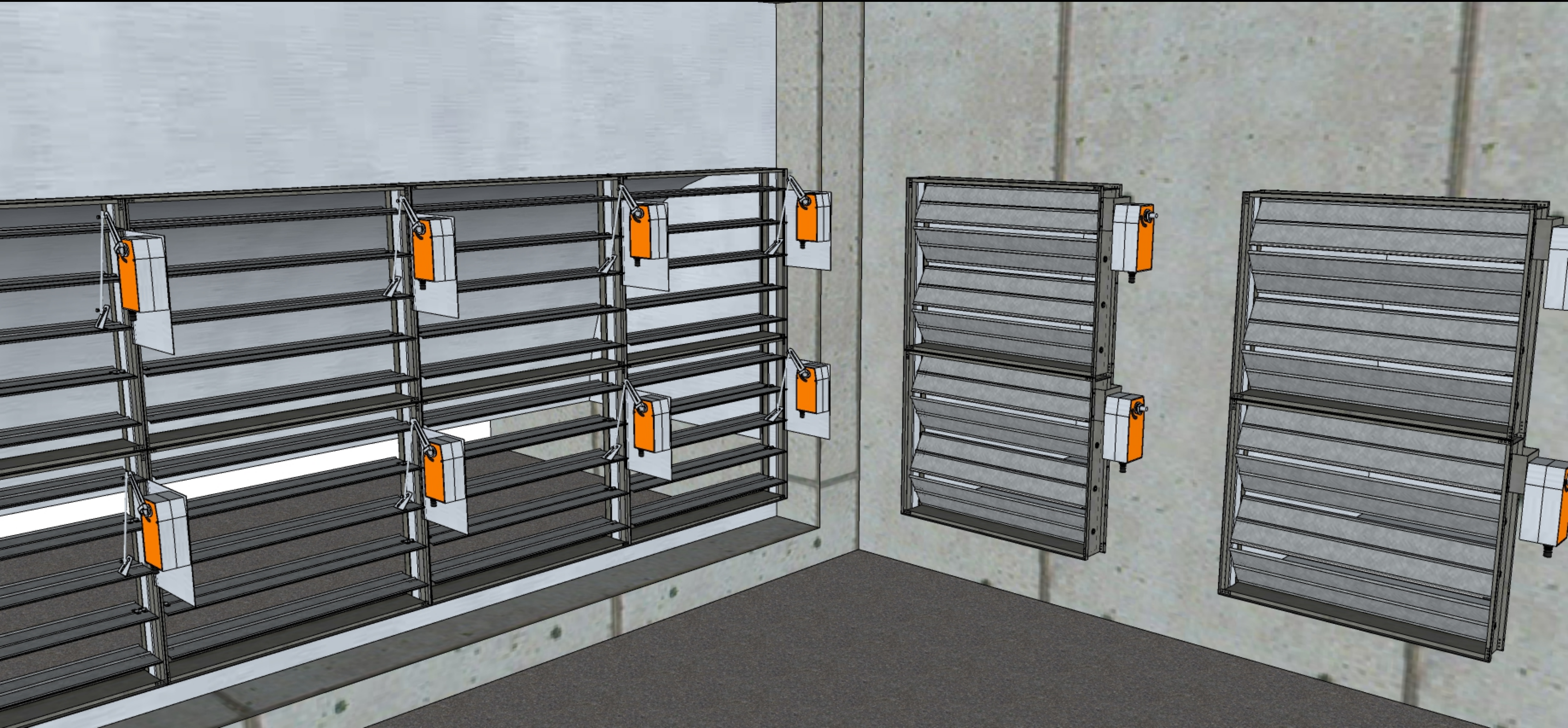
Evaluate the economizer in the Le Conte AHU

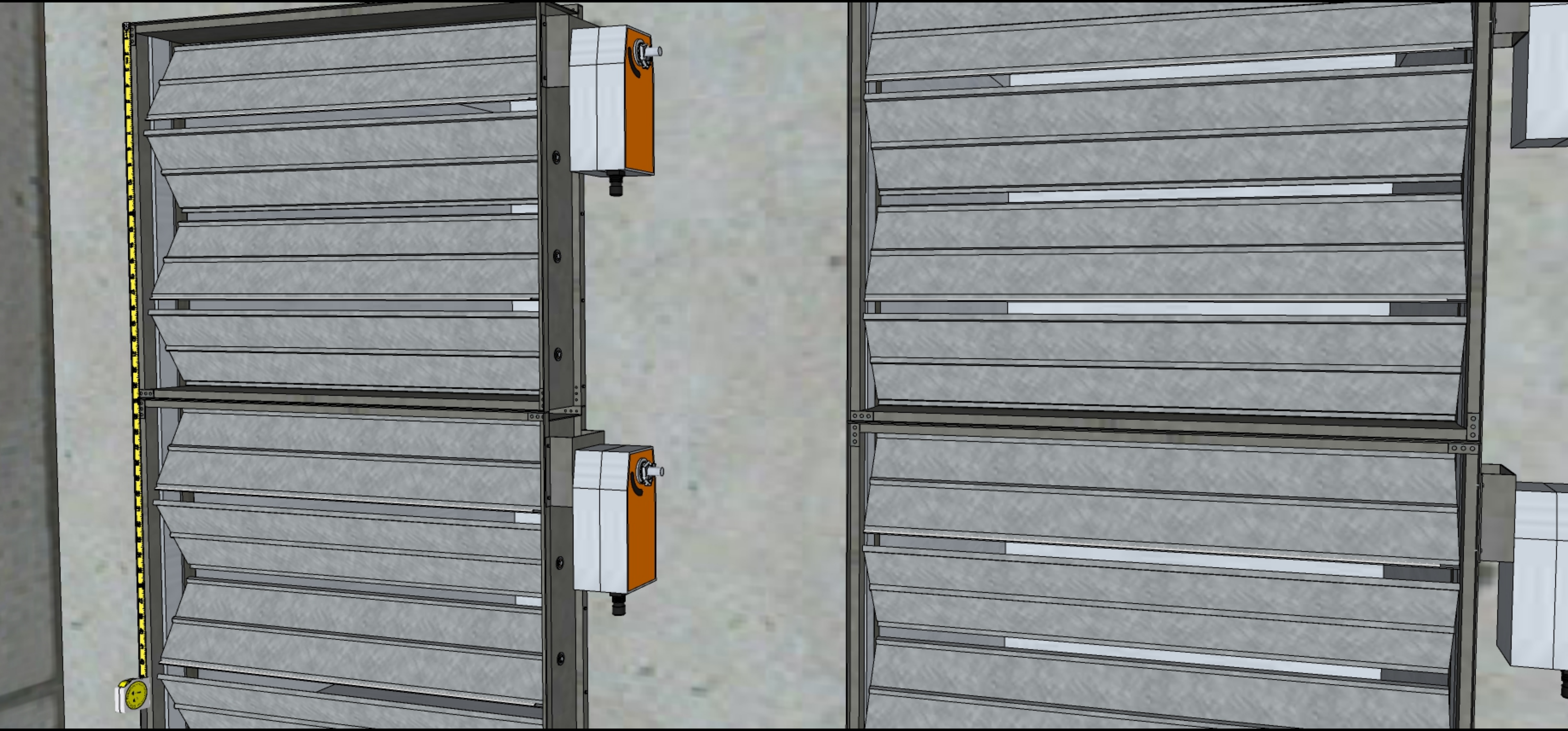
- How well do you think it mixes?
- How linear to you think the flow vs. pressure drop relationship is as the dampers stroke?
- Is the sensor located in a good position to control the dampers?
- Etc.

