ENCLOSURE HEAT DISSIPATION

DATA CENTER SOLUTIONS

A White Paper by Great Lakes Case & Cabinet Company

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Introduction

Dangerous heat levels inside an enclosure threaten to jeopardize the life of an operating system. Though the problem of excessive heat in enclosures is not new, developing a solution to cope with new high density equipment is. In the past, users implemented temporary fixes when legacy equipment experienced unacceptable temperature gradients. Today's enclosures must account for the demands of high power consumption due to a recent, dramatic increase in transistors that augmented processor speed. The result is an elevation in heat production and the eventual failure of equipment, demanding the creation of a stable, adequate, and long term solution to cabinet cooling.

Evolution of the Cooling Problem

True to Moore's Law, stating that the number of transistors located on a square inch of integrated circuit will double every 18 months, computer equipment manufacturers have installed more processors in smaller physical space, compounding the amount of heat generated in an area and raising it to dangerous levels. In a standard rack, levels are considered dangerous when they increase past 2-3kW.

In the late 1990s, heavy users of technology began to question the cooling methods for rack mounted data processing equipment when servers near the top of the rack began failing once they reached these dangerous heat loads.

Temporary Solutions

Operators began employing short term solutions to maintain the integrity of the computer room; however, none were sufficient to provide consistent cooling. The majority of "quick fixes" included:

- **Air Condition Systems –** Lowering the temperature of the computer room temporarily solves the issue, but it does not have the capacity to adequately cool high density equipment. Deficient air flow prevents consistent cooling, particularly at the top of the rack.
- **Ambient Raised Floor Plenum –** Manufacturers used external, ambient air generated by internal fans to force airflow through the enclosure and out the top. Yet air entering the equipment case did not generate a great enough heat transfer from the equipment to the existing air.

An Ideal Solution

As the use of high density data processors grew, so too did the number of reported overheating failures. Manufacturers conducted analysis based on the reported server failures and found, for optimum performance, an enclosure should meet the following five standards:

- ☐ **Deliver constant and consistent air throughout full length of the rack**
- ☐ **Compatible with existing data centers to prevent disruption of existing IT equipment**
- ☐ **Maximize use of existing air conditioning infrastructure**
- ☐ **Eliminate airflow restrictions within the cabinet**
- ☐ **Cools up to 10 kW per cabinet with 65˚F inlet air and 35˚F temperature rise through the equipment (ΔT of 35˚F)**

What the Market has to Offer

A market for server-cooling solutions rapidly emerged based on the results from reported cases. Manufacturers flooded the market with new products. Yet, their remedies varied in capability and carried potential risks for causing failure or damage to critical computer and cabinet infrastructure. **Table 1** illustrates various solutions operators may utilize and the risks and shortfalls associated with each.

Table 1 – Proposed product solutions

Product	Intent	Risk/Shortfalls
Door Fan Enclosure	• Mounts to the doors of cabinets to draw cool air through the servers	• System does not eliminate the temperature gradients at the front of the servers • Draws warm, mixed air through the servers instead
Rooftop Modular Air Conditioning	• Designed to sit on top of computer cabinets and deliver 55˚F air into the cabinet	• Refrigeration equipment on top of production equipment compromises up time • Potential exists for compressor failure; wiring or relay problems; refrigerant charges; redundancy issues; substantial cost; long lead time for parts • Reports of 55˚F delivered to new generation servers causing condensation on processor boards
Chilled Water Loops	• Chilled water runs through lines installed within cabinet infrastructure • 55˚F air distributed to enhance system performance and reduce heat loads	• Prevalent risk of water leak • Water treatment program must prevent pitting and scale buildup • Lag time for maintenance and retrofitting of system • Expensive service agreements and elevated insurance costs • High installation costs and moving costs should room need reconfiguration • Air cooled cabinets costs nearly 18 percent less than water cooled
Chimney Effect	• Remove 5kW of heat from cabinet using an adjustable plenum plate in bottom of the cabinet • Introduction of cold air through raised floor tiles cut into the pressurized sub floor • Cold air sent from bottom to top of enclosure, exiting from two rows of three fans	• Cutting into raised floor tile causes a reduction of pressure in the plenum • Five kilowatts is not a sufficient amount of heat removal • Servers with air intake from the front and exiting in the rear create a chaotic airflow pattern that causes a dangerous temperature gradient

Emerging products on the market provided temporary relief to overheating; however, a complete solution, void of risks and shortfalls, was not produced.

