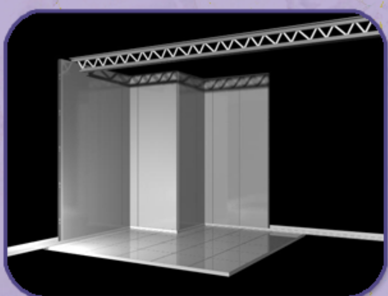
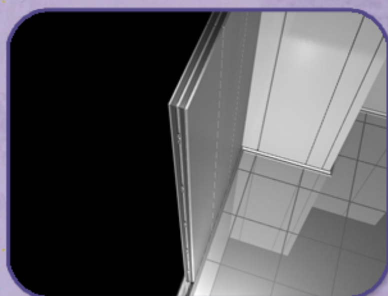
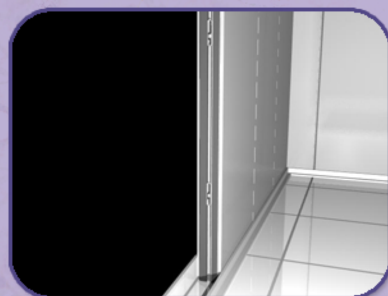
iFORTRESS

Modular • Structural Security™ • Solutions







FUTURE TECH

Delivering tomorrow's technology today!

Future Tech Enterprise, Inc. • 101-8 Colin Drive • Holbrook, NY 11741 • Tel: 631.472.5500 • Fax: 631.472.6599 • www.ftei.com

LAN
LAN ASSOCIATES SINCE 1965
ENGINEERING▪PLANNING▪ARCHITECTURE▪SURVEYING, INC.
445 GODWIN AVENUE, MIDLAND PARK, NJ 07432
201-447-6400 WWW.LAN-NJ.COM FAX 201-447-1233

Improved Data Center Cooling Efficiency within a MCF Series iFortress™ Sealed Enclosure

By Ronald Panicucci, PE
LAN Associates Engineering, Planning, Architecture, Surveying, Inc.

Today's modern data centers are large energy consumers, particularly with the movement toward higher density servers. As a result of the large energy consumption and the increased awareness of energy savings initiatives not only from the pure economic sense, but from the sustainable design perspective through the U. S. Green Building Council LEED programs and the joint U.S. Environmental Protection Agency/U.S. Department of Energy, Energy Star program, concern of improving data center cooling efficiency is rapidly increasing.

The total power requirement for a data center includes the IT/computing equipment itself along with the lighting, UPS losses, and air conditioning loads including the cooling units, heat rejection units and circulating equipment such as pumps and fans. According to the Uptime Institute, a typical data center has an average power usage effectiveness (PUE) of 1.8. This ratio is down considerably from the Uptime Institute's previous report of 2.5 due to the industry's increased awareness and implementation of energy saving tactics. The PUE metric championed by The Green Grid compares a facility's total power usage to the amount of power used by the IT equipment, revealing how much is lost in the cooling and circulation systems. At a PUE of approximately1.8 to 2.0, electricity consumption for cooling accounts for 1/3 of the total datacenter power consumption. Therefore, any improvements in cooling system operating efficiency can have a significant cost savings impact.

The cooling systems designed for today's data centers must operate continuously 24/7. The systems must remove heat produced by the electrical equipment, to prevent it from reaching an unacceptable level. The heat generated by the data center is the combination of heat generated by the data processing equipment, along with the infrastructure and support equipment including UPS, power distribution, air conditioning, lighting and occupants. The overall load is determined by the electrical load of the equipment and factors for lighting and occupants, typically expressed as watts/sq. ft. or watts/person. Data center cooling equipment is designed to provide air to the inlet of the computer equipment that ranges from 68° F to 77° F, with a relative humidity of 40% to 55%.

Building Envelope Losses

The load determination above ignores sources of environmental heat such as sunlight through windows and heat transferred though the building, and/or data center envelope. For small data or network rooms which do not have walls or windows to the outside, the building envelope effects can be ignored. However, for moderate to large data centers which typically have walls or a roof exposed to the outdoors, additional heat loads must be added to the design capacity of the air conditioning system. The parameters to be considered in the additional loads imposed by the building envelope include thermal resistance (insulation), thermal mass (heavy construction such as concrete versus light-weight steel), air-tightness, and moisture permeability.

Besides the added potential heat gain from exterior sources, the data center envelope of a conventionally constructed facility is subject to cooling losses. Valuable cooled air can be lost through floors, walls and ceilings as well as the many typical utility penetrations. It is common practice to oversize the cooling system by as much as 30% to overcome these losses, particularly in raised floor environments where a floor plenum must be pressurized to provide sufficient flow across the raised floor area while the under floor area is a popular location for cable, conduit and piping penetrations as well as potential breaches from past uses or tenants and other building modifications.

Humidity

Another important cooling load factor is humidity. A data center's cooling system can be operated more efficiently by sealing the room to control humidity and reduce the infiltration of humidity from outside. When the environment within the data center is at a lower humidity level than the outdoor space, the humidity levels will work to achieve equilibrium between the two spaces. The datacenter floors, walls and ceilings of a conventionally constructed data center will allow humidity to enter through porous surfaces, penetrations, cracks and other openings. The amount of humidity that can enter the data center space is dependent upon the amount of open area and difference in humidity and temperature between the spaces.

Besides cooling, the air conditioning system provides control of the data center humidity. In an ideal situation, once the specified relative humidity is achieved, the air conditioning equipment would operate without the need to add water. However, due to the cooling of the air by the air conditioning equipment, the temperature is reduced below the dew point, and moisture is removed as a result of condensation. Then, to achieve the desired minimum relative humidity, supplemental humidification is performed. This supplemental humidification is an additional heat load with must be factored into the design capacity and operation of the system and can lead to an overdesign of up to 30%.