Mixed Air Plenum Overview

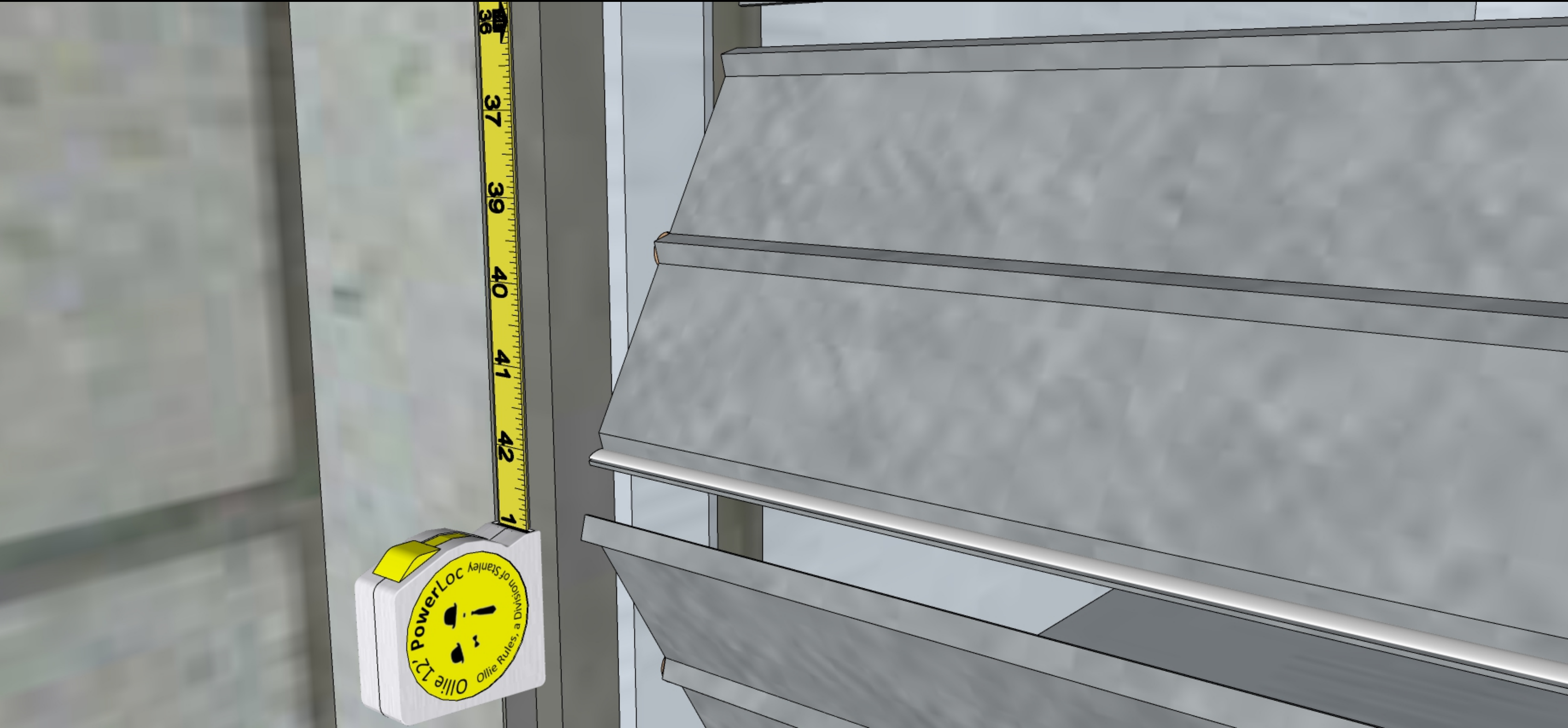


Outdoor Air and Return Air Dampers