Great Lakes Case & Cabinet Company: Lake Effect Enclosure

Based on the previous specifications, Great Lakes Case & Cabinet Company recognized that the computer cabinet can be an integral part of the solution to cooling equipment. Using this knowledge, they developed **the Lake Effect Enclosure** - the first complete solution to hit the enclosure market.

Its patented technology thoroughly meets the ideal standards by providing a consistent temperature curtain at the front of the enclosure by utilizing the coldest air above the raised floor.

☑ **Deliver constant and consistent air throughout full length of the rack**

Essential: Heat transfer is critical. Air delivery to the inlets of the equipment must maximize heat transfer.

- Cooling air not drawn internally through the equipment will not effectively cool – computer supply fans do not have enough power to pull air from the cold aisle through mesh doors to cool higher density enclosures
- Air temperature is ideally a few degrees above dew point to provide the lowest processor operating temperature without condensation
- No cooling air is needed in a rack's blank spaces or non-heat generating equipment – i.e. patch panels

The Lake Effect: Creates a usable air environment – as shown in Figure 1.

- The enclosure employs an 1/8" static, pressurized plenum – **within the enclosure** – not only directing the air intake of the servers, but also providing complete control of large air quantities delivered in the enclosure
- Utilizes high performance vanaxial fans, originally designed for the aerospace industry, to generate the correct air quality, pressure, and temperature from the top of the enclosure to the bottom without modification to the raised floor environment
- The enclosure draws air from the coolest part of the room, near the floor, ensuring the coldest air is delivered to intakes
- Drawn air is delivered at a constant temperature because it does not mix with ambient room air
- No recirculation of air from the hot aisle because of the Lake effect door design

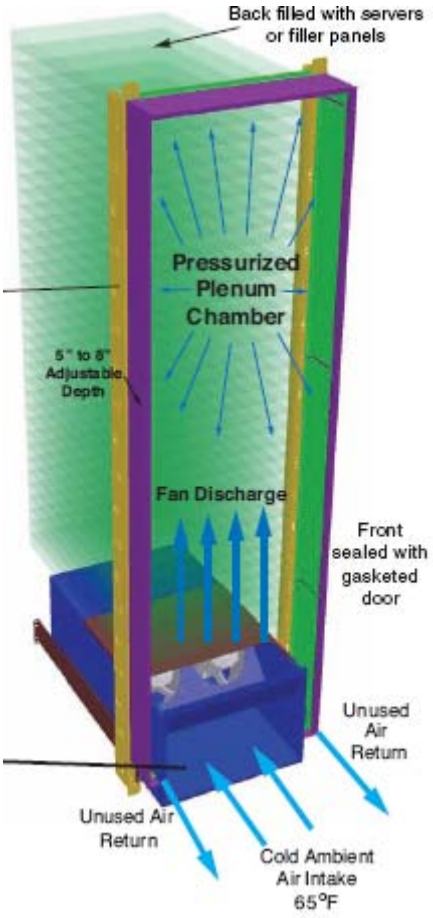


Figure 1 – A 7 RMU fan box creates a positive, usable air pressure environment by working with a three-sided adjustable depth plenum sealed to the front door, satisfying up to 10 KW of computer load and a consistent 65˚F temperature.

☑ Compatible with existing data centers to prevent disruption of existing IT equipment

Essential: Ensuring the enclosure consistently operates with the introduction of new generations of technology and within the diverse range of equipment developed by manufacturers

- Operators run a high risk of implementing data processing equipment that is obsolete because technology is developed and released rapidly
- Constrained by time and budget limitations, a functional, compatible enclosure for data systems becomes critical to operating without interruptions to business and extensive infrastructure improvements

The Lake Effect Enclosure: Requires no infrastructure changes to install and provides high quality, affordable, and easy-to-implement installation

- Does not require additional piping, duct work, or floor modifications called for by certain high density cabinet systems
- Enclosure can be placed on an existing data center floor, configured with servers and operate immediately
- The Lake Effect features numerous innovations including:
  - Two long life vanaxial fans, each rated at 115Volts/.9 Amps
  - Advancements in cable management
  - Numbered rails for “RMU” identification
  - Integral ground lugs
  - Welded 14 gauge steel enclosures, capable of supporting up to 2,000 pounds of rack equipment
- Reduces operating costs by eliminating equipment failures and optimizing performance of data room air conditioning systems

