PELICAN

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Sequence of Operation

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Pelican Zoning.

A modern approach to commercial zoned systems.

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360 Degrees of Visibility

The Pelican Zoning Solution's basis of design is built around using zone demand to directly affect the state of the AHU. To do this, Pelican uses a wireless mesh network communication backbone to create real-time communication between all Pelican zones thermostats and a Pelican air handler controller. This real-time data transfer turns a seemingly separate mechanical system into a single ecosystem. As each zone thermostat continuously communicates their demand, the air handler controller can optimize the output of the air handler and properly affect the overall building's climate.

The Pelican system architecture is built around this real-time relation between space demand and airflow adjustment.

01. Introduction
Sequence of Operation

01

1.1 Introduction

This document's intent is to inform HVAC contractors, mechanical engineers, facilities managers, building owners, and others associated with indoor climate design and controls, with the sequence of operations behind Pelican's zoning solution. The descriptions in this document identify key aspects to Pelican's approach to enhancing mechanically zoned systems. But, this document might not represent the entirety of the solution and does not restrict or hold Pelican at fault as changes or updates to the solution are made due to new discoveries. Pelican retains all rights to the following information.

1.2 Pelican's Sequence Goals

When developing these sequence of operations, Pelican had three primary goals:

1. Enhance tenant/occupant comfort.
2. Retain and enhance safeties.
3. Reduce inefficiencies.
4. Utilize on-demand automation.
5. Improve through data analysis.

1.3 Common Zoning Designs

There are six common mechanical designs the Pelican zoning solution can retrofit and control. Pelican's sequence of operation changes, in some aspects, between each system type. Through-out the document the acronym for these mechanical system will be identified if a unique sequence occurs for that operation. If there is no acronym then the sequence being described is used in all of the different mechanical designs.

1.3.1 Variable Temperature and Air Volume (VVT)

A single air handler which provides central heating, cooling, and ventilation to multiple ducted zones. Each zone has a local damper which opens and closes to allow heating, cooling, and recirculated air into its space.

1.3.2 Variable Air Volume (VAV)

A single air handler which provides central cooling, ventilation, and sometimes central heat to multiple ducted zone. Each zone has a local damper that opens and closes to allow cooling and recirculation air into the space. All or some zones (perimeter) have a local reheat capable of reheating the incoming air to heat the space.

1.3.3 Mixing Box Constant Air Volume (MB-CV)

A single air handler which provides central cooling and ventilation through one duct to multiple zones and central heating through a second duct to multiple zones. Each zone has two dampers connected to a single actuator. The dampers operate in reverse of each other, so either the cold deck is open and the hot deck is close, or vise versa.

1.3.4 Dual Duct Systems Variable Air Volume (DDS-VAV)

Two air handlers where one provides central cooling and ventilation to multiple zones through a single duct run and the other provides central heating to multiple zones through a second duct run. In some cases, the air handlers share a common fan. Each zone has two dampers, which operate separate from each other, and can be opened to allow heating, cooling, or recirculated air into its space.

1.3.5 Variable Air Volume with Parallel Fan Powered Boxes (FPB-VAV)

A single air handler which provides central cooling, ventilation, and sometimes central heat to multiple ducted zones. Each zone has a local damper that opens and closes to allow cooling and recirculation air into the space. All or some zones (perimeter) have a local reheat and a local fan that pulls air from a plenum (above the zone) through the reheat and back into the zone to heat the space.

1.3.6 Variable Air Volume with Series Fan Powered Boxes (FSB-VAV)

A single air handler which provides central cooling, ventilation, and sometimes central heat to multiple ducted zones. Each or some zones have a local damper that opens and closes and a local fan to pull cooling and recirculation air into its space. Some zones (perimeter) have a local reheat and a local fan that pull air from the plenum (above the zone) through the reheat and back into the zone to heat the space.

1.4 Definitions

Air Handler (AHU)

An air handler, or air handling unit, is a device used to regulate and circulate air as part of a heating, ventilating, and air-conditioning (HVAC) system.

Air Handler Controller (AHC)

An air handler controller is a digital device used to control an air handler.

Pelican Z24

A Pelican air handler controller capable of communicating with up to 30 Pelican zone thermostats.

Pelican Z8

A Pelican air handler controller capable of communicating with up to eight (8) Pelican zone thermostats.

Pelican Zone Thermostat

A Pelican zone thermostat is installed in a zone and is used to open and close a zone damper, activate a reheat, and/or start a local fan.

Zone Damper

A zone damper is a valve or plate that stops or regulates the flow of air inside a duct or VAV box.

Zone Reheat

A mechanically valve or on/off electric heater installed after a zone damper, controlled by a zone thermostat, used to reheat airflow into a zone.

Outside Air Damper

An Outside Air Damper is a motorized damper designed to mix fresh air (ventilation) with a building's return air and provide free cooling (economization).

Cubic Feet Per Minute (CFM)

CFM is short for cubic feet per minute (cu ft/min). It is a measurement of the velocity at which air flows into or out of a space.

Carbon Dioxide (CO2)

A colorless, odorless gas produced by respiration; a gas humans breath out.

Demand Control Ventilation

Demand controlled ventilation (DCV) is a feedback control method to maintain indoor air quality that automatically adjusts the ventilation rate provided to a space in response to changes in conditions such as occupant number or indoor pollutant concentration. The control strategy is mainly intended to reduce the energy use by heating, cooling, and ventilation systems compared to buildings that use open-loop controls with constant ventilation rates.

Parts Per Million (PPM)

Parts per million (ppm) is the number of units of mass of a contaminant per million units of total mass.

Modulation

A modulating control actuator is an auxiliary controlled actuator that is used to control the amount of flow in a system or process. They offer precise control of flow rates and some have feedback signals to verify they are in the correct position.

Floating

A floating control damper is a digital controlled actuator that is used to control the amount of flow in a system or process. They "float" between two points and can be placed anywhere in between these points.

Wireless Mesh Network

A wireless mesh network is made up of multiple wireless devices, normally spread across large footprints, which work together to create a single communication grid. Pelican devices use this form of a network to communicate between the AHC and zone dampers.

02. Cooling Demand Sequence of Operation

02

2.1 When is Central Cooling Enabled?

A central cooling cycle will be enabled when there is one or more zone thermostats in need of cooling and there are no heating cycles currently in operation. If a heating cycle is currently in operation and there is cooling demand, zones with cooling demand will be placed in a *waiting* state until a change-over-sequence occurs (Section 6.1 Change-Over Logic).

2.2 Central Cooling Sequence of Operation

The Pelican AHC will communicate to all zone thermostats when a central cooling cycle is available, but has not started.

2.2.1 Variable Air Volume (VVT) (VAV) & Parallel Fan Powered Box (FPB-VAV) Zones

Variable Temperature and Air Volume (VVT), Variable Air Volume (VAV), and Parallel Fan Powered Box Variable Air Volume (FPB-VAV) Zones in cooling demand will open their dampers to either 100% open or to their configured *Maximum Damper Position*.

At the same time, zones that do not need cooling will shut their dampers 100% to prevent over-cooling and to force all the conditioned air into the zones that are in cooling demand.

2.2.2 Series Fan Powered Box (FSB-VAV) Zones

Series Fan Powered Box Variable Air Volume FSB-VAV) zones in cooling demand, will follow the same damper sequence as above, but will also enable their fans.

2.2.3 Mixing Box Constant Volume (MB-CV) Zones

Mixing Box (MB-CV) Zones in cooling demand will rotate their dampers so the cool deck is 100% open and the hot deck is 100% closed.

At the same time, zones which do not need cooling will rotate their dampers so the hot deck is 100% open and the cold deck is 100% closed to prevent over-cooling and to force all the conditioned air into the zones that are in cooling demand.

2.2.4 Dual Duct Variable Air Volume (DDS-VAV) Zones

Dual Duct (TDS-VAV) Zones in cooling demand will open their cold deck dampers to either 100% or to their configured *Maximum Damper Position*.

At the same time, zones which do not need cooling will shut their cold deck dampers 100% to prevent over-cooling and to force all the conditioned air into the zones that are in cooling demand.

2.2.5 Zone Communication
Zone thermostats will communicate to the Pelican AHC when their dampers are opened or closed and the AHC will start a cooling cycle.

2.2.6 Bypass Damper
If a Bypass Damper (VVT) is installed for supply static management, the Pelican AHC will open it to 100% Bypass before enabling the fan, to prevent any dramatic pressure rises. The Bypass Damper position will be adjusted to maintain the configured *Target Operating Static*.

2.2.7 Variable Speed Fan (VFD)
If a Variable Speed Fan (VFD) is installed for supply static pressure management, the Pelican AHC will enable the VFD at the minimum fan speed, and adjust the speed to the configured *Target Operating Static*.

The default sequence is for the Pelican AHC to enable the Fan and cooling source at the same time and verify the *Minimum Static Pressure* configuration is met. If the *Minimum Static Pressure* is not met, the Pelican AHC will immediate disable mechanical cooling, but keep the Fan enabled.

On optional sequence is for the Pelican AHC to enable the Fan two (2) minutes before, and verify the *Minimum Static Pressure* configuration is met, before starting any mechanical cooling.

Note: The Pelican AHC uses its built-in static pressure transducers to monitor and control the supply duct static pressure.

2.2.8 Outside Air Damper
If the Pelican AHC is controlling an outside air damper and the Economizer configuration is set to **ON**, the AHC will identify if the outside air is more suitable to cool the building, than mechanical cooling. Economizer sequence of operation is further explained in section 2.3 Economizer.

If Economizer is active, the outside air damper will open to provide free cooling. If Economizer is not allowed, the outside air damper will open to the configured *Minimum Damper Position* to provide ventilation.

2.2.9 Enable Cooling Stages
If the supply air temperature is above the *Target Supply Air Temperature*, the first stage of mechanical cooling will be enabled to further condition the air. Mechanical cooling will stay enabled until all cooling demand is eliminated or a change-over-cycle occurs. Cooling staging sequence of operation is further explained in section 2.6 Staging.

2.3 Economizer
There are three Pelican AHC economizer configurations which affect when the economizer becomes active during a cooling cycle: *High Limit Shut Off*, *Activation Differential*, and *Fixed Enthalpy Limit*.

(Reference section 6.3 Economizer Fault Detection and Diagnostic, for details on economizer fault detection and diagnostic capabilities).