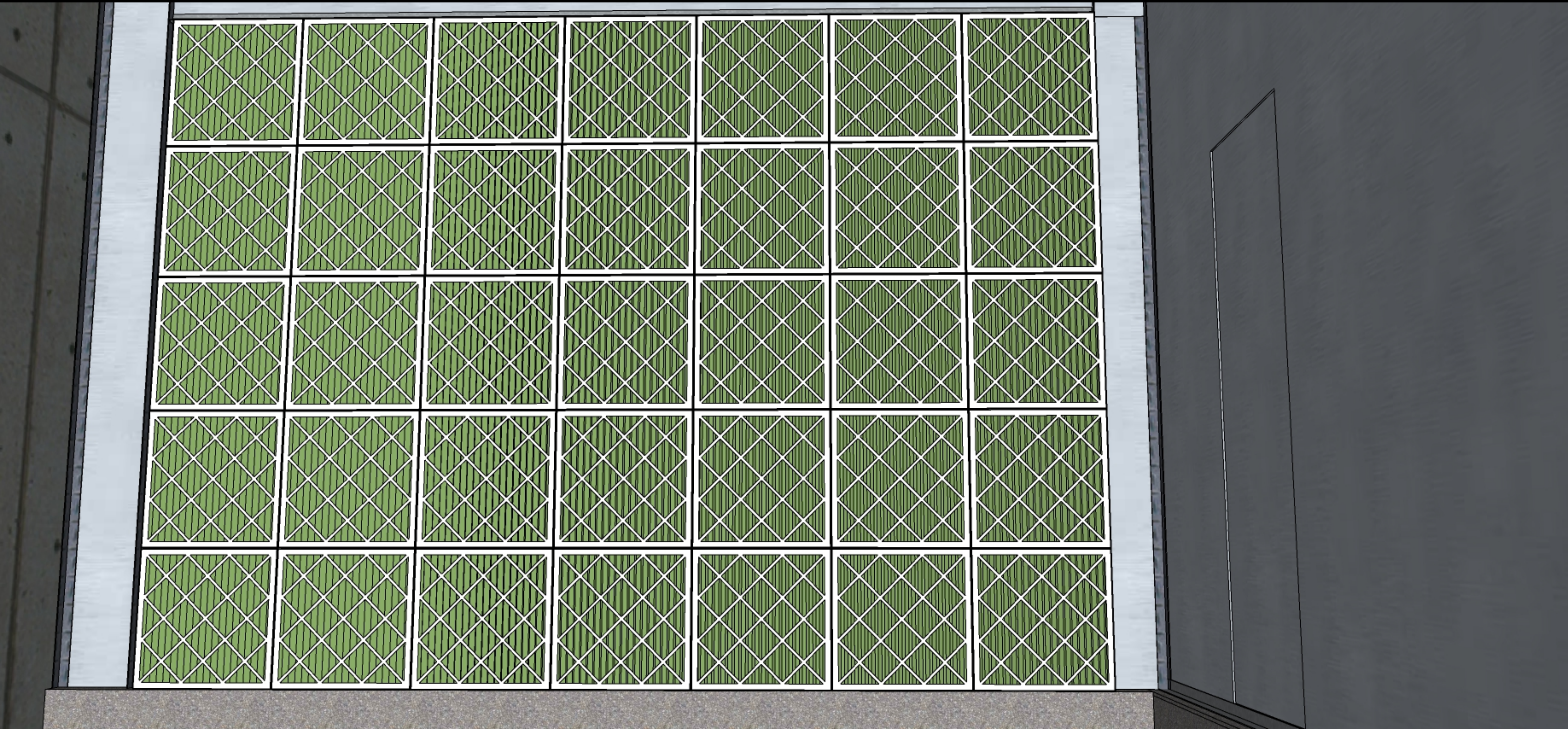




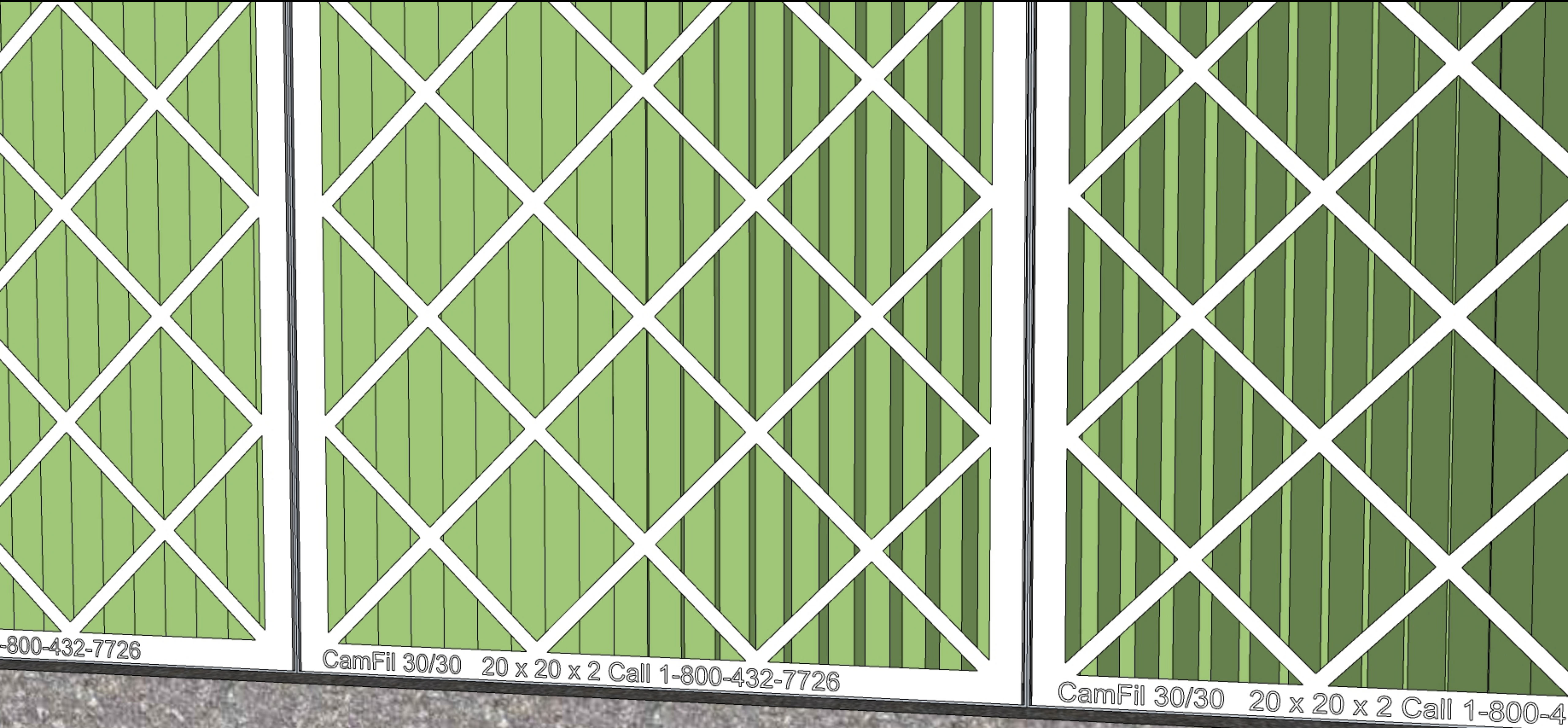
A Even Closer-upper of the Return Dampers