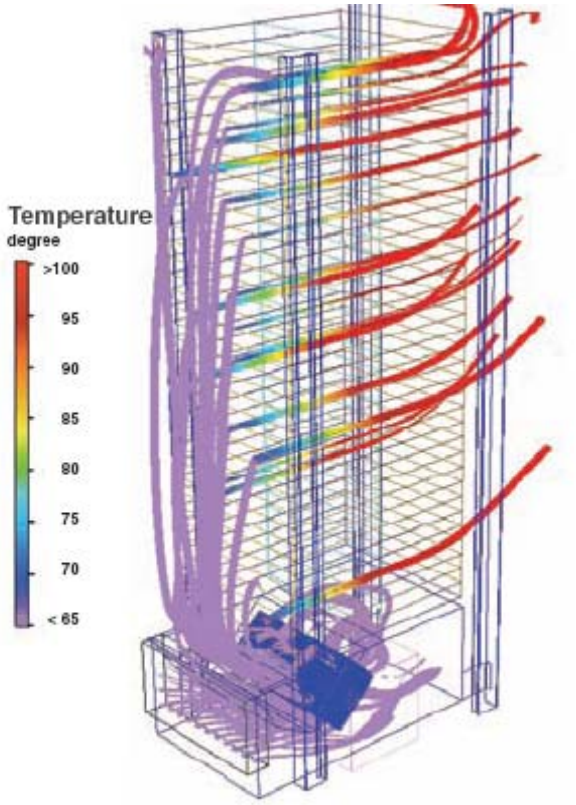


Figure 2 – Two vanaxial fans distribute an even flow of low temperature air to the front intake face of the servers, generating the correct air quality, pressure and temperature from the top of the enclosure to the bottom without modification to the raised floor environment

☑ Maximize use of existing air conditioning infrastructure

Essential: Eliminate unacceptable temperatures in high density areas when air conditioning systems do not run at capacity

- Problems arise with existing raised floor plenums because of obstructed air flow, low static pressure, and mixing of computer exhaust with inlet air
- Computer Room Air Conditioner (CRAC) units operate most efficiently with high return air temperatures
- Design capacity jeopardized when air bypasses equipment inlets and returns to CRAC units at cooler temperatures

The Lake Effect Enclosure: The pressurized plenum directs cooling air to the inlets of the data processing equipment, ensuring maximum heat transfer occurs and CRAC units operate at maximum efficiency and capacity

- The enclosure makes efficient use of air conditioning capacity without needing additional A/C equipment
- The Lake Effect functions on a non-raised floor as well, drawing air from the same cool, floor-level air
- Fans assist applications using ceiling air conditioners, helping to force cool air to the floor and supporting the law of thermodynamics, which confirms that “cold air sinks”

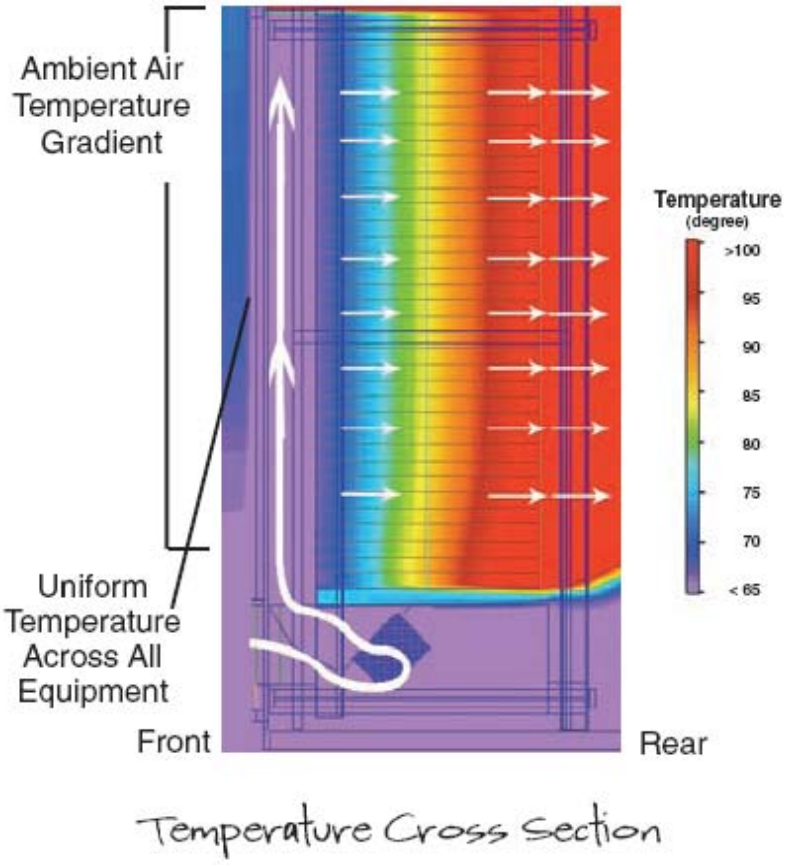


Figure 3 – Temperature gradients throughout the enclosure are eliminated because of the pressurized front plenum chamber and vanaxial fans that direct airflow of up to 1,224 CFM to the intake of the servers