2.3.1 High Limit Shut Off
Default = AUTO
If the outside air temperature is above this configured limit, the Pelican AHC will NOT open the outside air for economization. Leaving this configuration (BLANK), places the configuration into **AUTO** mode.

In **AUTO** mode the Pelican AHC will look at the difference (ΔT) between the return air temperature and the outside air temperature. If the outside air temperature is colder than the return air damper, by at least the configured *Activation Differential*, the outside air damper will open for economization.

The **AUTO** configuration makes the *High Limit Shutoff* configuration more dynamic than setting a fixed outside air temperature limit and allows for a greater usage of economization. A fixed *High Limit Shutoff* can be configured in the Pelican AHC.

2.3.2 Activation Differential

Default = 2°F

The outside air temperature must be this many degrees colder than the return air temperature for the economizer to be active. This is an adjustable parameter on a 2°F scale from 0°F to 6°F.

2.3.3 Fixed Enthalpy Limit

Default = OFF

When this configuration is enabled, the economizer will be active if the outside enthalpy is below 28 BTU/lbs or, at higher elevations, below the calculated enthalpy at 75°F and 50% relative humidity at that elevation.

Enthalpy levels are calculated by each Pelican AHC. The AHC looks at its local outside air temperature sensor, while receiving humidity levels and barometric pressure information from the Internet (this information is provided based on installation location zip code). These three data points are applied to an enthalpy calculation to generate the outdoor enthalpy level.

2.3.4 Why the Pelican AHC Must Control the Outside Air Damper!

It is important that if the AHU has a modulating outside air damper the Pelican AHC is in direct control over the movement of this damper, and not a third-party controller. If a third-party controller (or the air handler itself) is managing the outside air damper it has been found that the economizer is less affective and it does not meet many local and state codes.

Why? The Pelican AHC targets a supply temperature to condition the building. If a call for first stage of mechanical cooling occurs, the Pelican AHC expects a certain rate-of-change of the supply air temperature vs when the economizer is active.

When a third-party controller (acting as man-in-the-middle) is in control of enabling or disabling the outside air damper vs. the AHU's mechanical cooling, the Pelican AHC will not know what has occurred and might request additional mechanical cooling earlier than needed.

Another issue is the rebound affect. This occurs as the Pelican AHC stages down the AHU. For example, if while the Pelican AHC was staging up the AHU, the third-party controller enabled the economizer, but, as the Pelican AHC stages down the AHU, the third-party controller decided to switch to mechanical cooling and not economizer, the supply air temperatures will be irregular; moving at different rates than expected.

The final common challenge when the Pelican AHC is not controlling the outside air damper is low-limit mixed air prevention. The Pelican AHC has different low-limit safeties between when the economizer is active with mechanical cooling vs. when just mechanical cooling is active. If a third-party controller is used to control the outside air damper, the Pelican controller will not be able to utilize its low-limit safeties as effectively.

None of these scenarios will create any mechanical problems or noticeable discomfort, but they are not ideal since they add unknown mechanical sequences to the operation of the AHU equipment.

For information on why the Pelican AHC needs to control the outside air damper to meet local and state ventilation codes, go to section 5.6.3 Why the Pelican AHC Must Control the Outside Air Damper!

2.4 Cooling Target Supply Temperatures

Default = Differential
There are two Target Supply Temperature Strategies that can be applied to a Pelican AHC: *Differential* or *Absolute*.

2.4.1 Differential

The Pelican AHC will target a differential temperature (ΔT) between its return air temperature reading and the configured differential temperature setting. The ΔT targets are fully adjustable, with the defaults set to:
Moderate Cool Differential = 10°F
Aggressive Cool Differential = 20°F

2.4.2 Absolute

The Pelican AHC will target a specific supply air temperature. The supply targets are fully adjustable, with the defaults set to:
Moderate Cool Target = 60°F
Aggressive Cool Target = 55°F

2.4.3 Which one to use?

In most cases *Differential* vs. *Absolute* strategies will be very similar in their supply targets and in how they stage the available mechanical cooling sources.

The only advantage of *Differential* is that it is more dynamic, such as when the building goes from unoccupied to occupied and is starting in a very hot state.
There are a two scenarios where *Absolute* must be used: *Bypass Damper* and/or *No Return Air Probe*.

2.4.4 Bypass Damper, use Absolute.

If a Bypass damper is used for supply duct static pressure management, *Absolute* must be used.

Why? A Bypass damper recirculates the discharge air from the air handler back to the return air instead of allowing it into the zones. This will accentuate the supply air low temperature issue.

2.4.5 No Return Temperature Sensor, use Absolute.

If there is no return air temperature sensor connected to the Pelican AHC or the return air temperature sensor is not reading temperatures correctly, *Absolute* must be used.

Why? The *Differential* strategy uses the return air temperature reading to calculate a target supply temperature. If the Pelican AHC does not know the return air temperature or it is not reading it correctly, the supply air target will not be correct.

2.5 Supply Temperature Reset

The supply temperature the Pelican AHC will target is determined by zone thermostat demand: *Moderate* or *Aggressive*.

2.5.1 Moderate Demand

Zone thermostats request a *Moderate* cooling cycle if or when their space temperature is 1°F or less above their cool temperature set-point.

2.5.2 Aggressive Demand

Zone thermostats request *Aggressive*

cooling cycle when their space temperature is greater than 1°F above their cool temperature set-point.

2.5.3 Why these two resets?

In most situation, zones start with an *Aggressive* cycle when transition from unoccupied to occupied. But, once zones are tempered they are maintained by Moderate cycles.

This two step strategy is effective because it uses a lower supply temperature target (*Aggressive*) to quickly bring the building to occupied temperature set-points, while running at a slightly higher supply temperature (*Moderate*) to maintain spaces at their temperature.

2.6 Staging

2.6.1 Cool Stage Sequence of Operation

A Pelican Z8 AHC can control up to three (3) stages of cooling + economizer, while a Pelican Z24 AHC can control up to six (6) stages of cooling + economizer.

Economization is considered an added (+1) stage to the total number of cooling stages configured. For example, if the Pelican AHC is configured for three (3) stages of cooling and economizer is set to ON, the Pelican AHC does effectively operate with four (4) stages of cooling when economization is available.

When a cooling cycle is active, the Pelican AHC will stage the air handler up and down to maintain a target supply temperature.

The AHC will continue to stage up mechanical cooling until the supply temperature is at the supply temperature target, with an allowance of 5°F below the target supply temperature. For example, if the target supply temperature is 55°F, the Pelican AHC will continue to enable additional stages until 55°F is reached. It will keep that number of stages active until either the supply temperature drops to 49°F, at which point it will disable a stage, OR the target supply temperature resets, which can require either an increase or decrease in the number of active stages, OR cooling demand is eliminated, which requires all stages to be disabled.

The Pelican AHC has four-minute anti-short cycle timers built into the staging algorithm to allow for equalization before enabling a compressor again.

Note: During a cooling cycle the AHC will keep the first stage of mechanical cooling enabled, even if the supply temperature is more than 5°F below its target supply temperature, unless the supply temperature reaches the *Minimum Supply Temperature* configuration.

2.7 Modulating Cool Stage

If the AHU has a modulating chilled water valve or a modulating DX compressor, the Pelican AHC can be configured to control this modulation point to the target supply temperature.

2.7.1 Variable Temperature

The Pelican AHC can be configured to send 0 - 10 VDC control signal to a variable input to increase or decrease the cooling output of the AHU.

There are two configurations that affect the Pelican AHC modulating algorithm: *Initial Actuator Position* and *Change Actuator Delay Minutes*.

2.7.2 Initial Actuator Position

Default = 30%

This sets the starting percentage the Pelican AHC will place the variable cooling source to

when cooling is first enabled.
As the supply air temperature changes, the Pelican AHC will calculate a new variable output position and continue to adjust this position to maintain a target supply temperature.

It is important for the supply air temperature to drop at a proper rate when cooling is enabled. The percentage set in this configuration should correlate with a good initial supply temperature drop, but not be so extreme that the supply temperature surpasses the Pelican or AHU low limit temperature safeties.

2.7.3 Change Actuator Delay Minutes

Default = 1
This sets a delay between when the last variable output adjustment was made by the Pelican AHC and the next one occurs.

In most cases this should be left at 1 minute. The only reason to change this setting is if when the Pelican AHC makes an adjustment the affect on the supply air temperature is delayed over a long period. This occurrence is seen in some chilled water systems, but rarely seen on modulating DX compressors.

2.7.4 Sequence of Operation: Multi-Stage Air Handler with a Modulating First Stage

If the AHU's first stage of cooling is modulating and the other stages are fixed On/Off, the Pelican controller will modulate the first stage continuously to maintain the target supply temperature.

For example, at the start of a cooling cycle the first stage of cooling will be enabled. If the first stage modulates to 100% output, but the supply temperature is above the target supply temperature, then a second stage of mechanical cooling will be enabled by the Pelican AHC. Depending on the movement of the supply air temperature, the Pelican AHC will modulate the first stage of cooling to hit the target supply temperature. This sequence continues through all available cooling stages with a goal of maintaining the target supply temperature.

2.8 Limiting Temperatures

There are three cooling temperature limits built into the Pelican AHC: *Minimum Supply Temperature*, *Outside Air Low Limit Compressor Lock Out*, and, if Economizer is enabled, *Low Limit Mixed Air Temperature*.

2.8.1 Minimum Supply Temperature

Default = 48°F
During a cooling cycle, if the Pelican AHC sees the supply air temperature drop to or below the configured *Minimum Supply Temperature*, it will immediate back-off the number of stages active to allow the supply temperature to increase.

If the configured *Minimum Supply Temperature* is reached when only the first stage of cooling is active, the AHC will turn off first stage of cooling, wait four (4) minute (anti-short cycle timer), and for the supply temperature to raise to or above the target supply temperature before re-energizing stage one cooling.

2.8.2 Outside Air Low Limit Compressor Lock-Out

Default = NONE
If an outside air temperature sensor is installed anywhere in your Pelican solution, the Pelican AHC will have an Outside Air Low Limit Compressor Lock-Out configuration.

If left blank, then there is no outside air temperature limit. If a temperature is configured, the Pelican AHC will not enable

mechanical cooling when the outside air temperature is at or below the configured temperature.
The Pelican AHC will still enable economization, if available.

