GREAT LAKES
CASE & CABINET

Invest in Solid Engineering

A Study in Efficiency

April 2011

WeRackYourWorld.com

Opportunity:

Great Lakes Case & Cabinet was offered an opportunity to work closely with a data center manager, IT, and engineering professionals in the development of a data center to be used for telecommunications, financial transaction processing and co-location. The data center manager will provide customers with a highly reliable and efficient facility which could accommodate their long-term needs. Great Lakes took a consultative approach to the project. A variety of questions and potential scenarios for deployment of enclosures within the data center space were presented.

Design Criteria:

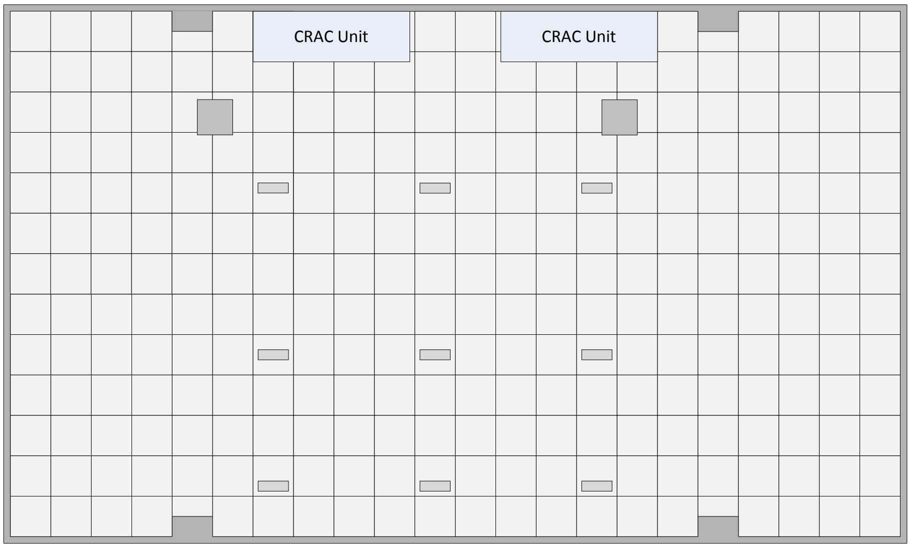
The data center manager wished to create a highly efficient and dynamic facility, one which would possess the capacity to adapt to network and cooling load changes without interruption. In addition to changes in network and cooling loads, they believed that the unused enclosures should not consume conditioned air. Those same enclosures however, should have the ability to easily “scale-up” whenever needed. They believed that network connectivity should not occupy any rack-mounted space within the enclosure; nor should it be allowed to interfere with airflow or equipment maintenance.

The Facility:

This metropolitan data center is located on the sixth floor of an office complex in Pittsburgh, Pennsylvania. The facility consists of a rectangular layout, measuring approximately 5′L x 28′ W x 8′H with a 12″ raised floor and a drop ceiling. The climate characteristics of the region made the inclusion of water-side economizers a highly attractive prospect. A water chiller package that contains dry contact air side economizer was installed on the roof and connected to two 26 ton chilled water CRAC (computer room air conditioner) units. These were configured to provide redundancy to system operations.

