

Liebert CRV Modular, Field-Adjustable Supply Air Baffle

System Overview

Revision: 2

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Executive Summary

This document provides an overview of the most important performance attributes of the Liebert CRV's baffle system and the benefits it provides. While it is clear that this component directs the supply air as it leaves the air conditioner, it is not as apparent how this simple device helps to reduce the energy consumption of the Liebert CRV, maintain peak unit efficiency, minimize the sound it generates, and prevent hotspots within the cold aisle. The Liebert CRV's supply air baffle system is an industry first, and is unmatched in its flexibility and performance.

Overview

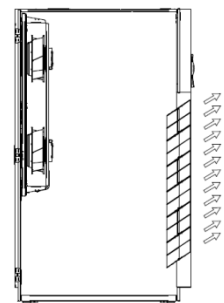
Liebert CRV's supply air baffle has been optimized to discharge cold supply air to neighboring server racks within a defined cold aisle. The design of this component was refined after several months of in-house testing in our application extreme heat density lab, CFD modeling with the assistance of the CFD software company to ensure accurate model results, and with the collaboration of an outside consultant. We have invested a large amount of time and resources into the development of this very important aspect of the product because it provides huge performance and energy efficiency benefits for the customer.

The baffle has several key aspects.

- 1. Angle of the Baffle Vanes:** The angles of the vanes have been optimized to ensure the air discharges from the unit in the intended direction. While this sounds simple, it is actually rather challenging to direct high velocity air through a baffle system that is only a few inches thick. We explored making the angle of the vanes adjustable, similar to the air vents on the dashboard of your car, but found that the performance of the baffle was reduced as the vanes were moved away from their optimal angle. For this reason, we fixed the discharge direction of the baffle vanes.

It is also important to recognize that the baffle system is only effective when the Liebert CRV is installed within a row of equipment with a defined cold aisle that is 4-6 feet wide. The baffles rely on a wall or row of racks across from the Liebert CRV to help direct the airflow down the aisle. Air, like any fluid, does not make U-turns naturally, so having a barrier across from the Liebert CRV is essential to maximizing its performance. The baffle focuses the cold air leaving the unit down the aisle and uses a wall or row of racks across from the unit to help contain the air.

- 2. Upward Angle of the Vanes:** Beyond simply angling the vanes left/right, we also direct the air slightly upwards as it flows out of the Liebert CRV. This is because cold air sinks and hot air rises. If we only discharged air horizontally, it would immediately sink to the floor leaving the top half of the racks without cold air. The slight upward tilt of the baffle



Left Side View

vanes provides the right amount of arc to the air to serve the top half of the racks before sinking. This angle has been optimized to work with our recommended 4-6 feet wide cold aisle as shown in Figure 1.

Also, it is important to note that the air discharge profile from the baffle is not perfectly uniform; meaning that the shape and size of the arc leaving the Liebert CRV varies across the face of the baffles. The non-uniform air distribution pattern corresponds with the different distances the air must travel to evenly distribute air across the face of the server racks.