2.8.3 Low Limit Mixed Air Temperature

Default = 56°F
If the outside air damper is open for economization, the Pelican AHC will modulate the outside air damper to this configured mixed air temperature limit.

This is also true for when the Pelican AHC is economizing and running stages of mechanical cooling.

2.9 Minimum Cooling Capacity

Some AHU's do not have a small enough first stage of cooling to keep the discharge air temperature from getting too cold or the airflow over the evaporator coil from going too slow when only one small zone is in cooling demand.

When this occurs, the moisture in the supply air, which condenses on the evaporator coil, will begin to freeze. This can create mechanical issues, but Pelican's *Minimum Supply Temperature* will prevent this occurrence.

To help manage this rare situation, Pelican uses their *Capacity Management Algorithm*. *Capacity Management* is further explained in section 6.4 Capacity Management and *Minimum Cooling Capacity* is further explained in this section.

2.9.1 Zone Sizes

Each Pelican zone thermostat can be configured to a *size* in the Pelican EMS. These sizes indicate how much airflow (CFM) is delivered into the space during a cooling cycle

Size Options:
x-small (< 200 sq. ft.)
small (200 - 500 sq. ft.)
medium (500 - 1000 sq. ft.) (*default)*
large (1000 - 2000 sq. ft.)
x-large (> 2000 sq. ft.)

When zones are configured with *sizes*, the Pelican AHC can be configured with a *Minimum Cooling Capacity* percentage to prevents cooling from being enabled until that percentage of cooling demand is reached. Default = 0%. *Minimum Cooling Capacity* can be set from 0% to 100%.
When a cooling cycle is in demand, the Pelican AHC divides the total square footage of all its zones by the square footage of the zone in cooling demand. If this percentage is at or above the configured *Minimum Cooling Capacity*, cooling will be enabled. If this percentage is below, then cooling will be held off.

This strategy is designed to prevent cooling when there is not enough cooling demand. This algorithm should only be used as a last resort option since it can create discomfort in some zones during low cooling demand periods.

For more detail on the entire Capacity Management algorithm, go to section 6.4 Capacity Management.

03. Heating Demand Sequence of Operation

03

3.1 When is Central Heating Active?

3.1.1 Central Heating Only

The Pelican AHC will only allow a heating cycle if one or more zone thermostats are in need of heating and there are no cooling cycles currently active. If a cooling cycle is active, zone thermostats with heating demand, will be placed in a *waiting* state until a Change-Over-Cycle occurs and heating becomes active.

Note: In a Dual Duct Zoning Systems (TDS-DD), even though the only available heat source is a central heating cycle, heating can begin even if there is a central cooling cycle active. This is because the heating system has its own separate duct route to the zones from the cooling system. But, the Pelican AHC will never mixed the hot deck with the cold deck.

3.1.2 Central Heating and Reheats

If there is central heating and local zone reheats, a central heating cycle is active when there is *Aggressive* heating demand and/or the individual zone reheat(s) are unable to heat the space at a proper rate-of-change.

This generally means that central heating will only be used during morning warm-up. But, it also allows for more dynamic access to central heating than traditional morning warm-up sequences. For example, if zones are struggling to heat on extremely cold days or if the boiler or reheats fail, central heat will automatically be used as a back-up to prevent the building from freezing and other mechanical issues from occurring.

For the sequence of operation for systems that have only reheats, go to Section 3.9 Reheat Sequence of Operation.

3.2 Central Heating Sequence of Operation

The Pelican AHC will communicate to all zone thermostats when a central heating cycle is available, but has not started.

3.2.1 Variable Air Volume (VVT) (VAV) & Parallel Fan Powered Box (FPB-VAV) Zones

Variable Temperature and Air Volume (VVT), Variable Air Volume (VAV), and Parallel Fan Powered Variable Air Volume (FPB-VAV) zones in heating demand will open their dampers to either 100% open or to their configured *Maximum Damper Position*.

At the same time, zones that do not need heating will shut their dampers 100% to prevent over-heating and to force all the conditioned air into the zones that are in heating demand.

3.2.2 Series Fan Powered Box (FSB-VAV) Zones

Series Fan Powered Variable Air Volume (FSB-VAV) zones in heating demand, will follow the same damper sequence as above, but will also enable their fans.

3.2.3 Mixing Box Constant Volume (MB-CV) Zones

Mixing Box (MB-CV) zones in heating demand will rotate their dampers so the hot deck is 100% open and the cold deck is 100% closed.

At the same time, zones which do not need heating will rotate their dampers so the cold deck is 100% open and the hot deck is 100% closed to prevent over-heating and to force all the conditioned air into the zones that are in heating demand.

3.2.4 Dual Duct Variable Air Volume (DDS-VAV) Zones

Dual Duct Variable Air Volume (DDS-VAV) zones in heating demand will open their hot deck dampers to either 100% or to their configured *Maximum Damper Position*.

At the same time, zones that do not need heating will shut their hot deck dampers 100% to prevent over-heating and to force all the conditioned air into the zones that are in heating demand.

3.2.5 Zone Communication

Zone thermostats will communicate to the Pelican AHC when their dampers are opened or closed and the AHC will start a cooling cycle.

3.2.6 Bypass Damper

If a Bypass Damper (VVT) is installed for supply static management, the Pelican AHC will open it to 100% Bypass before enabling the fan, to prevent any dramatic pressure rises. The Bypass damper position will be adjusted to maintain the configured Target Operating Static.

3.2.7 Variable Speed Fan (VFD)

If a Variable Speed Fan is installed for supply static pressure management, the Pelican AHC will enable the VFD at the configured minimum fan speed, and adjust the speed to the configured *Target Operating Static* or the *Target Heat Operating Static,* if configured.

The default sequence is for the Pelican AHC the enable the Fan and heating source at the same time and verify the *Minimum Static Pressure* configuration is met. If the *Minimum Static Pressure* is not met, the Pelican AHC will immediate disable mechanical heating, but keep the Fan enabled.

On optional sequence is for the Pelican AHC the enable the Fan two (2) minutes before, and verify the *Minimum Static Pressure* configuration is met, before starting any heating.

3.2.8 Outside Air Damper

If the Pelican AHC is controlling an outside air damper it will open it to the configured *Minimum Damper Position* to provide ventilation.

3.2.9 Enable Heat Stages

The first stage of heat will be enabled and additional heating stages will be enabled to reach the *Target Supply Air Temperature*. Heating will stay enabled until all heating demand is eliminated or a change-over-cycle occurs. Heating staging sequence of operation is further explained in section 3.4 Staging.

3.3 Central Heat Target Supply Temperatures

Default = Differential
There are two Target Supply Temperature Strategies that can be applied to a Pelican AHC: *Differential* or *Absolute*.

3.3.1 Differential

The Pelican AHC will target a differential

temperature (ΔT) between its return air temperature reading and the configured differential temperature setting. The ΔT targets are fully adjustable, with the defaults set to:
Moderate Heat Differential = 20°F
Aggressive Heat Differential = 30°F

3.3.2 Absolute
The Pelican AHC will target a specific supply air temperature. The supply targets are fully adjustable, with the defaults set to:
Moderate Heat Target = 100°F
Aggressive Heat Target = 115°F

3.3.3 Which one to use?
In most cases *Differential* vs. *Absolute* strategies will be very similar in their supply targets and in how they stage the available mechanical cooling sources.

The only advantage of *Differential* is that it is more dynamic, such as when the building goes from unoccupied to occupied and is starting in a very cold state.

There are a two scenarios where *Absolute* must be used: *Bypass Damper* and/or *No Return Air Probe*.

3.3.4 Bypass Damper, use Absolute.
If a Bypass damper is used for supply duct static pressure management, *Absolute* must be used.

Why? A Bypass damper recirculates the discharge air from the air handler back to the return air instead of allowing it into the zones. This will accentuate a supply air high temperature issue.

3.3.5 No Return Temperature Sensor, use Absolute.
If there is no return air temperature sensor connected to the Pelican AHC or the return air temperature sensor is not reading temperatures correctly, *Absolute* must be used.

Why? The *Differential* strategy uses the return air temperature reading to calculate a target supply temperature. If the Pelican AHC does not know the return air temperature or it is not reading it correctly, the supply air target will not be correct.

3.4 Supply Temperature Reset
The supply temperature the Pelican AHC will target is determined by zone thermostat demand: *Moderate* or *Aggressive*.

3.4.1 Moderate Demand
Zone thermostats request a *Moderate* heating cycle if or when their space temperature is 1°F or less below their heat temperature set-point.

3.4.2 Aggressive Demand
Zone thermostats request an *Aggressive* heating cycle when their space temperature is greater than 1°F below their heat temperature set-point.

3.4.3 Why these two resets?
In most situation, zones start with an *Aggressive* cycle when transition from unoccupied to occupied. But, once zones are tempered they are maintained by *Moderate* cycles.

This two step strategy is effective because it uses a higher supply temperature target (*Aggressive*) to quickly bring the building to occupied temperature set-points, while running at a slightly lower supply temperature (*Moderate*) to maintain spaces at their temperature.

3.5 Staging

3.5.1 Heat Stage Sequence of Operation

A Pelican Z8 AHC can control up to three (3) stages of heating, while a Pelican Z24 AHC can control up to six (6) stages of heating.

When a heating cycle is active, the Pelican AHC will stage the air handler up and down to maintain a target supply temperature.

The AHC will continue to stage up available heat stages until the supply temperature is at the supply temperature target, with an allowance of 5°F above the target.

For example, if the target supply temperature is 100°F, the Pelican AHC will continue to enable additional stages until 100°F is reached. And will keep that number of stages active until either the supply temperature raises to 105°F, at which point it will disable a stage, OR the target supply temperature resets, which can require either an increase or decrease in the number of active stages, OR heating demand is eliminated, which requires all stages to be disabled.

Note: During a heating cycle the AHC will keep at least the first stage of heating enabled, even if the supply temperature is more than 5°F above its target supply temperature, unless *Allow Zero Heat Stages* is set to **Yes**.

There is also a *High Limit Temperature Safety* that will force all active stage of heating to Off. For more information on *High Limit Temperature Reset*, go to Section 3.6 Maximum Supply Temperature Safety.

3.5.2 Allow Zero Heat Stages

Setting *Allow Zero Heat Stages* to **Yes** allows the Pelican AHC to disable first stage of heat during a heating cycle.

