

CLOSING THE LOOP

**AIRFLOW STRATEGIES FOR MULTI-TIER
CANNABIS GROW ROOMS**

THE START OF A NEW ERA

In 2017, Pipp Horticulture became one of the first manufacturers to offer a purpose-built **vertical mobile racking system** to indoor cannabis cultivators. For decades, growers have been building and refining the design of single-level grow rooms with HID lighting. However, grow room designs with vertically stacked tiers of benching on mobile carriages were virtually non-existent.

Multi-tier cannabis cultivation wasn't feasible until **2015-2017** when high-efficiency LED fixtures were introduced and allowed for **close proximity lighting** with little waste heat, much more suitable for vertical applications than HID technology. The concept of a vertically stacked cannabis grow room was born, but compared to single-level rooms, their designs were yet to be refined and presented some unique challenges.



Over the last 6 years, Pipp has installed vertical racking systems in hundreds of facilities worldwide, totaling **over 2,500 grow rooms** and tens of millions of canopy square feet. Along the way, we gained valuable insights into how to design a successful multi-tier grow room and the common challenges to avoid. By far the greatest limiting factor to the performance of these rooms is **insufficient airflow** and **poor mechanical system designs**.

With the proper airflow and mechanical system design, we have seen the product quality and yields in these rooms match or exceed single-level room yields per square foot. Read on to discover proven **best practices** for designing multi-tier cannabis grow rooms that facilitate good airflow and a homogenous environment.



SPACE PLANNING & ROOM LAYOUT

A good airflow strategy starts with space planning and the racking layout within your room. The goal is to create a racking layout that **maximizes the canopy footprint** within the room while leaving adequate space around the racking structures for air to mix and flow. Without a buffer zone around and between the racks, you run the risk of “choking” out the room and restricting airflow. There is such a thing as maximizing the cubic footage of your room too much to the detriment of plant health.

LENGTH

For a more consistent environment, consider the length of your rows and how far the air will travel from the front to the back of the room. The longer the air travels, the more humid and hot it will become, resulting in different canopy conditions in the front and back of your room. As a general rule of thumb, row lengths of **32-40' or less** are preferred to limit the distance air has to travel.

SPACING

Plan for at least **6-12” of space** between each row and the side walls of the room when the racks are in the resting position (evenly spaced, no mobile aisle). The recommended space in front, behind, and above the racks scales as you increase the number of grow tiers, the racks get taller, and the canopy footprint increases. For example, in a flower room with **2,000-2,500 sq. ft.** of canopy with 2-tiers, leave 6-8’ in the front main aisle, between 2-3’ in the back of the room, and as much space above the racks as possible.

HEIGHT

For the height of each grow tier, if you go too short you can restrict airflow, too tall and you decrease the headspace above the racks. On average, most veg rooms are **3-tiers with 4’ tier heights**, and flower rooms are commonly **2-tiers with a 5-5.5’ tier height**.



MECHANICAL SYSTEM DESIGN FOR MULTI-TIER ROOMS

A proper mechanical system design is crucial to the performance of a multi-tier room. Almost every time I speak with a grower struggling in a multi-tier room, it is due to a poorly designed mechanical system. A flawed mechanical system will limit the room's yield potential, slow growth rates, and **negatively affect plant health.**

Don't cut corners here, engage experienced professionals during the design phase and budget appropriately. Once installed, a mechanical system is a difficult and expensive retrofit in a

cultivation facility, get it right the first time. **Purpose-built designs are a must,** and installing vertical racking in a room with a mechanical system designed for single-tier or dry/cure is ill-advised.

While they are still prevalent due to their low cost, a non-integrated system consisting of separate air-conditioners for temperature control and standalone dehumidifiers for humidity control is **not ideal** for multi-tier applications. All those separate systems often complicate the airflow strategy for the room and the dehumidification capacity is typically

undersized for the amount of canopy in the room.

An integrated system with reheat is preferred which allows a single system to **efficiently control both temperature and relative humidity** eliminating the need for standalone dehumidifiers. These systems are typically outside the room, either on the roof or on-grade, and ducted into the room. Take great care during the sizing of this system and be confident it has enough capacity to handle the latent load of the room.



MECHANICAL SYSTEM DESIGN FOR MULTI-TIER ROOMS

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The best most accurately sized HVAC system will not perform appropriately if paired with poorly designed ductwork. With **rows less than 40'**, a racking layout that doesn't choke the room, and in-rack airflow, you can supply air evenly across the front of the room in the main aisle, ensuring it reaches the floor and then return it on the back wall at multiple elevations located at the height of each grow tier. This ductwork configuration will create a single-pass recirculating airflow strategy in conjunction with in-rack airflow.

A well-designed system will exchange all of the air in the room roughly every **2-3 minutes** ensuring a consistent environment, leaf temperature, and VPD. You cannot rely on your HVAC systems fan for in-room airflow, in-rack airflow systems are a requirement to close the loop in this circular airflow strategy. No matter how many fans you install in your room they can never make up for a poorly designed mechanical system. A well-designed mechanical system that facilitates good air exchange within the room is the foundation for getting consistently high-yielding and high-quality harvests in a multi-tier room.