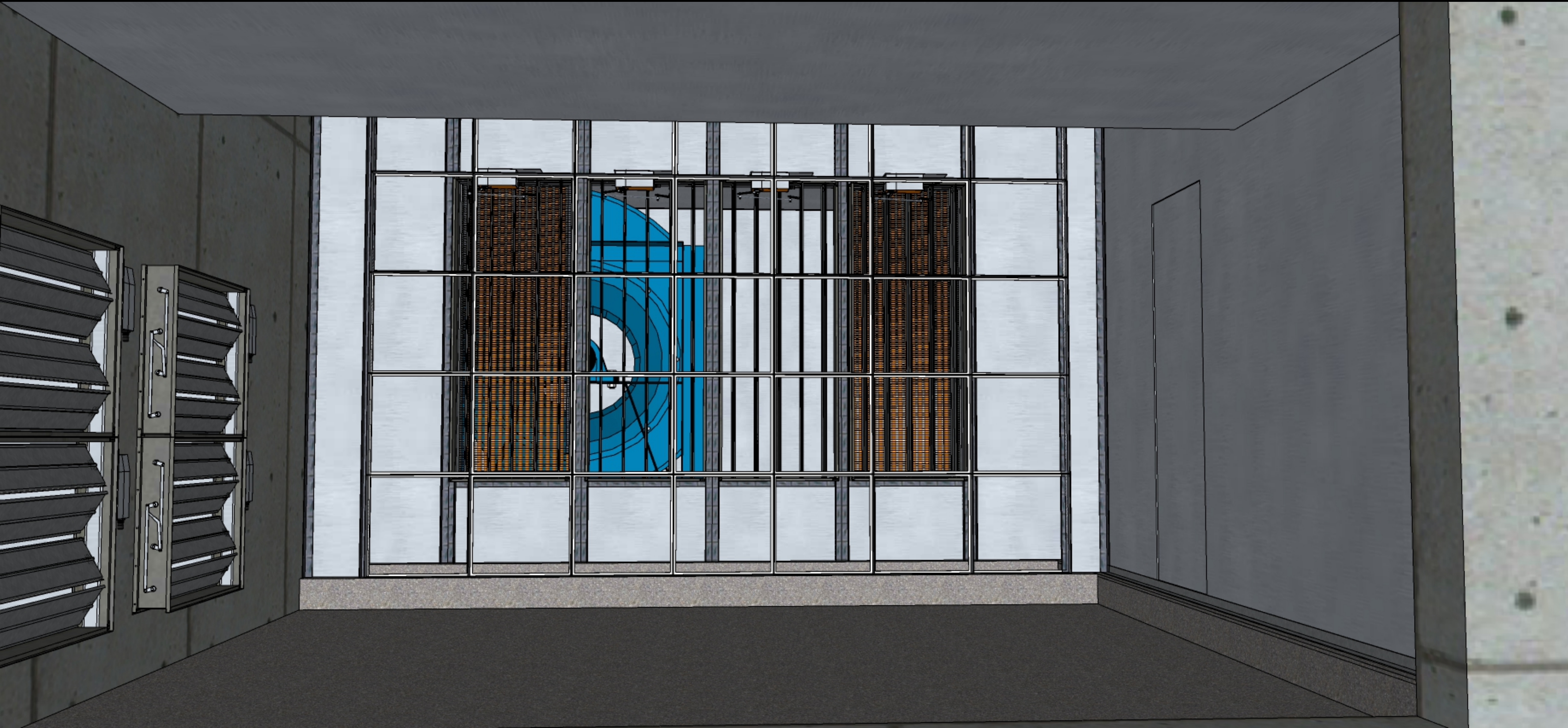
The Filter Bank



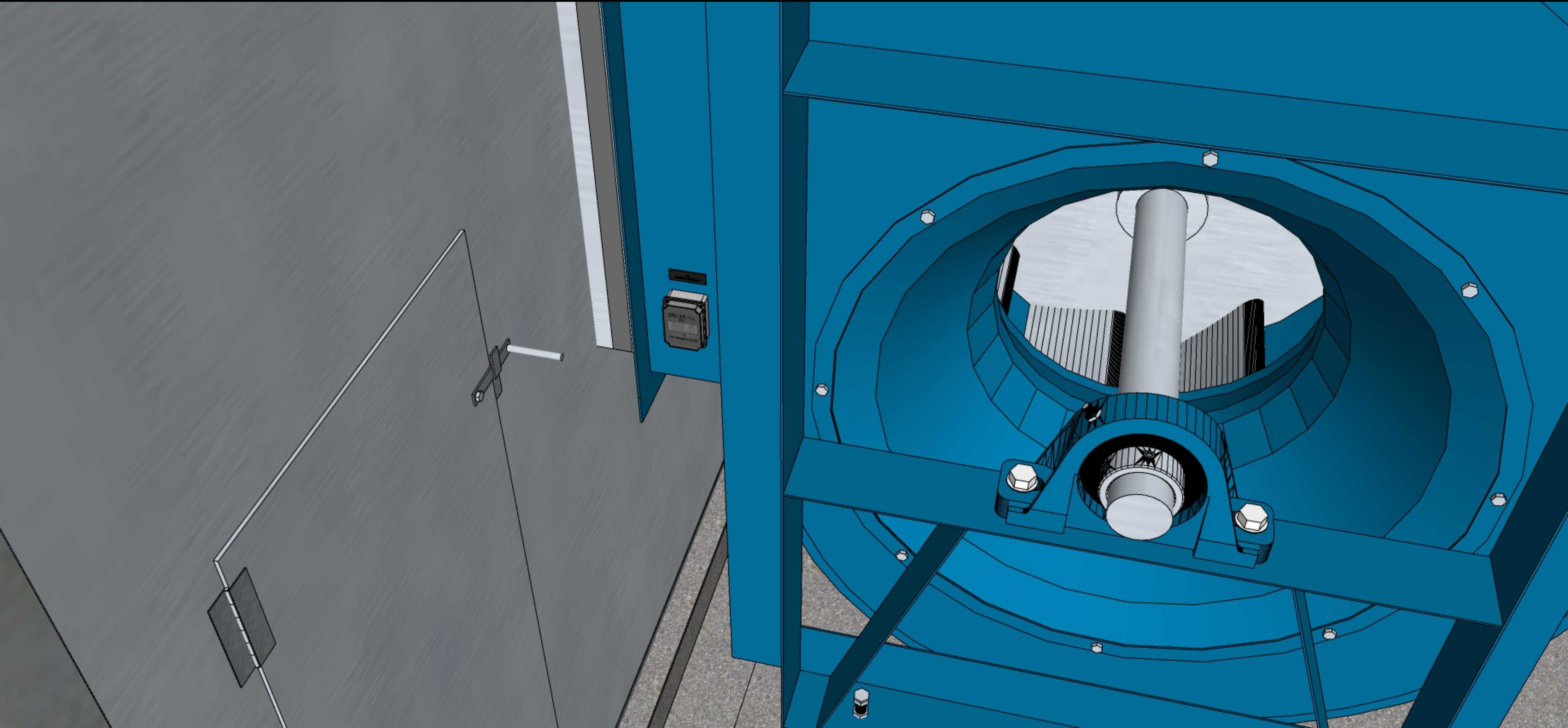
A Close-up of the Filters