For example, if the Pelican AHC has the first stage of heat enabled and the supply air temperature raises more than 5°F above the target supply temperature, the Pelican AHC will disable the first stage of heat until the supply temperature drops back below the target supply air temperature, and then re-enable the first stage of heat.

There are three cases where *Allow Zero Heat Stages* should be set to **Yes**: *Bypass Damper,* the output of *The lowest heating stage produces too much heat when the building is in low heating demand,* or the *Maximum Supply Temperature Safety* is ever reached.

3.5.3 Bypass Damper, set Allow Zero Heat Stages to Yes

If a Bypass damper is used for supply duct static pressure management, *Allow Zero Heat Stages* should be set to **Yes**.
Why? A Bypass damper recirculates the discharge air from the air handler back to the return air instead of allowing it into the zones. This will accentuate a supply air high temperature issue.

3.5.4 Lowest Heating Stage Produces too much Heat, set Allow Zero Heat Stages to Yes.

Some AHU's do not have a small enough first stage of heat to keep the discharge air temperature at the target supply temperature when only one small zone is in heating demand. Setting *Allow Zero Heat Stages* to **Yes** helps mitigate this high temperature issue.

3.6 Modulating Heat Stage

If the AHU has a modulating hot water/ steam valve or a modulating gas furnace, the Pelican AHC can be configured to control this modulation point to the target supply temperature.

3.6.1 Variable Temperature

The Pelican AHC can be configured to send 0 - 10 VDC control signal to a variable input to increase or decrease the heating output of the AHU.

There are two configurations that affect the Pelican AHC modulating algorithm: *Initial Actuator Position* and *Change Actuator Delay Minutes*.

3.6.2 Initial Actuator Position

Default = 30%

This sets the starting percentage the Pelican AHC will place the variable heating source to when heating is first enabled.

As the supply air temperature changes, the Pelican AHC will calculate a new variable output position and continue to adjust this position to maintain a target supply temperature.

It is important for the supply air temperature to rise at a proper rate when heating is enabled. The percentage set in this configuration should correlate with a good initial supply temperature rise, but not be so extreme that the supply temperature surpasses the Pelican or AHU high limit temperature safeties.

3.6.3 Change Actuator Delay Minutes

Default = 1

This sets a delay between when the last variable output adjustment was made by the Pelican AHC and the next one occurs.

In most cases this should be left at 1 minute. The only reason to change this setting is if when the Pelican AHC makes an adjustment the affect on the supply air temperature is delayed over a long period. This occurrence is seen in some hot water systems, but rarely seen on modulating gas furnaces.

3.6.4 Sequence of Operation: Multi-Stage Air Handler with a Modulating First Stage

If the AHU's first stage of heating is modulating and the other stages are fixed On/Off, the Pelican controller will modulate the first stage continuously to maintain the target supply temperature.

For example, at the start of a heating cycle the first stage of heating will be enabled. If the first stage modulates to 100% output, but the supply temperature is below the target supply temperature, then a second stage of heating will be enabled by the Pelican AHC. Depending on the movement of the supply air temperature, the Pelican AHC will modulate the first stage of heating to hit the target supply temperature. This sequence continues through all available heating stages with a goal of maintaining the target supply temperature.

3.7 Maximum Supply Temperature Safety

Default = 130°F

During a heating cycle, if the Pelican AHC sees the supply air temperature rise to or above the configured *Maximum Supply Temperature*, it will immediate disable all active heat stages, a reset will occur after ten (10) minutes, and an alarm will be generated at the Pelican EMS.

If the *Maximum Supply Temperature* is ever reached, *Allow Zero Heat Stages* should be set to **Yes**.

3.8 Minimum Heating Capacity

Some AHU's do not have a small enough first stage of heating to keep the discharge air temperature from getting too hot or the airflow over the heating coil from going too slow when only one small zone is in heating demand.

This can create mechanical issues, but Pelican's *Allow Zero Heat Stages* and *Maximum Supply Temperature Safety* are designed to prevent mechanical issues by placing the AHU into a reset cycle.

To help manage this rare situation, Pelican uses their *Capacity Management Algorithm*. *Capacity Management* is further explained in section 6.4 Capacity Management and *Minimum Heating Capacity* is further explained in this section.

3.8.1 Zone Sizes

Each Pelican zone thermostat can be configured to a *size* in the Pelican EMS. These sizes indicate how much airflow (CFM) is delivered into the space during a heating cycle.

Size Options:
x-small (< 200 sq. ft.)
small (200 - 500 sq. ft.)
medium (500 - 1000 sq. ft.) *(default)*
large (1000 - 2000 sq. ft.)
x-large (> 2000 sq. ft.)

When zones are configured with *sizes*, the Pelican AHC can be configured with a *Minimum Heating Capacity* percentage to prevents heating from being enabled until that percentage of heating demand is reached. Default = 0%. *Minimum Heating Capacity* can be set from 0% to 100%.

When a heating cycle is in demand, the Pelican AHC divides the total square footage of all its zones by the square footage of the zone in heating demand. If this percentage is at or above the configured *Minimum Heating Capacity*, heating will be enabled. If this percentage is below, then heating will be held off.

This strategy is designed to prevent heating when there is not enough heating demand. This algorithm should only be used as a last resort option since it can create discomfort in some zones during low heating demand periods.

For more detail on the entire Capacity Management algorithm, go to section 6.4 Capacity Management.

3.9 Reheat Sequence of Operation

The Pelican AHC will communicate to all zone thermostats when a reheat cycle is available, but has not started.

3.9.1 Variable Air Volume (VAV) Zones

Variable Air Volume (VAV) zones that have reheats and are in heating demand, will set their dampers to either 100% open or to their configured Maximum Damper Position.

At the same time, zones that do not need heating will either shut their dampers 100% or, if their Pelican zone thermostat FAN is set to **ON**, will open their dampers to 100% or their configured *Minimum Damper Position*, to accept circulation air.

3.9.2 FSB-VAV & FPB-VAV Zones

Series Fan Powered Variable Air Volume (FSB-VAV) and Parallel Fan Powered Variable Air Volume (FPB-VAV) zones in heating demand, will set their dampers to 100% closed and enable their local fan.

These zones do not request any cycles from the Pelican AHC when in heat demand since they operate local reheats and fans.

3.9.3 Bypass Damper

If a Bypass Damper (VVT) is installed for supply static management, the Pelican AHC will open it to 100% Bypass before enabling the fan, to prevent any dramatic pressure rises. The Bypass damper position will be adjusted to maintain the configured Target Operating Static.

3.9.4 Variable Speed Fan (VFD)

If a Variable Speed Fan is installed for supply static pressure management, the Pelican AHC will enable the VFD at the configured minimum fan speed, and adjust the speed to the configured Target Operating Static.

The Pelican AHC enables the fan two minutes before and verifies the that Minimum Static Pressure configuration is met before allowing any reheat cycles. Except for FSB-VAV and FPB-VAV reheat cycles since they have their own local fan.

3.9.5 Outside Air Damper

If the Pelican AHC is controlling an outside air damper it will open it to the configured *Minimum Damper Position* to provide ventilation.

3.9.6 Enable Reheats

The Pelican AHC will communicate to Pelican zones thermostats that have reheats and are in heating demand that they can enable their reheats.

Pelican zones thermostats will enable their reheats and keep them enabled until their spaces are satisfied or a change-over-cycle occurs.

If the Minimum Static Pressure or Maximum Static Pressures are ever reached, the Pelican AHC will communicate to all active reheat thermostats to go into a reset cycle.

Pelican zone thermostats will immediate disable their reheat and wait for a reset confirmation from the Pelican AHC.

04. Supply Duct Static Pressure Sequence of Operation

04

4.1 Supply Static Pressures

The Pelican AHC uses its built-in differential pressure sensors to detect the supply duct static pressure. The Pelican AHC will manage airflow rates to the active target supply duct static pressure anytime the air handler is operational. There are two target supply duct static pressure configurations for the Pelican AHC: Target *Operating Static* and Target *Circulation Static*.

4.1.1 When is Target Operating Static used?

During a central cooling, central heating, or reheat cycle, the Pelican AHC will adjust a VFD or Bypass Damper to maintain the *Target Operating Static*.

4.1.2 When is Target Circulation Static used?

During a circulation cycle, the Pelican AHC will adjust a VFD or Bypass Damper to maintain the *Target Circulation Static*.

4.2 Target Operating Static

Default = 0.75" W.C.

The *Target Operating Static* should be configured so when zone's are in a central cooling, central heating, and/or reheat cycle, the airflow (CFM) rate into each zone equals the correct airflow (CFM) rate to properly change the entire space's air temperature. For further assistance on how to find and balancing to the proper *Target Operating Static*, go to Section 7.2 Finding the Correct Target Operating Static Pressure.

4.3 Target Circulation Static

Default = 0.50" W.C.

The *Target Circulation Static* should be set so when zone's are in a circulation cycle, the airflow (CFM) rate into each zone allows for proper ventilation, limited noise, and re-balancing. For further assistance on how to find and balancing to the proper *Target Circulation Static*, go to Section 7.5 Finding the Correct Target Circulation Static Pressure.

4.4 Minimum Static Pressure Safety

Default = 0.10" W.C.

The *Minimum Static Pressure* safety prevents central cooling, central heating, and/or reheat cycles from running if there is insufficient airflow.

4.4.1 Air Handler Start-Up (Unoccupied to Occupied)

When the Pelican AHC enables the supply fan, if it sees the supply duct static pressure below the *Minimum Static Pressure* configuration, it will generated an alarm at the Pelican EMS and disable or hold off all mechanical heating or cooling sources.

4.4.2 During an Active Cycle

If the Pelican AHC is in an active central cooling, central heating, or reheat cycle and sees the supply duct static pressure at the *Minimum Static Pressure*, it will immediately disable all active central cooling, central heating, and reheat cycles and an alarm will be generated at the Pelican EMS. After ten (10) minutes the Pelican AHC will go into a reset cycle and re-enable central cooling, central heating, or allow reheats if the static pressure is at or above the *Minimum Static Pressure* configuration.

4.5 Maximum Static Pressure

Default =1.5" W.C.

The *Maximum Static Pressure* immediately disables all active functions at the AHU, including the supply fan, central cooling, central heating, and local functions at the zones such as reheats (zones will keep their dampers at their last position). An alarm will be generated at the Pelican EMS.