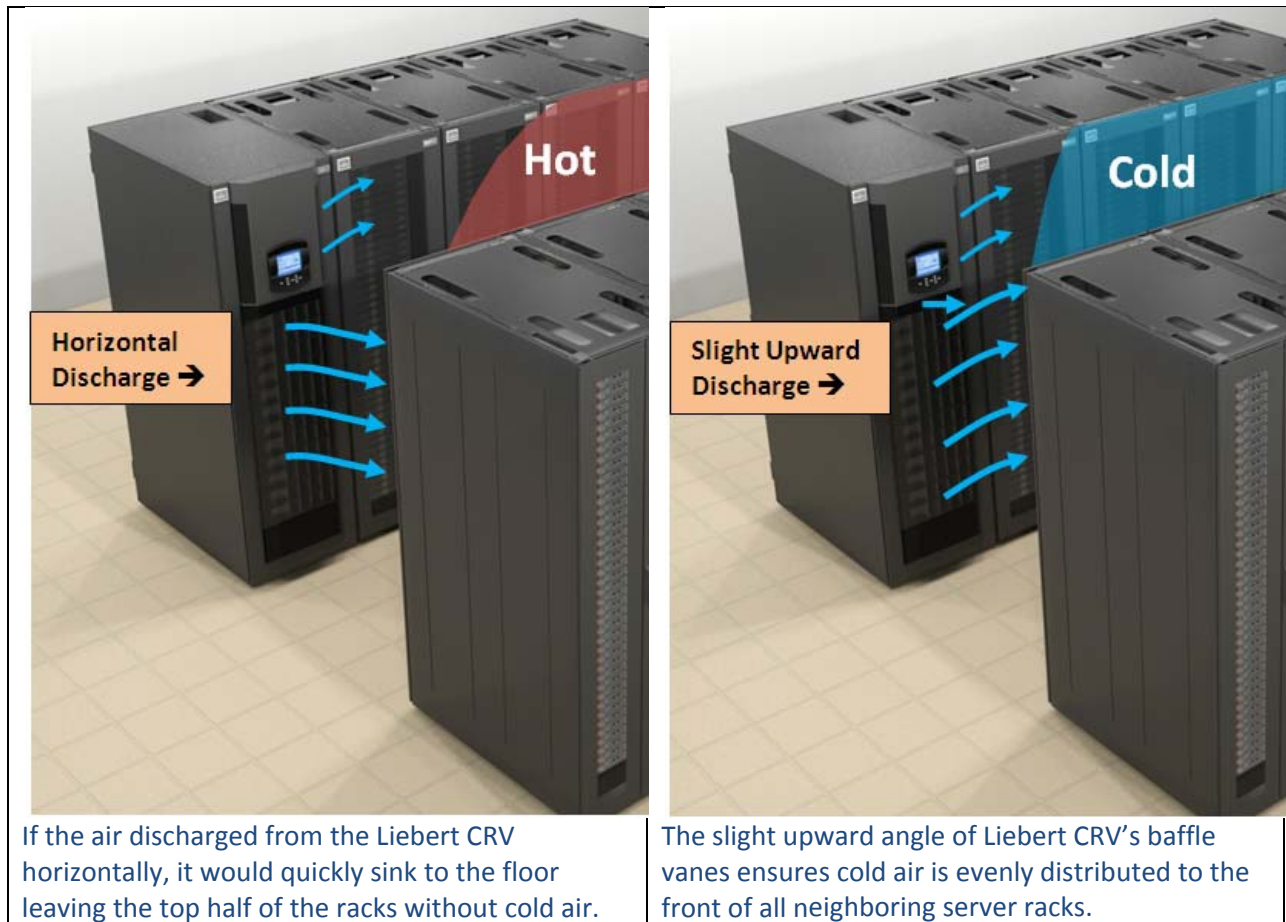
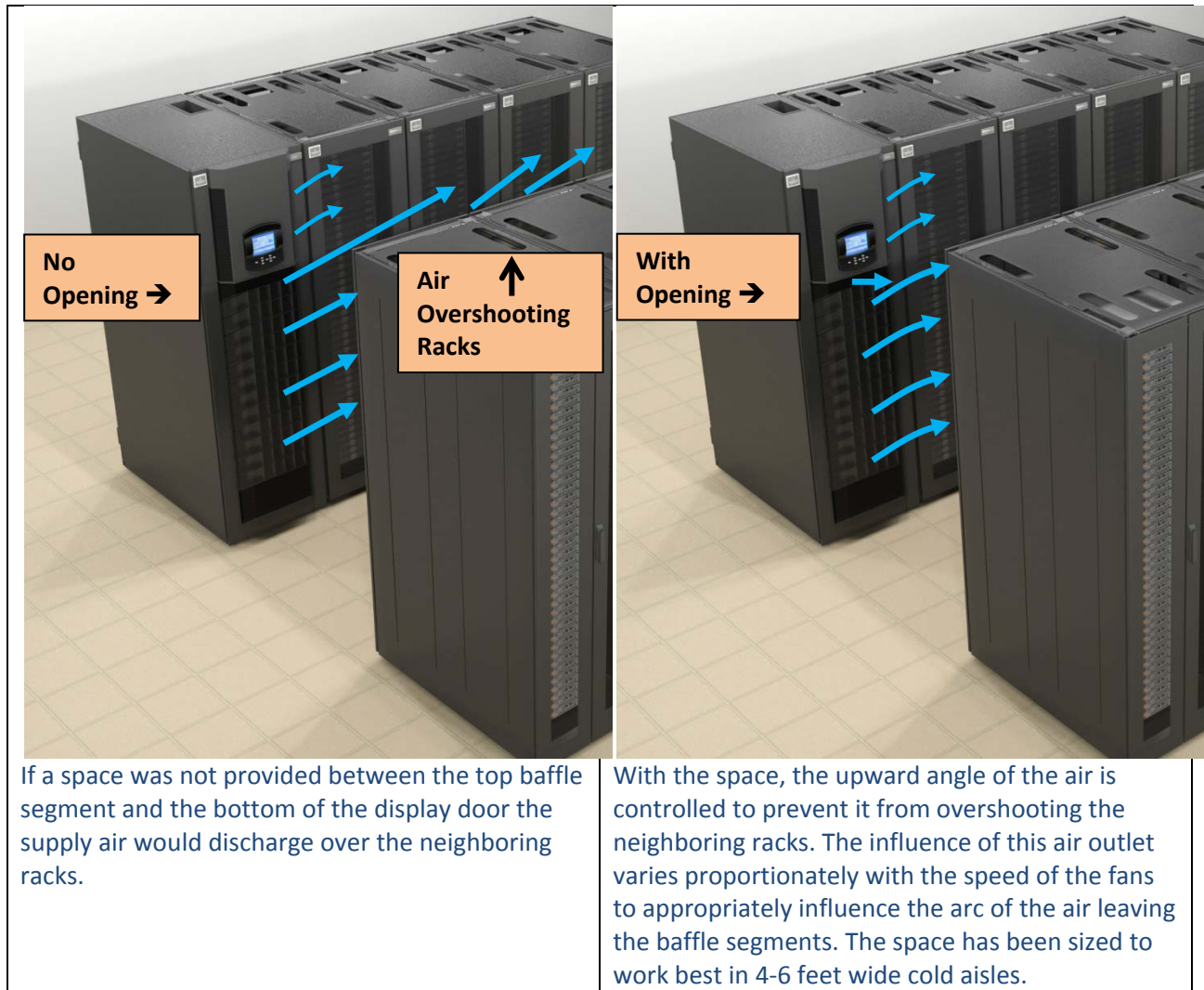