☑ Eliminate airflow restrictions within the cabinet

Essential: Air must flow unobstructed to the inlets through equipment and back to the CRAC

- The lowest server can block air brought in through floor cutouts, reducing not only cooling, but static pressure under the floor as well as air flow
- Cabling systems must allow the flow of exhausted hot air away from equipment

The Lake Effect Enclosure: Air drawn only from the cold aisle, eliminating the possibility for blockage associated with floor cutouts, to allow direct delivery to equipment air intakes

- The cable management system features a 12.5" section in the rear, housing a universal power strip bracket that accommodates any of the market's vertical power strips and accepts a vertical cable management lacing trough
- A divider panel separates power from data, further reducing air flow blockage from equipment exhaust, ultimately producing a cooler operating system with minimum failure rates

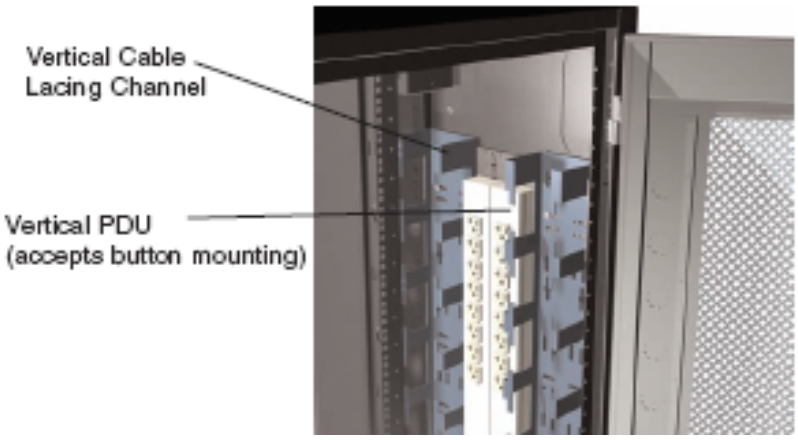
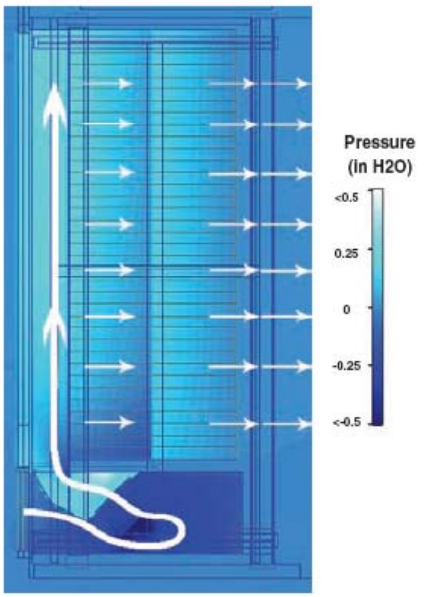


Figure 4 – The enclosure includes a 12.5" in the rear to house a universal bracket, concealed inside the frame and out of view to ensure easy access to the back of servers and sufficient air flow.

☑ **Cools up to 10 kW per cabinet with 65˚F inlet air and 35˚F temperature rise through the equipment (ΔT of 35˚F)**

Essential: Properly utilize air condition systems to provide 65F air without risking condensation buildup

The Lake Effect Enclosure: Air at 65˚F, directed at computer equipment inlets, will transfer enough heat to cause the proper 35˚F rise in air discharge for a cabinet with a 10kW load to function properly without risk of failure



Positive Pressure Cross Section

Figure 5 – The positive air pressure environment yields a consistent temperature curtain at the front of the cabinet without calling for chilled water, refrigerants, or other liquids that can jeopardize computer equipment.

Conclusion

The days of 35 watt per square foot data centers are obsolete. Today's data center facilities are designed and built to run at 65 watts per square foot, yet they don't operate at maximum performance because of antiquated equipment. The market supports and demands a solution to overheating high density data center equipment, and although temporary fixes are available, they do not guarantee equipment will function for the entirety of its life cycle.

The Great Lakes Case & Cabinet Company **Lake Effect Enclosure** offers the complete answer to data center questions by creating a usable air environment that satisfies up to 10kW of computer load and maintains a consistent 65˚ in the front plenum chamber.

The Lake Effect Enclosure offers revolutionary technology with easy implementation and low maintenance cost at an affordable price, allowing operators to conduct and manage their business without the worry of data center malfunction.