An automated reset occurs after ten (10) minutes to try and re-engage the supply fan. If the Maximum Static Pressure is reached, the Pelican AHC will go into another ten (10) minute reset cycle.

05. Ventilation Management Sequence of Operation

05

5.1 Design Regulations: California 2019 Title 24

The Pelican Solution is designed to meet California 2019 Title 24 regulations. For ventilation management, Pelican references *Section 120.1 - Requirements for Ventilation and Indoor Air Quality* and *ASHREA Standard 62.1-2019.* The California regulation exceeds ventilation requirements of *ASHREA 62.1*, so where *California 2019 Title 24* is identified in this section, it is meant to indicate the sequences will exceed *ASHREA 62.1*.

Key sections in *California 2019 Title 24* and *ASHREA 62.1* will be referenced in this section. The reader should reference and review these documents.

California 2019 Title 24: Go to the California Energy Commission (CEC) website or this direct link to the document https://ww2.energy.ca.gov/2018publications/CEC-400-2018-020/CEC-400-2018-020-CMF.pdf.

ASHREA 62.1: Requires a purchase of the regulations to review. This can be found by going to https://ashrea.org.

5.2 Ventilation Management

There are three main mechanical functions that apply to ventilation management: *Outside Air Damper Position*, *Fan Speed*, and *Zone Damper Positions*.

Between the six (6) different zone system's the Pelican Zoning Solution can control (reference Section 1.3 Common Zoning Designs), the only variable in ventilation sequence of operations is *Zone Damper Position*.

This section goes over *Outside Air Damper Position* and *Fan Speed* ventilation sequence of operation, and then each zoning system's *Zone Damper Position* sequence of operation.

5.3 Outside Air Damper Position

During occupied periods, the outside air damper must always opened to the calculated minimum ventilation airflow rate as required by local and state codes, or as defined in 120.1(c)3 of California 2019 Title 24 or ASHREA 62.1 Section 6.

This airflow rate is to be balanced and converted into an outside air damper open percentage and then configured into the *Minimum Damper Position* configuration of the Pelican AHC. For more information on how to find the correct Minimum Damper Position reference Section 7.4 Finding the Correct Outside Air Minimum Damper Position.

5.4 Standard Ventilation Sequence of Operation

During an occupied heating, cooling, reheat and circulation cycles, the Pelican controller will set the outside air damper to its configured *Minimum Damper Position*, or further open, as explained in Section 5.6 Fan Speed, but never less.

Note: Occupied, unoccupied, heating, cooling, and circulation cycles are dictated by the demands of Pelican zone thermostats.

Zone thermostats communicate their requests to the Pelican AHC, which responds in relation to these demands. If a Pelican zone thermostat is NOT calling for anything, then its zone damper will be 100% closed. If NO Pelican zone thermostats are calling for anything, then all zone dampers will be 100% closed and the AHC will be OFF.

It is **important** to schedule and/or set Pelican zone thermostats to have Fan **ON** during all occupied periods, so that circulation/ ventilation cycles occur when there are no heating or cooling cycles.

During unoccupied periods, Pelican zone thermostats can be scheduled to setback space temperature settings with *Outside Air Ventilation* disabled. This allows the Pelican solution to reduce unnecessary ventilation during unoccupied periods and generate energy savings.

5.5 Demand Controlled Ventilation Sequence of Operation

Demand ventilation is used to dynamically adjust the outside air damper position in relation to when and how occupied a space is.

For Demand Ventilation to be available, Pelican zone thermostats must be installed with integrated CO2 sensors. Each Pelican CO2 sensor has a configured *CO2 Threshold*, Default = 800 PPM.

California 2019 Title 24 Section 120.1(d)4 states: *For each system with demand control ventilation, CO2 sensors shall be installed in each room. . . CO2 sensors shall be located in the room between 3 ft and 6 ft above the floor or at the anticipated height of the occupants' head.*

The Pelican CO2 sensor is integrated into the Pelican zone thermostat, so it is in the ideal location for proper zone CO2 detection, if it is also in the ideal location for proper zone temperature detection.

5.5.1 CO2 Levels are Below the CO2 Threshold

During occupied hours, if all Pelican zone thermostat's CO2 readings are below their *CO2 Threshold*, the Pelican AHC will place the AHU's outside air damper at its configured *Minimum Damper Position* during a heating, cooling, reheat, and circulation cycles.

5.5.2 CO2 Level are Above the CO2 Threshold

During occupied hours, if any Pelican zone thermostat's CO2 readings are above their *CO2 Threshold*, the Pelican AHC will increase the AHU's outside air damper beyond its configured *Minimum Damper Position,* during a heating, cooling, reheat, and circulation cycles, but will never exceed its *Maximum Damper Position*.

California 2019 Title 24 Exception to Section 120.1(d)4C states: *The outdoor air ventilation rate is not required to be larger than the design outdoor air ventilation rate required by Section 120.1(c)3 regardless of CO2 concentration.*

The airflow rate required for the design of the building should be balanced and converted to an outside air damper open percentage and then configured into the *Maximum Damper Position* configuration of the Pelican AHC.

Otherwise, the increase in outside air damper open percentage will be in proportion to the increase in CO2 levels above the *CO2 Threshold*, with the outside air damper being 100% open if or when CO2 levels are at 1500 PPM.

5.6 Fan Speed

As the Pelican AHC adjusts the AHU's fan speed (VFD) or bypass damper, it dynamically adjusts the outside air damper position to maintain proper ventilation rates.

5.6.1 Ventilation During Target Operating Static Cycles

When the Pelican AHU is maintaining the *Target Operating Static* (central cooling, heating, and reheat cycles), the outside air damper will be at the Pelican AHC's configured Minimum Damper Position. Unless Demand Control Ventilation is active, For more information on Demand Control Ventilation, reference Section 5.5 Demand Controlled Ventilation Sequence of Operation.

5.6.2 Ventilation During Target Circulation Static Cycles

When the Pelican AHU is maintaining the *Target Circulation Static*, the outside air damper percentage will be adjusted to maintain proper minimum ventilation rates.

The Pelican AHC automatically adjusts the outside air damper open percentage in proportion to the difference between the configured *Target Operating Static* and *Target Circulation Static* configurations.

For example, if the configurations in the Pelican AHC are:

Minimum Damper Position = 10%
Target Operating Static = 1" W.C.
Target Circulation Static = 0.5" W.C.

The outside air damper position, during these different static targets, will be:

Operating Static Pressure:
10% open (Minimum Damper Position)

Circulation Static Pressure:
20% open (calculation below)

Calculating the Circulation Static Pressure:
(Operating Static Pressure) / (Circulation Static Pressure) = (Multiplier)

1" W.C. / 0.5" W.C. = 2.0

(Multiplier) * (Minimum Damper Position) = (New Damper Position)

2.0 * 10% = 20% open

5.6.3 Why the Pelican AHC Must Control the Outside Air Damper!

It is important that if the air handler has a modulating outside air damper the Pelican AHC is in direct control over the movement of this damper, and not a third-party controller. If a third-party controller (or the air handler itself) is managing the outside air damper it will be unable to adjust the outside air damper to proper ventilation rates as the fan speed or bypass adjusts, and will not meet local and state codes.

5.7 Zone Damper Positions

5.7.1 Ventilation in Variable Air Volume and Temperature (VVT) Zones

During a central cooling or central heating cycle, zones in cooling or heating demand will open their dampers to 100% or to their *Maximum Damper Position*. And zones with no heating or cooling demand, will shut their dampers 100%. The Pelican AHC will maintain the *Target Operating Static* pressure and place the outside air damper to the *Minimum Damper Position*.

During a circulation cycle, all zones thermostats with Fan set to **ON** will open their dampers to 100% or to their *Ventilation Damper Position.* The Pelican AHC will maintain the T*arget Circulation Static* pressure and place the outside air damper to the *calculated Minimum Damper Position*; as described in section 5.6 Fan Speed.

It is **important** to schedule and/or set Pelican zone thermostats to have Fan **ON** during all occupied periods, so that circulation cycles occur during satisfied periods.

With all VVT systems the only source of heating and cooling are from the central air handler. This means that during a cooling or heating cycle the only zones that can open their dampers are zones which have cooling or heating demand (the other zones must completely shut their dampers to prevent over-cooling or over-heating). Because there are periods where zone supply dampers are completely shut, there are allowances during these periods that the Pelican Zoning Solution (as with other VVT systems) work within.

5.7.2 How does this meet Minimum Ventilation Regulations?

California 2019 Title 24 recognizes the need for this exception of continuous outdoor air rates to a space in Exception to Section 120.1(d)1, which states: *Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section 120.1(c) for up to 30 minutes at a time if the average rate for each hour is equal to or greater than the required ventilation rate.*

This is a critical part of design for proper operation with a VVT system. Why? If zones are not allowed to fully shut their dampers in a VVT system, then zones, which are satisfied or are in need of the opposite cycle, will over-cool or over-heat and be forced into a change-over-cycle request. And zones which are receiving heating or cooling will not get all the conditioned air from the air handler, which reduces their space temperature rate-of-change, making heating or cooling the space take longer than needed. Both of these sequences prevent VVT zones from going into a circulation cycle and can prolong periods of no ventilation, which is undesirable.

Because circulation cycles occur regularly and over extended periods, the Pelican solution is able to make up the difference of short missed ventilation periods, with these longer circulation cycles.

California 2019 Title 24 Section 120.1(c)3 defines another key aspect to VVT zoned ventilation: *Transfer Air. The rate of outdoor air required by Section 120.1(c)3 may be provided with air transferred from other ventilated spaces if: A. Use of transfer air is in accordance with Section 120.1(g); and B. The outdoor air that is supplied to all spaces combined, is sufficient to meet the requirements of Section 120.1(c)3 for each space individually.*

This exception identifies that as long as the circulation air from the building is being mixed with outside air at the total minimum airflow rate, as required by local and/or state codes, it meets minimum ventilation requirements. Why? Because zoned systems use a common return duct, there is always air being removed from all zoned spaces (since indoor spaces are not perfectly sealed) and returned to the air handler to be mixed with outside air. Pelican keeps the outside air damper at the configured total "all spaces" minimum ventilation position no matter how many actual zone's supply dampers are open. This additional exception and definition mean that even when some zone dampers are shut, there is still a full "all spaces" ventilation airflow rate going into the building and being mixed with the return air to meet the required reduction in airborne particles for the entire zoned system.