Figure 1. The supply air discharges the Liebert CRV at different angles to condition the nearby server racks.

- 3. Venturi Effect:** At the top of the baffle assembly and below the display door there is a space where air discharges from the Liebert CRV at a high velocity. This opening serves two purposes:
 - First:** It ensures that the air leaving the top baffle segment at an upward angle does not shoot over the racks 4-6 feet across the aisle from the Liebert CRV. The vertical spacing of this air outlet was sized to work in conjunction with the air leaving the top baffle segments and not to completely flatten out the upward arc as shown in Figure 2.



If a space was not provided between the top baffle segment and the bottom of the display door the supply air would discharge over the neighboring racks.

With the space, the upward angle of the air is controlled to prevent it from overshooting the neighboring racks. The influence of this air outlet varies proportionately with the speed of the fans to appropriately influence the arc of the air leaving the baffle segments. The space has been sized to work best in 4-6 feet wide cold aisles.

Figure 2. The space between the top baffle segment and the bottom of the display door ensures the cold air reaches the top of the server racks without overshooting them.

Second: When installing the Liebert CRV at the end of an aisle, the opening prevents hot air from the hot aisle from being drawn into the cold aisle, simulating a cold aisle containment door. During testing when we did not provide the space above the baffles, hot air was drawn from the hot aisle into the cold aisle as the baffles blew air towards the servers as shown in Figure 3. To prevent this, we created what we call the Venturi opening at the top of the baffles.