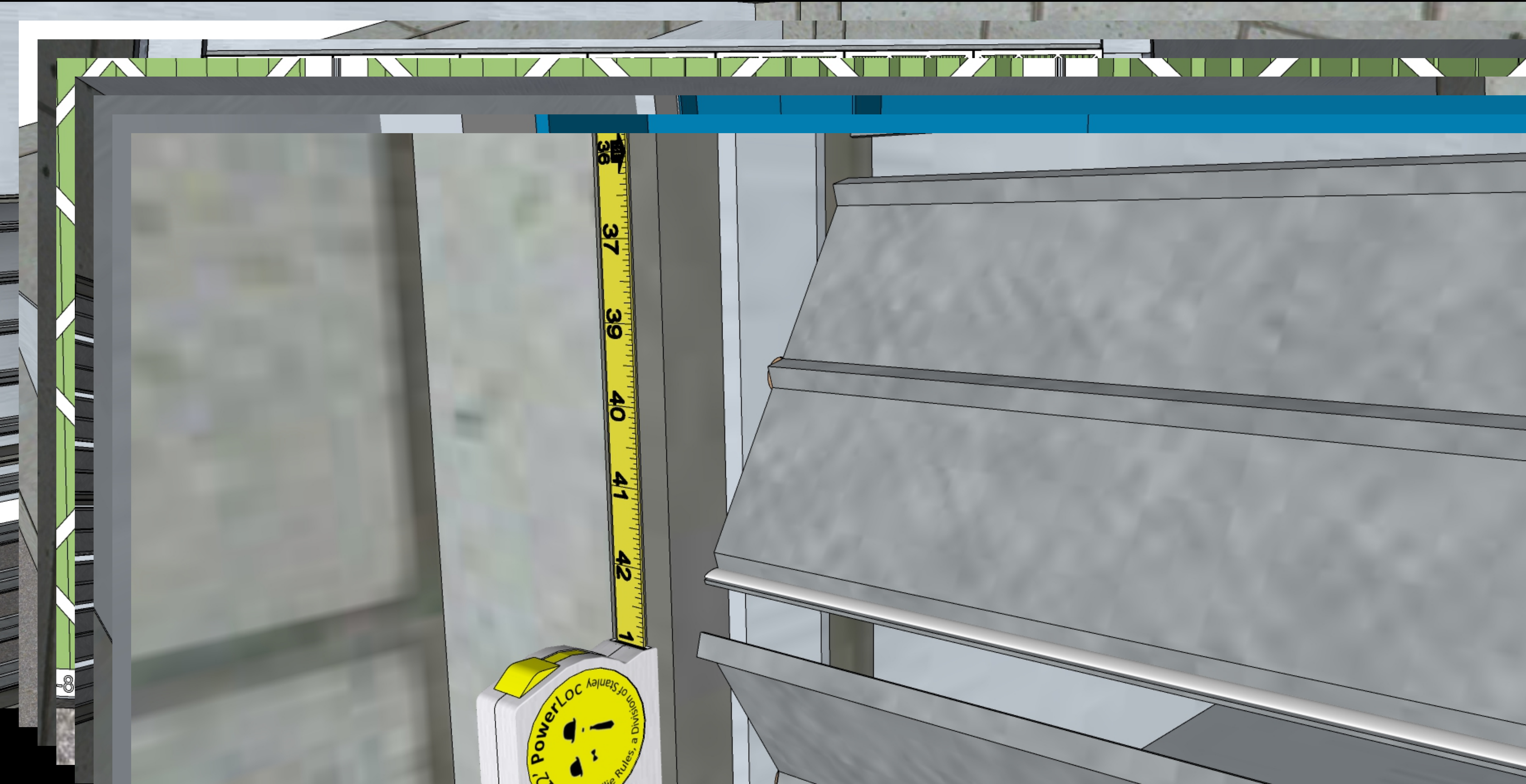


Looking Through the Filter Bank with No Filters



The Fan Discharge