5.7.3 Ventilation in Variable Air Volume (VAV) Zones

For Variable Air Volume (VAV) zones, Pelican adds one more sequence of operation, outside of what is explained above.

VAV systems use local reheats to heat zones, so the only time some zone dampers will be fully shut is during an occupied central cooling cycle (to prevent satisfied zones or zones with opposite demand from over-cooling).

When some zones are in a reheat cycle, the Pelican AHC maintains the *Target Operating Static* pressure or the *Target Heating Operating Static*, if configured, sets the outside air damper to the *Minimum Damper Position*, and disables mechanical cooling.

Zones with active reheats will open their damper to 100% open or their configured *Maximum Damper Position*. And zones that do not have heating demand, will either open their dampers to their configured *Minimum Damper Position* (if their Fan setting is set to **ON**) or set their dampers to 100% closed (if their Fan setting is set to **AUTO**).

It is **important** to schedule and/or set Pelican zone thermostats to have Fan **ON** during all occupied periods, so that circulation cycles occur during reheat cycles and satisfied periods.

This sequence accomplishes two goals :

1. It allows for ventilation to continue into every zone, even when some zones are being heated.

2. It allows the Pelican solution to effectively balance the entire zoned system because air is being moved around the building at a proper airflow rate (which eliminates hot/cold spots).

5.7.4 Ventilation in Fan Powered Variable Air Volume (FPB-VAV) & (FSB-VAV) Zones

During a central cooling cycle, the zone thermostats operate the same as in Variable Air Volume (VAV) systems, the Pelican AHC maintains the *Target Operating Static* and sets the outside air damper to the *Minimum Damper Position*. The main difference from VAV systems is, FPB-VAV and FSB-VAV zones which do not need cooling, will shut their supply dampers 100%, but if they need heating, will enable their local fans to transfer common return plenum air into their space and will enable their reheats.

During a recirculation cycle, the Pelican AHC maintains the *Target Circulation Static* pressure, sets the outside air damper to the *calculated Minimum Damper Position*, and disables mechanical cooling. All FPB-VAV and FSB-VAV zones will open their supply dampers to 100% or to their configured *Minimum Damper Position*. (if their Fan setting is set to **ON**) or set their dampers to 100% closed (if their Fan setting is set to **AUTO**).

It is **important** to schedule and/or set Pelican zone thermostats to have Fan **ON** during all occupied periods, so that circulation cycles occur during reheat cycles and satisfied periods.

5.7.5 Ventilation in Mixing Box Constant Volume (MB-CV) Zones

Mixing Box (MB-CV) zones are always ventilated and the supply fan is constant volume. The outside air damper is normally ducted to both the cold deck and hot deck, so both decks get the same mixed ventilation air when the supply fan is in operation.

During occupied hours, the fan is always at 100% fan speed and the outside air damper will be at the configured *Minimum Damper Position*. Zones will either have their hot deck open or their cold deck open, so there is always continuous ventilation when the supply fan is active.

During cooling, ventilation, and/or economizer cycles, the Pelican AHC can be set to temper the hot deck to prevent over-cooling of satisfied zones.

It is **important** to schedule and/or set Pelican zone thermostats to have Fan **ON** during all occupied periods, so that circulation cycles occur during satisfied periods.

5.7.6 Ventilation in Dual Duct Variable Air Volume (DDS-VAV) Zones

DDS-VAV zones are always ventilated. The outside air damper is normally ducted to the cold deck. When a cooling cycle is active, the Pelican AHC on the cold deck AHU will maintain the *Target Operating Static* pressure, the outside air damper will be at the *Minimum Damper Position*, and zones in cooling demand will open their cold deck damper 100% or to their configured *Maximum Damper Position,* while their hot deck dampers will be 100% closed. At the same time, zones not in cooling demand, will open their hot deck dampers to 100% or to their *Minimum Damper Position* and close their cold deck dampers 100% to prevent over-cooling.

The zones with their cold deck dampers open will receive the total building minimum ventilation rates, while zones with their hot deck dampers open, will receive *Transfer Air* ventilation, since all zones share common return ducts.

The reverse sequence occurs when a heating cycle occurs. The Pelican AHC on the cold deck AHU will maintain the T*arget Circulation Static* and the outside air damper will be at the *calculated Minimum Damper Position*. Zones in heating demand will open their hot deck damper 100% or to their Maximum Damper Position and shut their cold deck dampers 100% to prevent overheating. At the same time, zones not in heating demand, will open their cold deck dampers to 100% or to their configured *Minimum Damper Position* and close their hot deck dampers 100% to prevent over-heating.

The zones with their cold deck dampers open will receive the total building minimum ventilation rates, while zones with their hot deck dampers open, will receive *Transfer Air* ventilation, since all zones share common return ducts.

The only time a DDS-VAV zone will be in a temporary ventilation reduction period is when both a cooling cycle and heating cycle are active. Zones that do not need either heating or cooling will shut both their hot and cold deck dampers

The allowance for temporary ventilation reduction in California 2019 Title 24 recognizes the need for this exception of continuous outdoor air rates to a space in Exception to Section 120.1(d)1.

In a DDS-VAV zoned system, this is an extremely rare occurrence. The Pelican AHC's approach to recirculating and balancing air in a dual duct system prevents imbalance between zones and a simultaneous heating and cooling cycle are almost never seen.

It is **important** to schedule and/or set Pelican zone thermostats to have Fan **ON** during all occupied periods, so that circulation cycles occur during satisfied periods.

06. Additional Algorithms
Sequence of Operation

06

6.1 Change-Over Logic

6.1.1 From Unoccupied to Occupied

If there are no active heating or cooling cycles, and simultaneous demand occurs, the Pelican AHC will start on a first come, first serve basis.

6.1.2 Voting for Change-Over

If an active cycle has been in operation for 30 minutes and zones in demand are not satisfied, the Pelican AHC will take a vote from all zones to determine if a change-over sequence should take place.

Zones with space temperatures furthest from their set-point will have higher votes than zones with space temperatures close to their set-point.

If the vote for the current cycle exceeds the vote for a change-over, then the Pelican AHC will keep the current cycle active until either all zones in the current demand cycle are satisfied or another 30 minutes hits, at which point the AHC will immediate change to the opposite cycle.

If the vote for the opposite cycle exceeds the vote for the current cycle, then the Pelican AHC will immediate change to the opposite cycle and reset its vote timer.

This sequence occurs and resets continuously.

6.2 Optimum Start

Each Pelican zone thermostat can be scheduled to an occupied time, with an occupied heating and cooling set-point, which can then be set for *Optimum Start*.

When thermostats are set for *Optimum Start*, thermostats will calculate when its zone requires cooling or heating to reach its occupied space temperature set-point by the set occupied time.

This optimized start-time is a calculation based on the previous seven (7) days of operational data, specific to that thermostat's spaces' rate-of-change. This algorithm incorporate using outside air (economizer) to pre-cooling the building; when available.

During an *Optimum Start* sequences, thermostats can be scheduled to NOT request ventilation. Many local and state codes require *Optimum Start* sequences to have the outside air damper shut, until one (1) hour before the building becomes occupied, at which point the outside air damper should go to the *Minimum Damper Position* to pre-ventilate the building. This is scheduled for each Pelican zone thermostat.

6.3 Economizer Fault Detection and Diagnostics

Economizer fault detection and diagnostics provides continuous feedback of proper outside air damper operation. The Pelican

AHC has an input used to monitor a position feedback signal from the outside air damper actuator.

6.3.1 System Status

Through the Pelican EMS the following statuses are indicated in real-time and stored for historical viewing. (Note: This is a requirement by California 2019 Title 24 Section 120.2(i) Economizer Fault Detection and Diagnostics):

1. Free cooling available.
2. Economizer enabled.
3. Compressor enabled.
4. Heating enabled, if the system is capable of heating.
5. Mixed air low limit cycle active.
6. All sensor values are displayed.

6.3.2 Outside Air Damper Faults

When the Pelican AHC places the outside air damper to a specific position, if the feedback signal from the outside air damper actuator is not within 2% of the Pelican AHC output, one of the following faults will be generated at the Pelican EMS:

1. Not economizing when it should.
2. Economizing when it should not.
3. Damper not modulating.
4. Excess outdoor air.

Not economizing when should.

This fault indicates that the Pelican AHC is trying to open the outside air damper for economization, but the outside air damper is not opening to the Pelican AHC configured fully open damper position.

There are two items to check to discover why this alarm was generated: 1. The outdoor air damper should be visually checked that it is moving correctly. 2. If the outdoor air damper is moving correctly, the Pelican AHC configured voltage for the economizer *Open Damper Position* should be checked for accuracy.

Economizing when it should not.

This fault indicates that the Pelican AHC is trying to close the outside air damper, but the outside air damper is open further than it should be.

There are two items to check to discover why this alarm was generated: 1. The outdoor air damper should be visually checked that it is moving correctly. 2. If the outdoor air damper is moving correctly, the Pelican AHC configured voltage for the economizer *Closed Damper Position* should be checked for accuracy.

Damper not modulating.

This fault indicates that the Pelican AHC is trying to open the outside air damper for ventilation, but the outside air damper is not moving.

If this alarm was generated a visual check of the outdoor air damper should be made to confirm it is moving correctly.

Excess outdoor air.

This fault indicates that the Pelican AHC is trying to set the outside air damper to the correct ventilation position, but the outside air damper is staying further open than desired.

If this alarm was generated a visual check of the outdoor air damper should be made to confirm it is moving correctly.

Temperature Faults

A temperature fault identifies if the Pelican AHC sees the supply air, outside air, or return air temperature sensor has failed. These faults will also be generated at the Pelican EMS.

If this alarm was generated a visual check of the failed alarm temperature should be made to confirm it is making good contact with the inputs on your Pelican AHC.