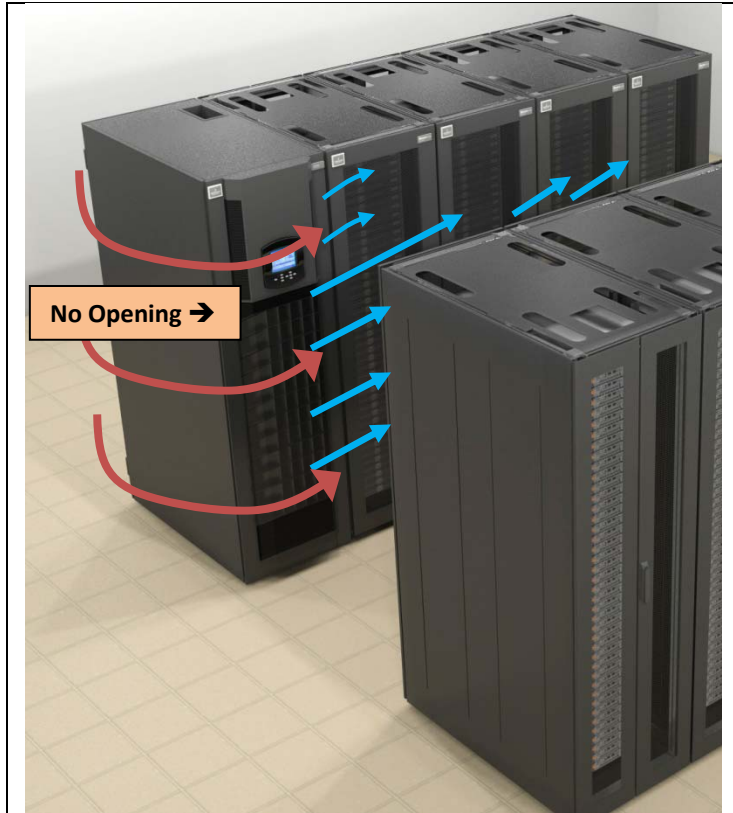


Figure 3. With no opening above the baffles, hot air was drawn from the hot aisle into the cold aisle.

In short, a Venturi is when flow is constricted through a smaller opening which increases its velocity. When the flow then exits into a larger space it expands and slows down as shown in Figure 4. For example, this is what happens when you place your thumb over the end of a garden hose to create a fast stream of water that spreads out as it travels away from the hose outlet.

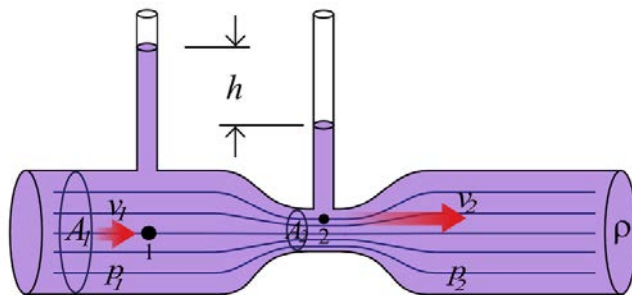


Figure 4. Venturi flow diagram

With the Liebert CRV, as air passes through the opening between the top baffle segment and the bottom of the display door the velocity of the air increases. Then as the air discharges straight out of the Liebert CRV it rapidly expands into the cold aisle as shown in Figure 5.