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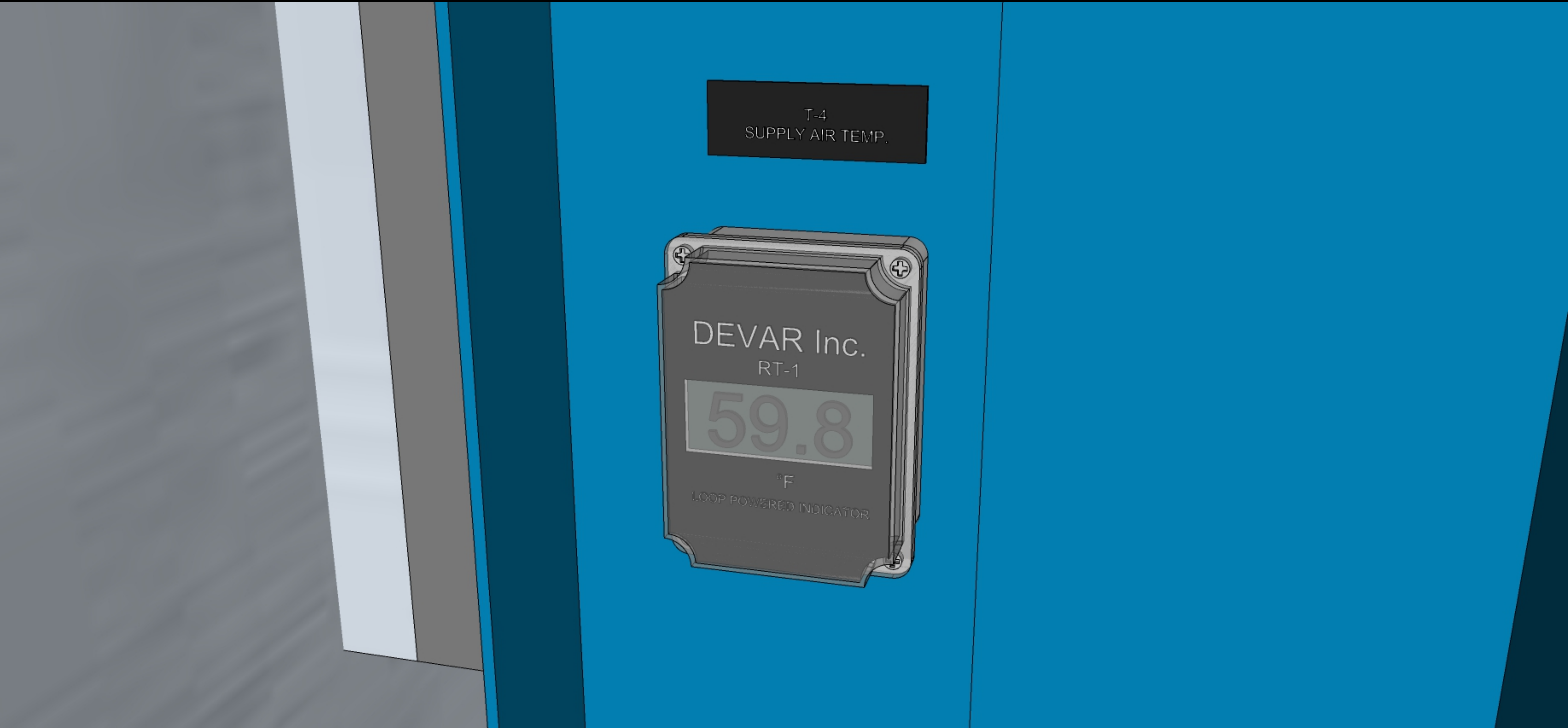
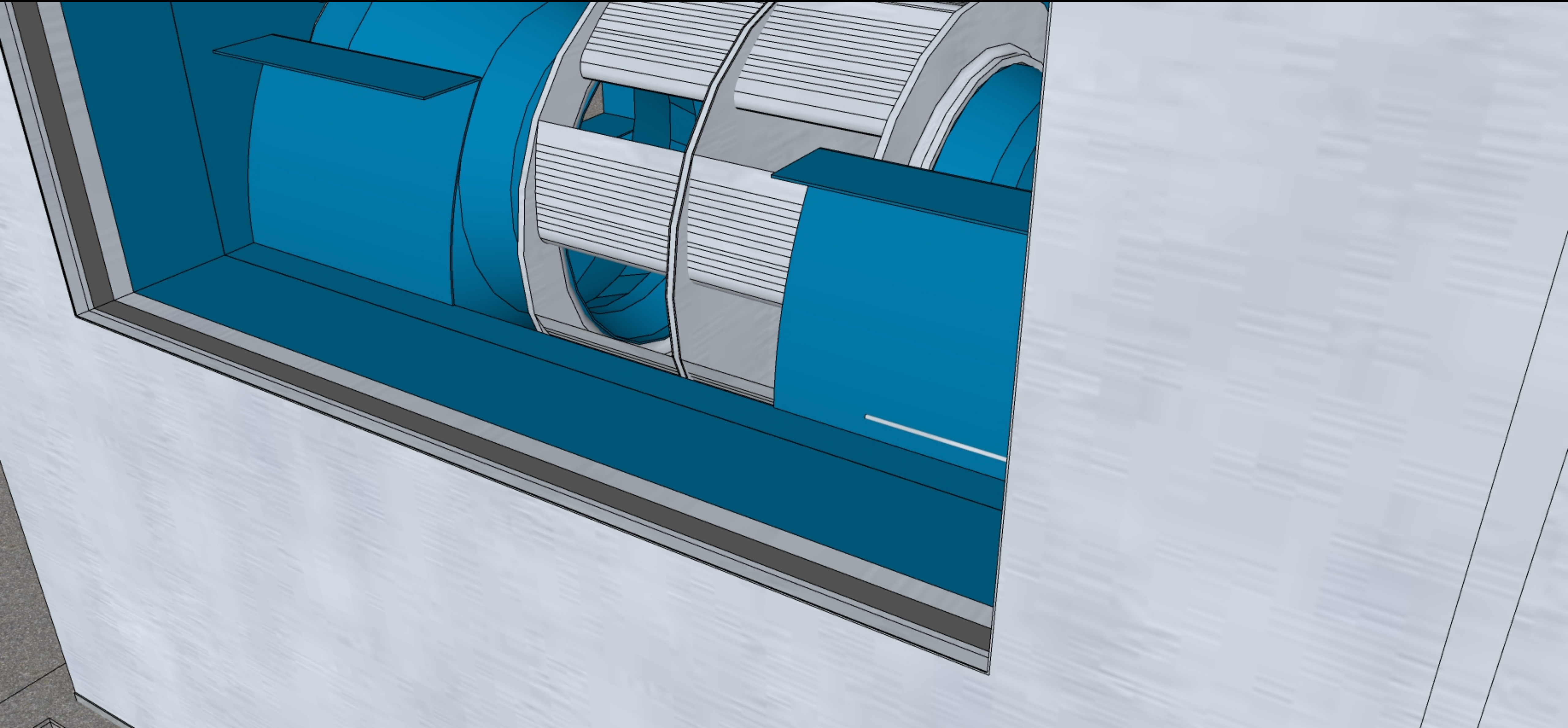
A Temperature Sensor