6.3.3 California 2019 Title 24 Regulations on Economizer Fault Detection and Diagnostics

California 2019 Title 24 Section 120.2(i)6 states: *Faults shall be reported in one of the following ways: A. Reported to an Energy Management Control System regularly monitored by facility personnel. B. Annunciated locally on one or more zone thermostats, or a device within five (5) feet of zone thermostat(s), clearly visible, at eye level, and meeting the following requirements: i. On the thermostat, device, or an adjacent written sign, display instructions to contact appropriate building personnel or an HVAC technician; and ii. In buildings with multiple tenants, the annunciation shall either be within property management offices or in a common space accessible by the property or building manager. C. Reported to a fault management application which automatically provides notification of the fault to remote HVAC service provider*

Pelican meets 120.2(i)6 by reporting all faults to the Pelican EMS, which is normally utilized by facility personnel and can be utilized by HVAC service providers.

6.4 Capacity Management

One challenge with zoned systems is operating the air handler when only one small zone is in central heating or central cooling demand and the rest of the building is satisfied. This only becomes a challenge if the air handler does not have a small enough first stage to be active when only this small zone is in demand.

Why? When only one small zone is in heating demand, the amount of air (CFM) that is pulled from that zone and across the heating coil might not be great enough and/or moving fast enough to prevent the supply temperature from getting too hot. When the supply air temperature gets too hot, mechanical damage can occur. This can create mechanical issues, but Pelican's *Allow Zero Heat Stages* and *Maximum Supply Temperature Safety* are designed to prevent mechanical issues by placing the AHU into a reset cycle.

When only one small zone is in cooling demand, the amount of air (CFM) that is pulled from that zone and across the evaporator coil might not be great enough and/or moving fast enough to prevent the supply temperature from getting too cold. When the supply air temperature gets too cold, the moisture in the supply air, which condenses on the evaporator coil, will begin to freeze. This can create mechanical issues, but Pelican's *Minimum Supply Temperature* configuration is designed to prevent mechanical issues by placing the AHU into a reset cycle.

To help manage this challenge and prevent resets from occurring, Pelican uses their *Capacity Management* algorithm.

6.4.1 Minimum Heating, Cooling, and Fan Capacity Percentage

There are three capacity limiters configurable for a Pelican AHC: *Minimum Heating*, *Minimum Cooling*, and *Minimum Fan* capacity. Defaults for all capacities are = 0%. Setting can be set from 0% to 100%.

When a cooling cycle is in demand, the Pelican AHC divides the total square footage of all its zones by the square footage of the zones in cooling demand. If this percentage is at or above the configured *Minimum Cooling Capacity*, cooling will be enabled. If this percentage is below, then cooling will be held off.

When a heating cycle is in demand, the Pelican AHC divides the total square footage of all its zones by the square footage of the zones in heating demand. If this percentage is at or above the configured *Minimum Heating Capacity*, heating will be enabled. If this percentage is below, then heating will be held off.

When a circulation cycle is in demand, the Pelican AHC divides the total square footage of all its zones by the square footage of the zones in circulation demand. If this percentage is at or above the configured *Minimum Circulation Capacity*, the fan will be enabled. If this percentage is below, then the fan will be held off.

6.4.2 Zone Sizes

Each Pelican zone thermostat can be configured to a *size* in the Pelican EMS. These sizes indicate how much airflow (CFM) is delivered into the space during a cooling or heating cycle.

Size Options:
x-small (< 200 sq. ft.)
small (200 - 500 sq. ft.)
medium (500 - 1000 sq. ft.) (*default)*
large (1000 - 2000 sq. ft.)
x-large (> 2000 sq. ft.)

6.4.3 Setting Zone Sizes

Knowing exact square footage of each zone is not required when configuring Zone Sizes in the Pelican Capacity Management algorithm. The importance piece is that size selections are close to accurate in the amount of airflow (CFM) going into each zone. This way the Pelican AHC can accurately calculate when the required percentage of airflow (CFM) is available to it and when it is not.

One way to think about each *Zone Size* setting is to simplify the ratio:

x-small (< 200 sq. ft.) = 1
small (200 - 500 sq. ft.) = 2
medium (500 - 1000 sq. ft.) = 3
large (1000 - 2000 sq. ft.) = 4
x-large (> 2000 sq. ft.) = 5

By breaking down the sizes into simple numbers, we are able to think of them in simpler ratios to each other. In this example, if there are three zones:

zone 1 = x-small (1)
zone 2 = x-small (1)
zone 3 = x-large (5)

And the only zone calling for cooling is zone 1, then only 14% of the total spaces are in demand.

1 (zone 1) + 1 (zone 2) + 5 (zone 3) = 7
1 (zone 1) / 7 = 0.142 or 14%

If the Minimum Cooling Capacity percentage is set to 20% then the above example will not allow for the cooling cycle to start, unless other zones are able to allow for dump air (6.4.4 Zone Dump Allowance).

If zone 3 is set to *Limited Dump Allowance* and it determines that it can be a temporary dump zone, then the new total space percentage is 86% and the cooling cycle will be allowed.

1 (zone 1) + 1 (zone 2) + 5 (zone 3) = 7
(1 (zone 1) + 5 (zone 3) / 7 = 0.857 or 86%

If zone 2 is set to *Limited Dump Allowance* and it determines that it can be a temporary dump zone, then the new total space percentage is 29% and the cooling cycle will be allowed

1 (zone 1) + 1 (zone 2) + 5 (zone 3) = 7
(1 (zone 1) + 1 (zone 2) / 7 = 0.285 or 29%

These calculations occur continuously before and during a cooling, heating, or circulation cycle. As zones become available the total capacity percentage will increase and vise versa as zones are no longer available.

6.4.4 Zone Dump Allowance

Each zone can be configured to a *Dump Allowance*. A dump allowance indicates when the zone can or cannot be used to accept extra airflow (CFM). There are three (3) zone dump allowance configurations: *No, Limited, Yes.*

No (Dump Allowance)

No Dump Allowance means that during an active heating or cooling cycle these zones will never allow additional airflow (CFM) into their spaces, unless they are participating in the heating or cooling cycle.

Limited (Dump Allowance)

Limited (Dump Allowance) is interpreted differently between an active heating or cooling cycle:

When heating is held off by the *Minimum Heating Capacity* percentage limiter, zones not in heating demand, but have a space temperature 1°F or less above their heat set-point, and are set as *Limited (Dump Allowance)*, will open their dampers to accept heat from the central AHU, with an allowance of over-conditioning by 1°F above their heat set-point.

For example, if a zone is set to *Limited (Dump Allowance)* and the *Minimum Heating Capacity* percentage is set to 20%, but the total in demand zones only equate to 15%. Zones set to *Limited (Dump Allowance)* can open their dampers to provide additional airflow (CFM), increasing the total in demand percentage, but only as long as their zone's space temperature stays 1°F or less above their heat set-point. If their heat set-point is 72°F then this allowance is no more than a space temperature of 73°F.

When cooling is held off by the *Minimum Cooling Capacity* percentage limiter, zones not in cooling demand, but have a space temperature 1°F or less below their cool set-point, and are set as *Limited (Dump Allowance)*, will open their dampers to accept cooling from the central AHU, with an allowance of over-conditioning by 1°F below their cool set-point.

For example, if a zone is set to *Limited (Dump Allowance)* and the *Minimum Cooling Capacity* percentage is set to 20%, but the total in demand zones only equate to 15%. Zones set to *Limited (Dump Allowance)* can open their dampers to provide additional square footage, increasing the total in demand percentage, but only as long as their zone's space temperature stays 1°F or less below their cool set-point. If their cool set-point is 70°F then this allowance is no more than a space temperature of 69°F.

Yes (Dump Allowance)

Yes (Dump Allowance) when heating or cooling is held off by the *Minimum Capacity* percentage limiters, zones set as *Yes (Dump Allowance)*, will always open their dampers to accept heating or cooling from the central AHU to increase the total in demand percentage.

6.4.5 Zones with Two-Position Damper Actuators

Zones with a two-position damper actuator set to *Limited* or *Yes (Dump Allowance),* will open their dampers to 100% open or their configured *Maximum Damper Position*, when temporary dumping is required.

6.4.6 Zones with Floating Damper Actuators

Zones with floating damper actuators set to *Limited* or *Yes (Dump Allowance),* will calculate a percentage open position between fully closed and their *Maximum Damper Position,* when temporary dumping is required.

This calculation is designed to allow for additional airflow (CFM) rates, while trying to keep zones from over-heating or over-cooling.

6.4.7 Best Practices

It is extremely important that before enabling *Capacity Management* all zone dampers are verified to be operating correctly and all other mechanical pieces in the system are operating as described in this document.

If there are <u>any</u> mechanical issues, enabling capacity management will make these issues worse.

It is also extremely important that before enabling *Capacity Management* the entire system has been balanced correctly.
For assistance with balancing, reference section 7.1 Balancing Process.

Capacity Management is used in very rare situations and as a last resort option. Normally issues being identified by the Pelican solution, is due to other mechanical issues that do not require *Capacity Management*. These mechanical issues should first be fixed, before enabling *Capacity Management*!

6.5 Pelican AHC with Boiler Controller set to ON

The Pelican AHC has a configuration called *Boiler Controller.* This sequence will only operate if the Pelican AHC has a temperature input labeled *Boiler Supply Water Temperature*.

Note: Turning this configuration **ON** changes the signal outputs of the Pelican AHC. It sets (W) as a boiler pump start/stop and (W2) as a boiler start/stop.

This configuration prevents reheat zones from operating until the Pelican AHC sees the Boiler Supply Water Temperature within configured temperature ranges.

6.6 Loss of Internet Connection

6.6.1 Loss of power at the Pelican AHC.

A power failure will shut off the Pelican AHC due to power loss. Zones will be unable to receive information from the Pelican AHC and will go into a *waiting* state and shut down all operations. When power resumes, the air handler controller will automatically reconnect with zones and resume normal operations.

6.6.2 Loss of power at a Pelican zone thermostat.

A power failure will shut off the Pelican zone thermostat due to power loss. When power resumes, the thermostat will shut down its damper and any reheat cycles (if still active).

It will automatically reconnect with the Pelican AHC and resume normal sequences.

6.7 Loss of Internet

The Pelican solution does not rely on an Internet connection for the sequences in this document to operate. There are only two items lost due to no Internet connection: No access to make adjustments from the Pelican Web-App and No historical data stored on the Pelican Web-App. Once Internet is restored, these two items become available.

6.7.1 Loss of power, during loss of Internet

In the rare case of a power failure when there is no Internet access, when Pelican zone thermostats power back-up they will not know the current time until they can connect back to the Internet. This will disable thermostat's schedules, but it does not prevent the operation of the Pelican zoning solution.