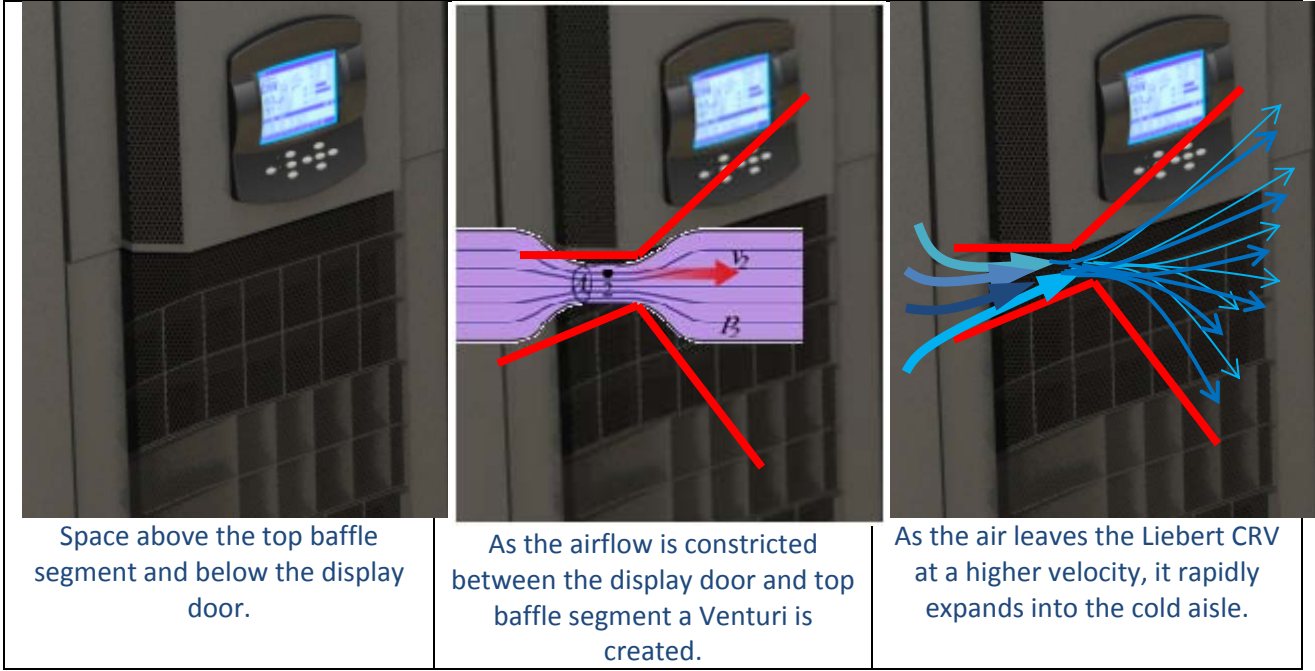
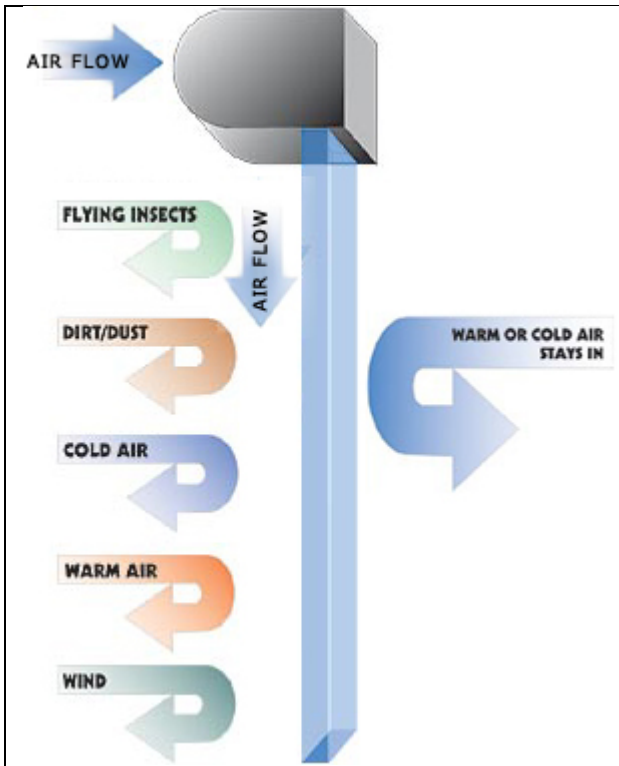