The Temperature Sensor from a Different Angle



Indicators of Potential Economizer Issues

1. Damper sizes are very different (outdoor air vs. return air); thus, they will have different characteristics
   a) The resistance to flow of the outdoor air damper on 100% outdoor air will likely be less than the resistance to flow or the return air damper on 100% return air
   b) Assuming the system does not have a large minimum outdoor air percentage and that it has a constant speed fan, as you drive to 100% OA, the fan will run out its curve and move more air than necessary (or on 100% RA, it will move less air than necessary)
2. No apparent independent minimum outdoor air regulation method
3. Damper sizing check indicates the outdoor air damper is oversized (next slide)
4. Single point sensor after the fan will still see stratified air due to the configuration of the fan wheel and the orientation of the fan relative to the stratification
5. Blade seals are mostly missing

2020 Phone Log > June 2020

6/3/2020 CERL Webinar Notes

Le Conte AHU Air Flow Estimate

Filters - 5 high, 7 wide
Filter size - 20 inches by 20 inches

(20*20)/144=2.7778 sg ft.

2.8*(5*7)=98 sq.ft.

98 sq.ft x 500 ft/min 90*500=45,000

Damper area required for rule of thumb velocity \
At 1,500 fpm
48600/1500=32.4

At 2,500 fpm
48600/2500=19.44

Damper velocity estimate

Outdoor Air

8 modules approximately 30 inches by 24 inches
(8*30*24)/144=40 sq.ft.

On 100% outdoor air
45000/40 = 1125 fpm; below the rule of thumb so probably will not work very well and not very linear. And certainly the damper will have a very different characteristic from the return air damper.

Return Air

2 modules approximately 30 inches by 48 inches
(2*30*48)/144 = 20 sq.ft.

If return flow was equal to outdoor air flow (no minimum outdoor air)
45000/20=2250 fpm; should be fairly linear

At 8% minimum out door air, the return air flow is:
.92*45000=41400
Velocity is:
41400/20=2070 fpm; still should be fairly linear

Damper Sizing Check

The Office Hours Challenge

Given:

1. The images that follow
2. The maximum face velocity rule of thumb;

   Face velocities through filters and coils are generally held between 350 and 500 feet per minute to minimize the potential for blowing water off a condensing cooling coil and to manage fan energy
3. The formulas that follow