07. Balancing
Process of Events

07

7.1 Balancing Process

The Pelican system will use its configured Static Pressure Targets during different cycles; as explained in section 4.1 Supply Static Pressures. It is important that these targets are set correctly to produce the correct airflow (CFM) rate into each zone.

All configurations and adjustments to the Pelican system are done through the Pelican Connect app. The Pelican Connect app can be accessed on any Internet connected (Smartphone, Tablet, or Personal Computer) through a web-browser.

To properly balance the system you will need a certified air balance hood to record zone airflow (CFM) rates and the outside air damper airflow (CFM) rate.

Start this balancing sequence by setting Pelican zone thermostats *System Mode* to **OFF** and *Fan Mode* to **AUTO,** until Step 4.

7.2 Initial Target Static Settings

Step 1: Pelican Connect app
Log into the Pelican Connect app associated with this building's Pelican system.

Step 2: Intiail Thermostat Configurations
In the app select Admin > Thermostat Configuration and configure all the Pelican zone thermostats that are part of this zone system, as follows:

System Type: Zone Damper

Zone Controller: (select the Pelican Air Handler Controller that this thermostat communicates with)

Damper Type: Open/Close (for balancing purposes it is best to start with Open/Close and then set Floating on as needed (section 7.3.3).

Reheat Type: Open/Close

Select the *Back* button in the upper left hand corner. These configurations will automatically be saved and pushed to the Pelican zone thermostats.

This section does not go through all the configurations for a Pelican zone thermostat, but points out the important configurations for balancing the system.

Step 3: Intial Zone Controller Configurations
Select Admin > Zone Controller > the Pelican AHC you are balancing > Configuration Settings.

This section does not go through all the configurations, but points out the important configurations for balancing the system.

Enable the modulating type for static pressure management: Variable Speed Fan OR Bypass Damper.

Variable Speed Fan (VFD)
Set *Variable Speed Fan* is to **ON** if there is a modulating fan. Set the *Minimum Operating Speed* to the lowest speed allowed for your AHU design. Default = 20%.

OR

Bypass Damper
Set *Bypass Damper* is to **ON** and set the *Open* and *Closed* damper voltages for your Bypass damper actuator.

Step 5:
Static Pressure
Under *Static Pressure* find *Target Opporating and Circulation Static.* Input the expected *maxium static pressure* (in inch W.C.) into both fields.

Set *Minimum Static* to 0.00 inch W.C. and *Maximum Static* to 0.25 inch W.C.

Step 6:
Navigate to the Main Menu on your Pelican Web-App and set all Pelican zone thermostats that are part of this zoned *Fan* set to **ON** and *System* set to **OFF**.

Why? When all zone thermostats call for Fan, they will open their dampers to 100% open or to their configured Maximum Damper Position. The Pelican AHC will start the supply fan and modulate to the configured *Target Circulation Static* from step 5.

Step 7:
Using a certified air balance hood, measure the airflow (CFM) rate at all zone supply air ducts. Find the zone with the lowest airflow (CFM) rate.

Step 8:
On the Pelican Web-App, navigate to the Pelican AHC page from Step 3:

Select Admin > Zone Controller > the Pelican AHC you are balancing > Configuration Settings

While measuring the zone with the lowest airflow (CFM) rate, increase the *Target Circulation Static* configuration until the zone's airflow (CFM) rate matches the specified maximum airflow (CFM) rate for this zone.

Once this is found, this will be the *Target Operating Static* pressure for the entire zoned system. Copy this *Target Circulation Static* configuration and paste it into the *Target Operating Static* configuration for this Pelican AHC.

7.3 Balancing all Remaining Zones

Now that the *Target Operating Static* pressure is found, you will need to balance the remaining zones so they are at their correct maximum airflow (CFM) rates.

Do not start this process if you have not gone through section 7.2 Finding the Correct Target Operating Static Pressure.

Make sure all Pelican zone thermostats have their *Fan* set to **ON** and *System* set to **OFF**.

Balancing Open/Close Dampers
Open/Close dampers require the use of a certified air balance hood to record the airflow (CFM) rate at each zone, and manually balancing them by setting mechanical maximum open stops on their damper actuators.

Never set mechanical stops to prevent zone dampers from fully closing with the Pelican Solution. This document explains why this is not required and also why this will prevent your Pelican solution from operating correctly. If you have questions about this, contact Pelican Technical Support and request Sales Engineering assistance.

Balancing Floating Dampers
Floating dampers can be balance through the Pelican App.

Step 1:
Take a certified balancing hood to the zone you want to balance and measure the airflow (CFM) rate going into the zone.

Step 2:
Log into the Pelican Web-App associated with this building's Pelican Solution.

Select Admin > Thermostat Configuration > and navigate to and select the Pelican zone thermostat that controls the zone damper for the zone you are in.

Step 3:
Set the following configurations:

Damper Type: Floating.

Actuator Travel Time: set to the travel rate to move the damper from fully closed to fully open for this zone. Common = 95 sec.

Ventilation Damper Position: 100% (this will be balanced later) .

Maximum Damper Position: set to the maximum open percentage you want this zone to be at to adjust to the maximum airflow (CFM) rate.

Go to the Pelican zone thermostat. Change the *Fan Mode* to **AUTO**, wait one minute, and then back to **ON**. The thermostat will shut its damper and then re-open its damper to its configured *Maximum Damper Position*.

Once opened, re-use a certified balancing hood to measure the new airflow (CFM) rate going into the zone. If the CFMs are not at the correct rate, go through this process again until the zone is balanced to the correct maximum cooling CFM.

Step 3:
Follow Step 2 for all remaining zones, until all zones are balanced.

7.4 Finding the Correct Outside Air Minimum Damper Position

With the correct *Target Operating Static* pressure configured and all zone balanced to their correct maximum airflow (CFM) rate, you can balance the *Outside Air Damper* to the correct airflow (CFM) rate for occupied ventilation.

Do not start this process if you have not gone through Section 7.2 Finding the Correct Target Operating Static Pressure and 7.3 Balancing All Remaining Zones.

Make sure all Pelican zone thermostats have their *System Mode* set to **OFF** and *Fan Mode* set to **ON**.

Step 1:
Log into the Pelican Web-App associated with this building's Pelican Solution.

Select Admin > Zone Controller > the Pelican AHC you are balancing > Configuration Settings.

Navigate to *Economizer* and set to **ON**.
Set the following configurations:

High Limit Shut Off: Auto

Activation Differential: this is a personal choice. Default = 4°F.

Fixed Enthalpy Limit: set to Yes if you are in a climate where it becomes humidity. Default = No.

Variable Damper: set the Open and Closed voltages to the correct outputs to place your outside air damper to 100% open and 100% closed.
Default Open = 10.0 VDC, Closed = 2.0 VDC

Minimum Damper Position: this is what we are balancing, so leave at Default = 10%.

Track Damper Position: set to Yes if there is a position feedback signal from your outside air damper actuator to your Pelican AHC. Set to No if there is no feedback loop.

Demand Ventilation: set to OFF (for now, even if you have Pelican CO2 thermostats).

Maximum Ventilation Position: set to 100%.

Step 2:
After you are done with Step 1, your Pelican AHC will set your AHU's outside air damper to 10% (the default Minimum Damper Position), since all your Pelican zone thermostats are calling for Fan.

Take a certified balancing hood to the AHU's outside air damper and measure the airflow (CFM) rate going into the AHU.

Step 3:
Navigate back to the configuration page of the Pelican AHC as explained in Step 1 of this section.

Find *Minimum Damper Position* and adjust the configuration to either a lower or higher percentage, depending on if you want to increase or deceases the airflow (CFM) rate you recorded coming into your Outside Air Damper.

There is no save button, once you type the new percentage your Pelican AHC will begin to move the outside air damper to this new configuration.

Using a certified balancing hood, re-measure the airflow (CFM) rate going into the AHU. Follow this step until the airflow (CFM) rate matches the required ventilation airflow (CFM) for this zoned system.

Step 4:
Now that you have configured the correct *Minimum Damper Position*, you can enable Demand Ventilation (if you have Pelican CO2 zone thermostats).

7.5 Finding the Correct Target Circulation Static Pressure

With the correct *Target Operating Static* pressure configured, all zones balanced to the correct maximum airflow (CFM) rate, and your *Minimum Damper Position* configured, you can finish balancing your *Target Circulation Static*.

Do not start this process if you have not gone through Section 7.2 Finding the Correct Target Operating Static Pressure, 7.3 Balancing All Remaining Zones, and 7.4 Finding the Correct Outside Air Minimum Damper Position.

Make sure all Pelican zone thermostats have their *System Mode* set to **OFF** and *Fan Mode* set to **ON**.

Step 1:
Log into the Pelican Web-App associated with this building's Pelican Solution.

Select Admin > Zone Controller > the Pelican AHC you are balancing > Configuration Settings.

Navigate to *Static Pressure*.
Set the *Target Circulation Static* to half (0.5) of what you have configured in your *Target Operating Static*.

For example, if your *Target Operating Static* is configured for 1.0" W.C., then you will want to configured your *Target Circulation Static* to 0.5" W.C.

Step 2:
Take a certified balancing hood to any zone in the building and measure the airflow (CFM) rate going into the zone.

If the statis pressure is above the minimum static pressure, you are done balacing. Of it is below the minimum static pressure go to Step 3.

Step 3:
Navigate back to the Pelican AHC configuration page as described in Step 1 of this section.

Navigate to *Static Pressure*:
Adjust the configuration next to T*arget Circulation Static* until the airflow (CFM) rate going into this zone is around the minimum airflow (CFM) rate for that space.

There is no save button, once you type the new configuration into *Target Circulation Static* your Pelican AHC will begin to adjust to the static pressure configured.

Once this zone's minimum airflow (CFM) rate is found, you have found the correct *Target Circulation Static* and are done with this process.

7.6 Balancing Complete

With your Pelican AHC balanced, you can now operate and schedule the Pelican zone thermostats as desired.

Note: When scheduling the Pelican zone thermostats for normally occupied periods, make sure *Fan Mode* is scheduled to be **ON** for all Pelican zone thermostats. This accomplishes two objectives: It makes sure that zones are calling for circulation during all occupied hours and it helps balance the air temperatures between all the zone's in the mechanical system.