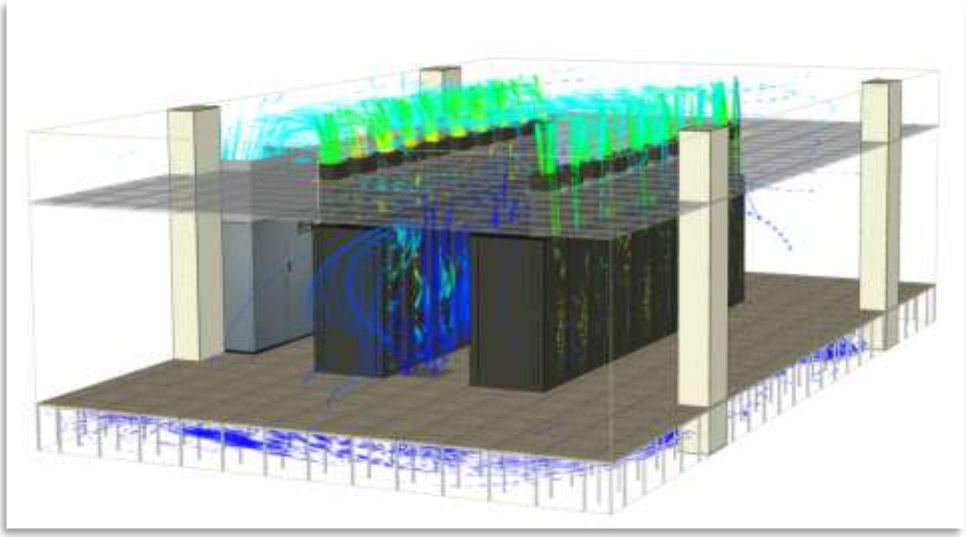
Room Layout

- 1144 sq. ft.
- Raised floor
- Drop ceiling
- Two, 26 ton CRAC units



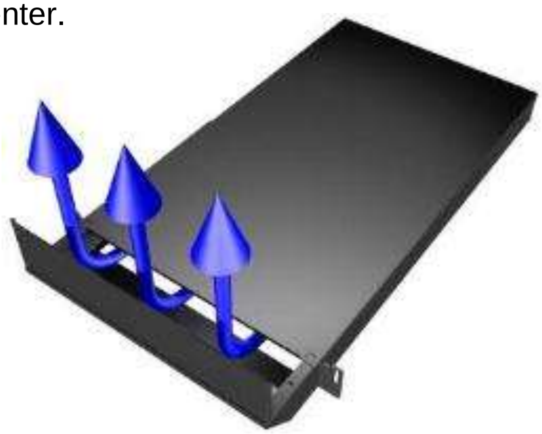
A Unique and Innovative Approach with an Emphasis on Containment

After a detailed process of interviews, discussions and site visits, combined with a comprehensive review of the criteria provided by the end user, Great Lakes worked to develop an approach which would maximize the infrastructure planned for the space. Great Lakes' goal was to focus conditioned air (generated within the facility) where it is needed most, at the intake of rack mounted equipment. At the same time, the design criteria included the minimization of any wasted cooling or bypass airflow and the containment of exhaust, which would then be channeled back to the CRAC return.



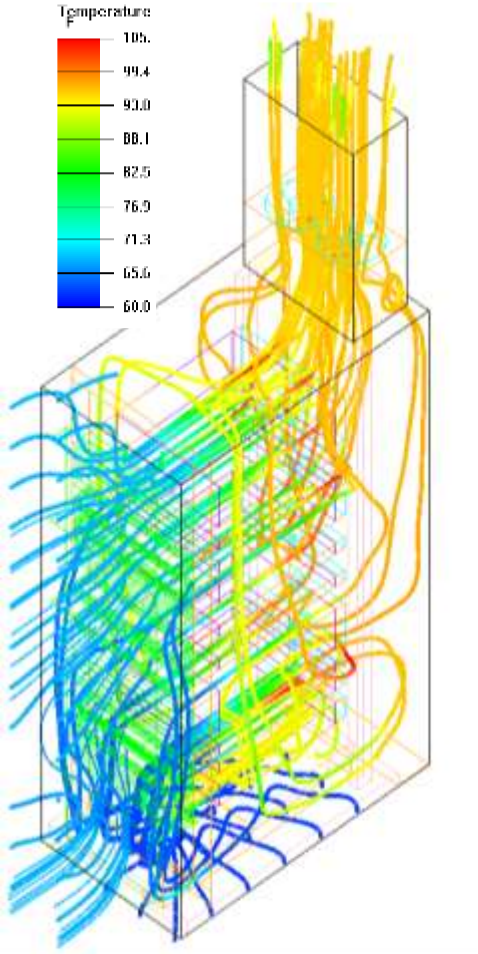
Rendering of the facility showing the full data center cooling solution. Air is forced under the raised floor and blown through the vents and the air manager, where it is consumed by the equipment, heated, then it returns via the ceiling plenum to the CRAC unit.