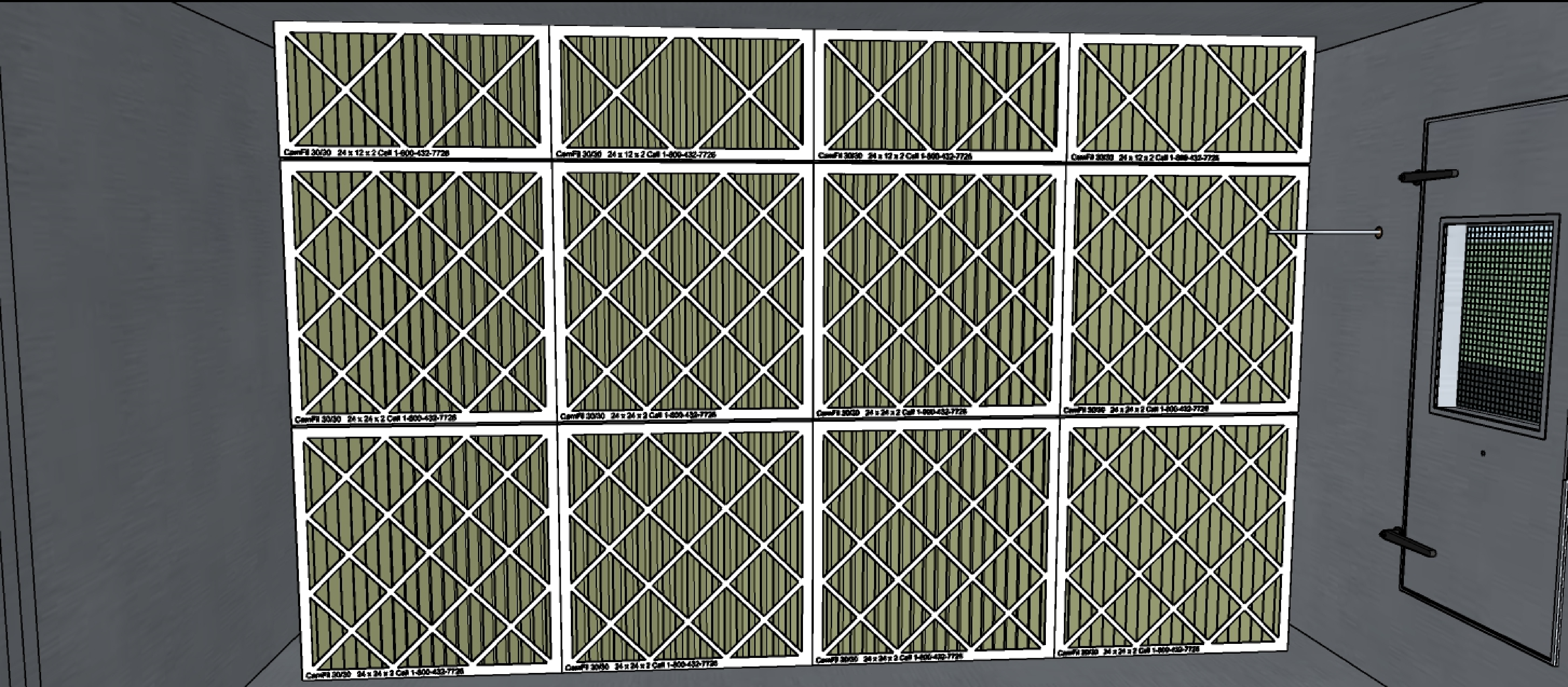
Estimate

- The load on the motor
- The system static pressure

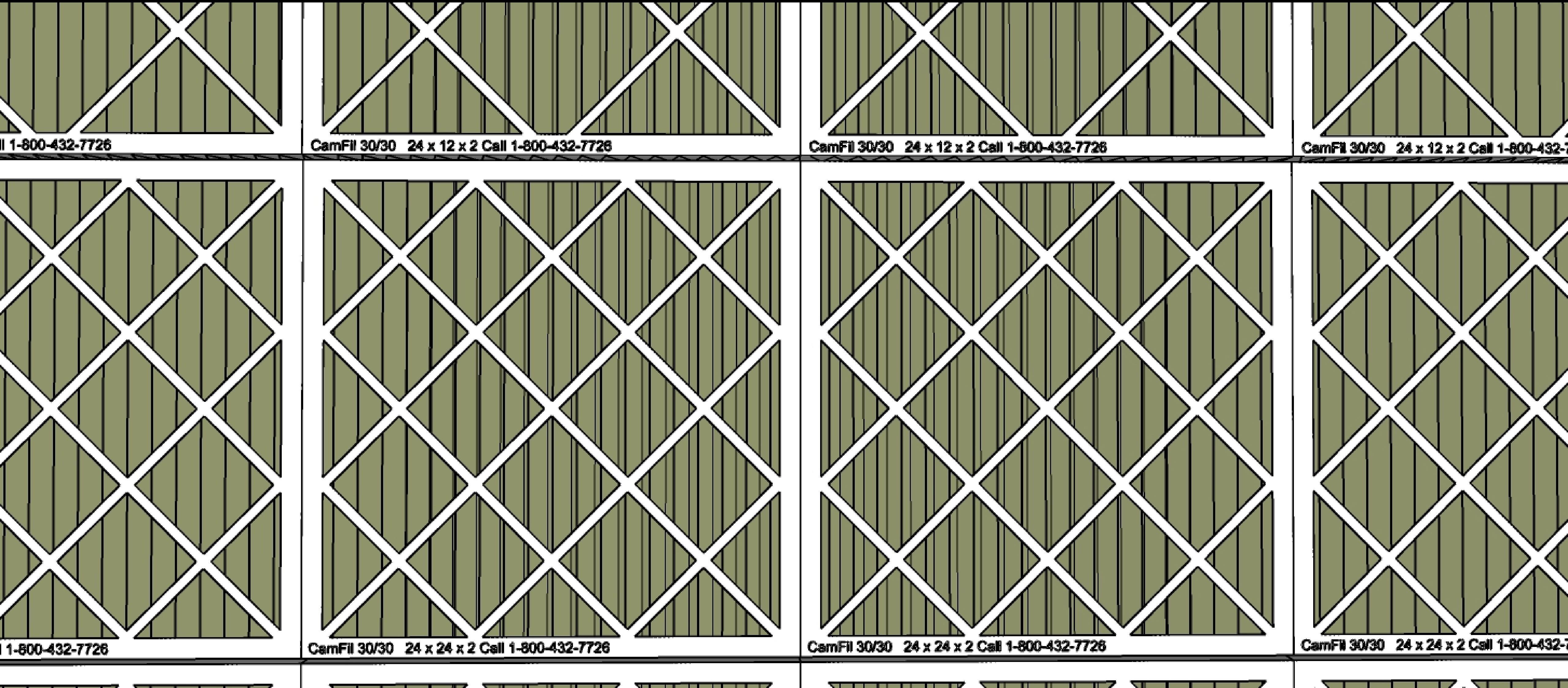
The Motor Nameplate

The Motor Speed

Filter Bank


CamFil 30/30 24 x 12 x 2 Call 1-800-432-7726
CamFil 30/30 24 x 12 x 2 Call 1-800-432-7726
CamFil 30/30 24 x 24 x 2 Call 1-800-432-7726
CamFil 30/30 24 x 24 x 2 Call 1-800-432-7726

Filter Detail



The Relationship Between Slip and Motor Load

$$\left(\frac{HP_{FullLoad}}{Slip_{FullLoad}}\right) = \left(\frac{HP_{MeasuredSpeed}}{Slip_{MeasuredSpeed}}\right)$$

Therefore:

$$Slip_{MeasuredSpeed} = \left(\frac{HP_{MeasuredSpeed}}{HP_{FullLoad}}\right) \times Slip_{FullLoad}$$

And:

$$\left(\frac{HP_{FullLoad}}{Slip_{FullLoad}}\right) \times Slip_{MeasuredSpeed} = HP_{MeasuredSpeed}$$

The Relationship Between Slip and Motor Load

$$kW = \left(\frac{Flow_{cfm} \times Static_{in.w.c.}}{6{,}356 \times \eta_{Fan} \times \eta_{Belts} \times \eta_{Motor} \times \eta_{VSD}} \right) \times .746$$