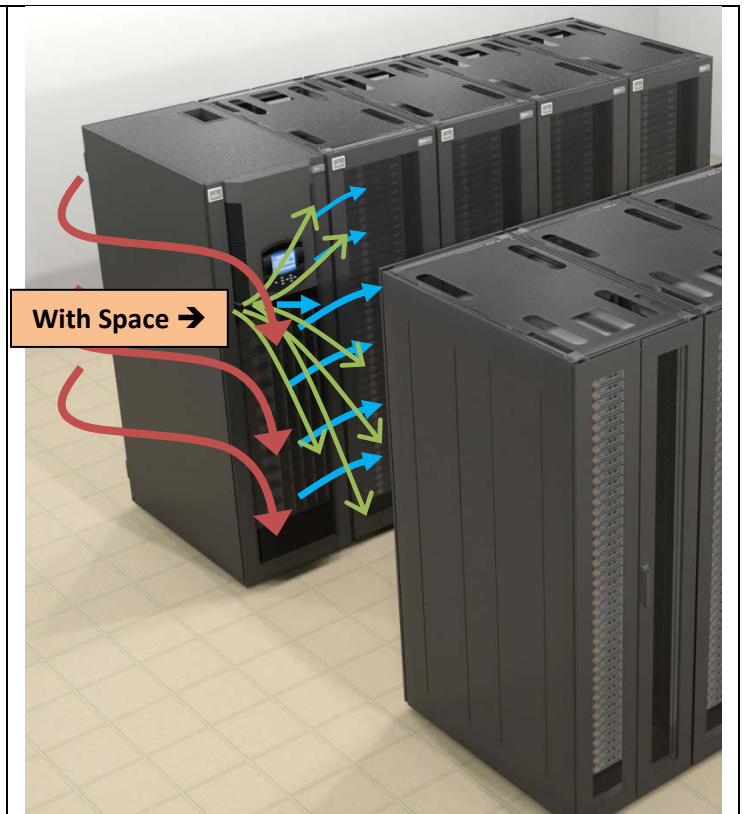
Figure 5. Liebert CRV Venturi effect illustration

This expansion creates an air curtain at the end of the cold aisle. This air curtain works in the same manner as the air curtains typically seen at the entrances to grocery stores to prevent outside air from mixing with air inside the store. The Liebert CRV creates the same type of air curtain, the only difference is the flow is horizontal, not vertical as shown in Figure 6.



Vertical air curtain commonly seen at grocery stores entrances to keep inside and outside air separated.

Image source: macspares.co.za



The Liebert CRV's horizontal air curtain (green arrows) prevents hot air from being drawn down the cold aisle. This air flow simulates cold aisle containment doors.

Figure 6. Liebert CRV creates a barrier of cold air at the end of the cold aisle to prevent hot air from entering.

When standing in front of the unit it may feel like a lot of air is being used to create the horizontal air curtain. In actuality, only a small amount of air is being used. It feels significant due to the Venturi effect increasing the velocity of the air at the baffle exit. In addition, while some of the air used to create the air curtain is lost to the room, this approach is still many times more efficient than using larger fans to overfill the cold aisle to keep the hot air out.

- 4. Temperature Profile:** When using a row based cooling solution, the temperature of the air that leaves the air conditioner is near the temperature of the air that enters the server racks, but it is not the same. You can actually feel a temperature differential as you move through the height and length of the cold aisle. This temperature change is normal and acceptable as defined by the ASHRAE guidelines to maintain 64°F to 80°F entering air conditions for servers.

Supply Air Baffle Benefits

Now, let's refocus our attention from the technical design aspects of the supply air baffle system and look at the overall benefits it provides. As shown in Figure 7, there are several performance and efficiency benefits.

Prevents hot spots: The most obvious benefit the baffle provides is that it directs the cold air where it is needed to prevent hotspots.

Adjustable: The modular baffle system can be adjusted to direct air left, right, or both directions depending on where the Liebert CRV is installed within the row. This adjustability exists because cooling needs change over time. This provides the same type of flexibility that floor tiles offer for under floor cooling.

Need to move less air: Since we can focus the cooling towards the server rack equipment, we are able to adjust the speed of the fans to output the same amount of air that the servers are requiring using our advanced iCOM control system. This eliminates having to move excessive amounts of air to overcool an entire row of racks, which in turn allows for the use of smaller fans.

Smaller Fans: By directing all the air towards the server racks and not losing large amounts of air to the room, we are able to use smaller fans. Smaller fans consume less energy.

Save Energy: By using smaller fans, the unit consumes less energy and therefore cost less to operate. Even if a larger fan slows down to the same level as a smaller fan, the larger fan still consumes more energy.

Minimizes Mixing: By not overfilling the cold aisle with air, we are not losing air to the room that will eventually enter the hot aisle and reduce its temperature. The hotter the air that enters the air conditioner, the more efficient it will operate.