To accomplish the goal, Great Lakes proposed the use of its proprietary air manager (AMES), which mounts to the bottom of the ES Series enclosure, thus, "managing" the flow of conditioned air into the enclosure, inside the door and in front of rack-mounted equipment. An adjustable slide allows the amount of air to be adjusted, as necessary, while maintaining raised floor pressure throughout the data center.



Rendering of Air Manager showing air flow

Great Lakes Air Manager (AMES)
front view



CFD analysis showing the air manager/chimney/ brush grommet kit solution

The proposed configuration would also include an option for a brush grommet kit (BGRK30), designed to direct conditioned air, and to restrict heated exhaust from recirculating throughout the enclosure through the use of grommet along the rails covering the open area between the rails and side panel. The grommet is easily installed with tool-less hardware and mounted directly to the rails without sacrificing any equipment mounting space between the rails. This is accomplished through the use of Great Lakes' flexible mounting profile (FMP), a series of mounting points on the rail outside of the RMU mounting pattern.

Cross section view of the proposed cooling solution using the chimney and air manager.

The proposed configuration utilized a chimney to redirect the exhaust from the enclosure back to the CRAC unit at the highest possible temperature, thereby increasing the system's thermal delta and achieving a higher rate of efficiency. For higher CFM (cubic feet per minute) requirements (higher loads), fan units (AM-FTES30) consisting of two 6-inch van-axial fans add 600 CFM of intake and exhaust to each enclosure.

The concept behind the configuration proposed by Great Lakes, reduced the amount of "whitespace" (open area that does not have active equipment running and therefore, does not need cooling). By reducing the amount of whitespace being conditioned, less energy is used by the HVAC (heating ventilation and air-conditioning) system, resulting in higher efficiencies and greater capacity to cool equipment.

The room design consisted of a 12-inch raised floor with CRAC units providing conditioned air via vented tiles in the data center. The design required using several small vents in the cold aisle and in the hot aisle. These vents are installed to provide supplemental cooling to the equipment and to the room.

The enclosures were configured with exhaust chimneys and the Great Lakes air manager (AMES). Each enclosure was placed on a raised-floor tile with a custom cut-out to provide airflow to the air manager. The enclosures were set-up in two rows of ten in a standard hot aisle/cold

View of the ceiling plenum with cut-out and installed chimney.

CRAC unit with plenum installed in the ceiling plenum for hot air intake

aisle configuration. This configuration allows the data center manager to scale the amount of cooling being delivered to equipment based on the amount of load or, to close the air manager and redirect cooling when the enclosure is not populated.

The enclosure chimney (GL-EC-42-1832) was installed to direct exhaust air into the drop ceiling which acts as a plenum return duct to the CRAC unit.

The overall approach proposed by Great Lakes was designed to be passive in nature and to minimize the amount of power required for infrastructure. In certain enclosures, where the load within any given enclosure was anticipated to be higher, fans could be installed in the air manager and exhaust chimney to create higher ventilation and to properly accommodate the needs of the higher load.