IN-RACK AIRFLOW SYSTEMS

As mentioned before, in-rack airflow systems operate within the grow room and work in conjunction with a well-designed ductwork configuration to close the loop on the circular air path. These systems are installed on every tier of every row and consist of one or more inline fans and a ducting system to deliver air to the plant canopy. The **fans are sized based on your row length and tier height** and are located at the front of your room near the main aisle where the supply air is delivered to the room. These fans then capture the conditioned, dehumidified, CO2-enriched air from your HVAC system and push it down the row along the canopy to the back of the room where the return grilles are. In-rack airflow fans typically operate 24/7, are variable speed, and are usually only ramped down or shut off during foliar spray events or room resets.



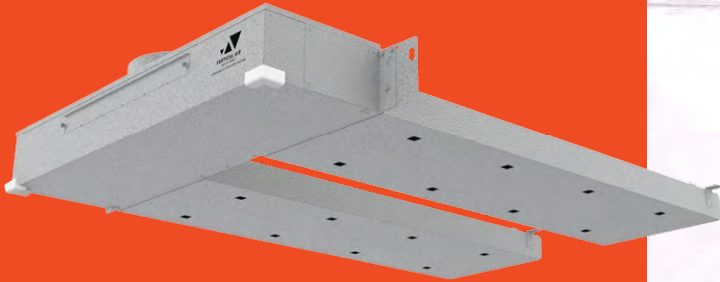
Don't forget to account for the **electrical draw** of your in-rack airflow fans during the design phase, they add up quickly and are usually single-phase. Also, check to see if they have an **EC motor** because most utilities will provide rebates for every EC motor in your facility helping offset the cost of the system. If you have a backup generator for your facility, I typically recommend tying in the fan motors in your HVAC units and as many in-rack airflow fans as possible to keep the air moving. A best practice is to include an **irrigation pump** to keep your plants watered and a small percentage of your lights to maintain the photoperiod during an outage.



IN-RACK AIRFLOW SYSTEMS

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Vertical Air Solutions was the first in-rack airflow system designed specifically for multi-tier cannabis cultivation. It was developed by Matt Bogner and James Cunningham of Fog City Farms in Santa Cruz, one of the first multi-tier cannabis cultivation facilities in the United States.





PLANT HEIGHT & CANOPY MANAGEMENT

Even the most well-designed multi-tier grow rooms can still struggle with airflow if you don't carefully manage your plant height and canopy. Cannabis can rapidly double or triple in size during the first few weeks of flower, a process commonly referred to as "**plant stretching**". Growers transitioning from single-level to multi-tier tend to over-veg their plants and underestimate the stretch. If your plants are too big when you flip them into flower, or you are growing a cultivar that tends to stretch a lot, they will grow right into the LED fixtures and choke out the space in the rack for air to flow. There are many strategies to manage the stretch and control plant height to allow good airflow through your room.

The fundamentals of controlling plant stretch in early flower begin in the **veg room**. Start by familiarizing yourself with the genetics you have in rotation, track their growth rates in veg, and get to know which cultivars tend to stretch a lot or not at all in flower. Group cultivars into harvest groups based on these growth characteristics and then time the veg rotation and do the required plant training techniques to manage the final plant height. Some combination and amount of **plant training** (trellising, topping, super cropping) is usually done along with the strategies above. The goal with plant training is to do the least amount possible to limit touches and labor costs while still getting the desired result.

PLANT HEIGHT & CANOPY MANAGEMENT *(Continued)*

Environmental crop steering

techniques can also be used in the early flower stage to help control plant stretching. Environmental crop steering is a technique where growers manipulate the environment to either add or remove stress signals to their plants to get an intended growth response.

A simple example of this is when plants don't receive enough light they stretch and become taller in an attempt to get more light, an undesirable trait for indoor cultivation.

Growers will alter the environment by delivering a higher lighting level, steering the crop to remain shorter.

Another way to manage stretch with environmental cues is by controlling the day and night air temperatures within your room. The **DIF technique of temperature control**, or the difference between day and night temperatures, can be used to control the stretch in many plants. Warm days and cold nights result in plants stretching, the more significant the difference between the two, the more plants stretch.

You can leverage this by running a slightly warmer night temperature than your day temperature at the beginning of flower to suppress stem elongation.

A similar, but somewhat easier technique of getting the same suppression response is called a **“cool air dump”** or **“cool morning pulse”**. To do this, reduce the day temperature to 5°F-10°F lower than the night temperature for the first 2-3 hours during the first few weeks of flower.



PLANT HEIGHT & CANOPY MANAGEMENT

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In addition to controlling the plant height, **defoliation** is another necessary step to ensure good airflow through your canopy. Defoliation is the process of manually removing excess fan leaves and branches to thin out the canopy. Despite being a tedious task that requires a high labor cost, defoliation has numerous benefits for plant health, yield, and product quality. The more you stay ahead on your defoliation the less of a chore it becomes. Start your defoliation in veg with a healthy thinning of the canopy before flipping the plants into flower. The specific day and frequency you need to defoliate in flower is cultivar dependent, but a common strategy is to defoliate on **day 21 and day 42**. These defoliation events and skirting the under portion of your canopy are great ways to ensure good air circulation and have healthy harvests.






LOOKING TOWARDS **THE FUTURE**

As the cannabis industry continues to mature more and more indoor cultivation facilities will be built, older facilities will be retrofitted or shut down, and the design of multi-tier grow rooms will get even better. Innovative new products will undoubtedly come to market, and the airflow strategies above will likely be refined and optimized. The design and operation of commercial indoor grow rooms is an exciting new field filled with opportunities to learn and innovate. The team at **Pipp Horticulture** is thrilled to be on the cutting edge and continue sharing what we discover.



Contact our team of experienced grow experts to learn how **Vertical Air Solutions** can take your facility to the next level!

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