More friendly work environment: By moving less air without compromising on cooling performance, it makes the cold aisle a more friendly work environment by not blowing a large volume of air at people.

Reduces Noise: The majority of sound that is emitted from an air conditioner is generated from the air passing through it. By reducing the amount of air that travels through the air conditioner, the sound level is greatly reduced. The Liebert CRV is actually quieter than a full rack of blade servers. This means that a Liebert CRV will not increase the noise level in a data center when installed next to racks of operating server equipment.

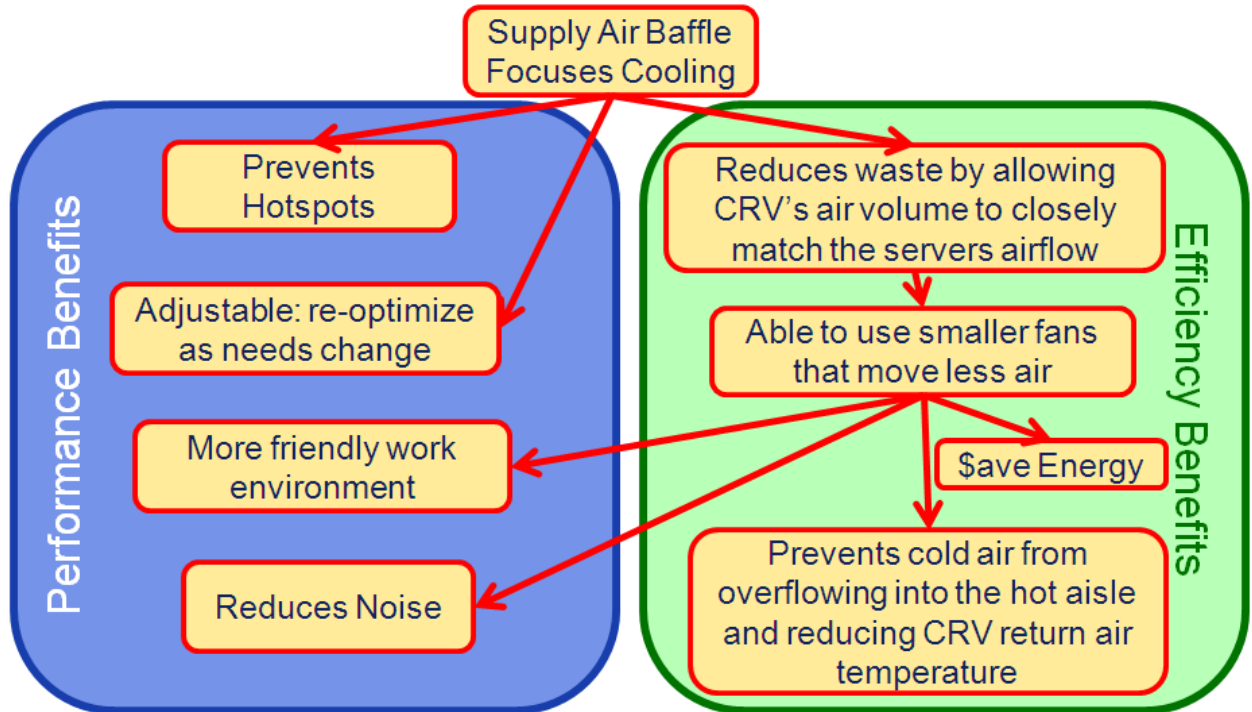


Figure 7. Performance and efficiency benefits of the Liebert CRV modular, field-adjustable supply air baffle system.

Additional Resources

If you would like to learn more about the Liebert CRV baffle system, please visit AMP for more information.

- On AMP search, "*Liebert CRV audio training supply air baffle system*" for a narrated PowerPoint training on how to adjust the baffle system for optimum performance and benefits it provides.
- On AMP search, "*Liebert CRV Airflow Comparison Animation*" to see a short video that shows how the Liebert CRV baffle system directs supply air compared to row based unit without a baffle system.
- On AMP search, "*Liebert CRV Baffle Animation*" to see a short video that shows how a baffle segment is easily adjusted by removing two screws.