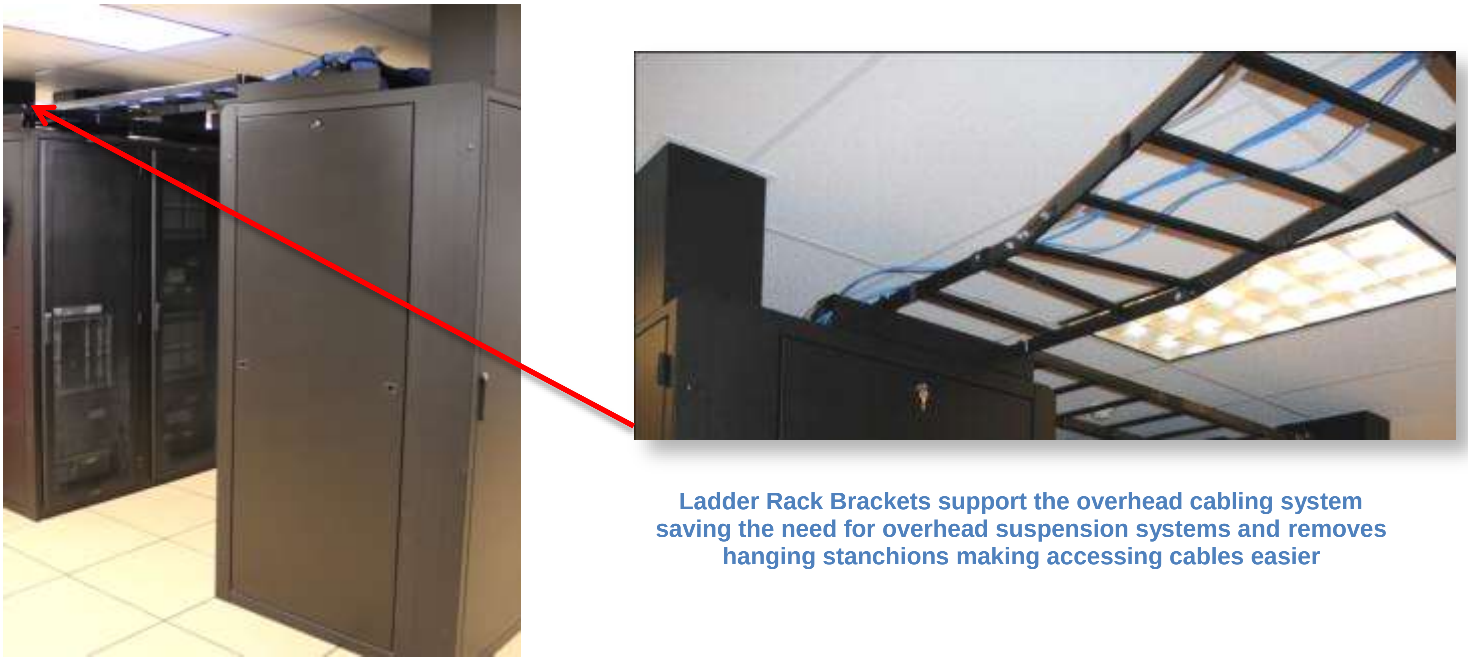
Enclosure Layout

- Enclosure **GL780ES-3042**
- Chimney **GL-EC-42-1832** (fan option on some)
- Ladder Rack Bracket **LRB-12**
- Solid Rear Door **7083-29**
- Brush Grommet Kit **BGRK30** (option on some)
- Air Manager **AMES** (fan option on some)
- Mesh Contour Front Door **7802E-MC29**

Power and Connectivity Infrastructure

Connectivity – Network Cabling

It was decided that ladder rack was to be used to provide network connectivity to the enclosures while power would run under the floor, segregating power from network cabling to avoid EMI (electromagnetic interference). Great Lakes Ladder Rack Brackets (LRB-12) were installed on top of the enclosure creating a platform for the ladder rack. Knockouts in the top of the enclosure provided cable entry reducing infrastructure costs and installation time as no overhead mountings were needed to support the ladder rack.



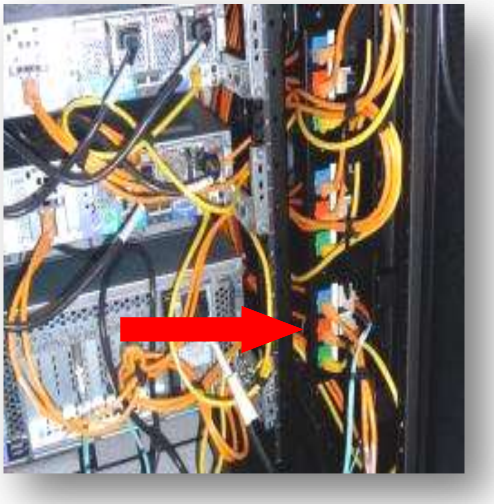
Ladder Rack Brackets support the overhead cabling system saving the need for overhead suspension systems and removes hanging stanchions making accessing cables easier

RMU – The most valuable real estate in the Datacenter

RMU (Rack Mount Units) can be thought of as the most valuable real estate in a data center. The use of RMU for anything other than servers and networking equipment required to perform business functions is not economical. For this reason, the data center manager decided that no RMU were to be used for network cabling. Instead, custom patch panels were created to mount to the outside of the rails. This solution provided network cable access to the equipment front or back. Custom length patch and power cords were used to eliminate slack; thus reducing the amount of airflow obstructions.

View of an enclosure using vertical patch and custom cable lengths

Cabling run from overhead to vertical patch installed toward the enclosure front which supports core switch



Zero RMU mounting of patch using Vertical Patch Panel

Power – PDU mounting and monitoring

The data center was designed with an A/B power bus. Equipment with dual power supplies, will operate without interruption should either a single bus or power supply fail; the second or "failover" will remain. By using a 30-inch wide enclosure, the installed rack mount PDUs (power distribution units) did not interfere with the RMU pattern making upgrading and maintaining equipment in the enclosure easier. The PDUs were installed in the rear corners of the enclosure. They were connected to the respective bus underfloor. The facilities team chose metered PDUs, which not only display the current voltage and amperage locally via LCD readouts, but are also IP addressable and may be monitored and logged remotely. This monitoring/metering gives the facilities and IT teams the ability to measure the usage of a specific enclosure or piece of equipment and helps to ensure that the three phases of each bus are operating "in-phase" (with the same amount of amperage per phase as most utilites charge per highest phase). It also allows them to calculate the efficiency of the data center as a whole.

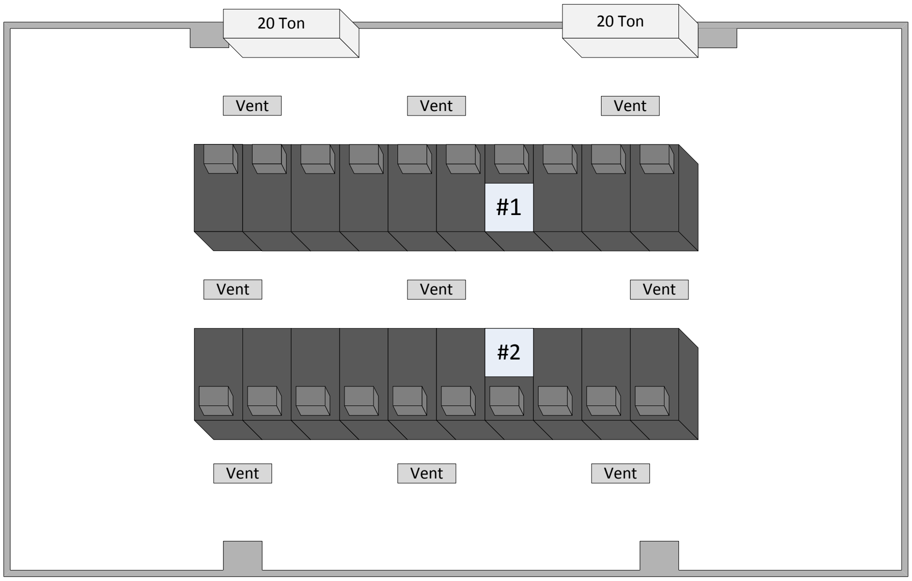
Metered PDU readouts help balance phases and calculate power usage

2011 Data Center Performance Review

The data center was fully commissioned in 2008 and has been running without interruption since. In 2011, Great Lakes was invited to come back and survey the data center performance.

The facility power envelope is currently operating at 21.6kW total load with 80kW UPS (uninterruptable power supply) capacity. The CRAC units in the room were ‘dialed-down’ to the lowest blower settings. The settings were as follows: Room Temp: 72^{o}F, Humidity: 29%, and Discharge Air: 66^{o}F. By using IT load data from metered PDUs, we were able to derive the facility load of 15.9kW using the current data center efficiency metric, PUE (Power Usage Effectiveness). The total facility load was divided by the IT load, resulting in the following: 1.36 PUE.

$$\text{PUE} = \frac{\text{Facility Load}}{\text{IT Load}} \qquad \frac{21.6kW}{15.9kW} = 1.36$$



	Rack # 1	Rack # 2	Delta Rack #1/#2
Intake Temp. °F	57.1	55.9	1.2
Exhaust Temp. °F	71	81.2	10.2
Delta	**13.9**	**25.3**	**11.4**

Cost Savings in Lower PUE (yearly)

	IT Load (kW)	**PUE**	**Total Load (kW)**	**Cost per kW/hr**	**Yearly Cost**	**Savings**
National Avg	**15.9**	**1.7**	**27.03**	**$0.088**	**$20,551.45**	**0**
	15.9	1.6	25.44	$0.088	$19,342.54	$1,208.91
	15.9	1.5	23.85	$0.088	$18,133.63	$2,417.82
Datacenter	**15.9**	**1.36**	**21.624**	**$0.088**	**$16,441.16**	**$4,110.29**

Enclosure Performance

As part of Great Lakes survey of their data center performance, two of the enclosures were examined. The first, using the standard configuration mentioned earlier, and the second using an active cooling system with fans installed in the air manager and chimney. Additionally a brush grommet kit was installed along the front rails to prevent by-pass airflow. The choice of the two enclosures was based on similar load as well as proximity to the CRAC unit to maintain consistent under-floor pressure and temperature. The racks are highlighted in the layout above (see chart on pg. 8). An anemometer was used to measure airflow and temperature. The results were then calculated to determine CFM from the enclosure intake and chimney exhaust. It was determined that while the air manager provided a large amount of the CFM needed, the equipment was drawing conditioned air from the vents installed in the aisle. This result was in line with our original testing and it should be noted that the use of solid front doors is not recommended for use with the air manager. However, the air manager greatly improves efficiency by creating a consistent intake temperature across the entire RMU in the front of the enclosure.

Anemometer showing feet per minute and air temp in Farenheit

The notable difference in the enclosure temperature Δ Delta, is related to the brush grommet kit (BGRK30). By preventing by-pass air, the conditioned air was better utilized by the equipment resulting in higher exhaust temperatures. If no grommet is used, the conditioned air by-passes the equipment intakes and mixes with the exhaust air. Thus, resulting in cooler exhaust temperatures which affect the overall performance of the data center HVAC system. This facility utilizes free cooling and rarely uses mechanical chillers, therefore by-pass air has only a negligible effect on PUE. However, in scenarios where the mechanical system is used, PUE would be negatively impacted, making the need for segregation of conditioned and exhaust air highly important.

Conclusion

In conclusion, this is an excellent example of what can be achieved in modern data center design. The proposed cooling solution significantly reduced the amount of whitespace cooling and was easily identified by the efficiency of the CRAC units operating in the data center. This allows for a much higher equipment load capacity than by traditional cooling methods which would have conditioned more air in the room as opposed to the equipment itself. The use of ladder rack brackets and ladder rack network cabling is easier to maintain as it rests above the enclosure itself. Also, initial cost and installation time were saved. The RMU per enclosure, saved by providing patching alongside the rails allowed the data center’s IT team to maximize the available hardware mounting space while reducing the amount of cabling obstructions that could inhibit exhaust air from exiting the enclosure. From a working environment, the room ambient temperature provided a comfortable environment for personnel to work in no matter which aisle. Feedback from the data center management team confirms the design implementation has exceeded the expectations of the planners.

Corporate Headquarters
P.O. Box 551 • Edinboro, PA 16412
1-866-TRY-GLCC • (1-866-879-4522)
Phone: 814.734.7303• Fax: 814.734.3907

Western Distribution
4750 Joule Street • Reno, NV 89502
Phone: 775.829.9913 • Fax: 775.829.9926

International
Aerbridge House
Unit 14 Dunshauglin Business Park
Dunshauglin Co. Meath, Ireland
+353(0) 1 825 8777
fax +353(0) 1 825 8778

ETSI Associate Member