Improved Efficiencies Within a MCF Series iFortress™ Sealed Enclosure

As a general, overall rule, it is good practice to size a cooling system for small data or network rooms based on a factor or 1.3 times the total anticipated equipment load, plus an added capacity for redundancy. However, for larger data centers, air will pass into the interior of the data center, through cracks and other unsealed openings in the building and data center envelope. The primary areas of leakage tend to be at gaps around windows and doors, joints in building façade elements, wall/roof junctures, utility penetrations and other areas where it is difficult to develop an air-tight seal. This type of leakage and losses is typical for many of today's larger data centers and is common for co-location type facilities which are often constructed within large warehouse or industrial type buildings rather than in better constructed commercial or office type spaces. Such leakage will have a negative impact on indoor temperature and humidity, must be accounted for in the design process, and provides for an area of improvement to increase the efficiency of conventional air conditioning systems.

The analysis described above takes into consideration the rated equipment loads, peak demands and steady-state conditions that are just representative "snapshots" of data center performance. However, this simplified analysis does not provide the designer with information regarding the dynamics of indoor temperature and humidity, two of the most crucial factors necessary to accurately design an efficient data center cooling system.

One means of eliminating the dynamic factors and simplifying the design is to construct the data center within a MCF Series iFortress™ sealed enclosure. The MCF Series iFortress™ is a well-insulated, air-tight, water-tight, hermetically sealed enclosure, and by constructing a data center within such an enclosure, the effects of environmental heat, infiltration and humidity fluctuations can be reduced considerably, if not eliminated.

The example below compares the environmental heat load of a 5,000 square foot data center constructed conventionally to that of an iFortress enclosure with R-22 insulation and sealed construction. The analysis shows that the MCF Series iFortress™, which is a sealed assembly that provides an R22 insulation value, results in a sensible heat loss reduction of 60% over the conventionally built facility. Also, because the iFortress enclosure results in an airtight, water tight, hermetically sealed enclosure, infiltration is eliminated, thereby reducing the effects of fluctuations in humidity, providing for increased efficiency. Based on the reduction in environmental heat load alone, a minimum increase in overall cooling load efficiency of 9% can be expected (As indicated above, it is good practice to overdesign the system by 30%. The 60% reduction results in an overdesign of 0.3 x 0.6, or 0.18. A design factor of 1.18 compared to 1.3 is a reduction of 9%).

iFORTRESS/CONVENTIONAL CONSTRUCTION DATA CENTER COMPARATIVE

COOLING LOAD CALCULATIONS - FOR ONLY THE BUILDING ENVELOPE

LENGTH AND WIDTH (FEET)	**50**	**100**
CONNVENTIONAL BLDG HEIGHT (FEET)	**20**	
iFORTRESS HEIGHT (FEET)	**10**	
PERIMETER (FEET)	**300**	
(SF)	**5,000**	
ENERGY COST (PER kW HOUR)	**0.12**	
CONSUMPTION REDUCTION:	**60%**	

BASED ON STD GYP BOARD CONSTRUCTION/CONCRETE ROOF DECK
Standard Conventional Roof (R10)/Interior Slab (R2) r Value

	AREA (FT2)	PERIMETER (FEET)	HEIGHT (FEET)	U VALUE	DELTA TEMP (F)	WATTS/ SF	WATTS	SENSIBLE LOAD BTUH
		300	20	0.067	20			8,040
CEILING/ROOF	5,000			0.1	20			10,000
			SENSIBLE LOAD					**18,040**

BASED ON iFORTRESS CONSTRUCTION (R-22)

	AREA (FT2)	PERIMETER (FEET)	HEIGHT (FEET)	U VALUE	DELTA TEMP (F)	WATTS/ SF	WATTS	SENSIBLE LOAD BTUH
		300	10	0.05	20			2,727
CEILING/ROOF	5,000			0.05	20			4,545
			SENSIBLE LOAD					**7,273**

NOTES:

01. IT IS ASSUMED THAT THE COMPARISION IS FOR A SPACE WITH NO GLASS WINDOWS.
02. THE ABOVE CALCULATIONS ARE ONLY BASED ON BUILDING ENVELOPE.
03. TOTAL COOLING LOAD CONVERSION INTO KWH IS BASED ON 12,000 BTUH SENSIBLE LOAD = 1 TON)
04. A.C. UNIT ELECTRICAL CONSUMPTION HAS BEEN TAKEN AS 0.9 KW/TON

Dust and Dirt

In addition to the cooling system design factors discussed above, the presence of dust and dirt can cause a significant reduction in the quantity of circulated air. By eliminating dust and dirt, the pressure drop through the air handling systems is greatly reduced, providing for another potential energy savings. Experience shows that dust and dirt accumulation in filters and other parts of the cooling system will result in significant pressure reduction resulting in the need for additional fan power and energy consumption.

Constructing a data center within a MCF Series iFortress™ sealed enclosure will greatly reduce the infiltration of dust and dirt. By reducing the infiltration of dust and dirt, there will be a reduced need to clean or replace filters and more efficient air movement. Clean HVAC system surfaces will also result in greater efficiency of heat transfer.

Airflow and Distribution

Additional efficiencies can be gained by constructing a data center within a MCF Series iFortress™ sealed enclosure due to the ability to optimizing air flow. I addition to the typical improvements like rack arrangement and cable management, further efficiency is gained within an iFortress™ enclosure through improved capture of hot air for return to the inlet of the HVAC equipment when compared to ceiling plenum systems and some ducted arrangements.

In addition to the above note efficiencies that are gained by a sealed iFortress enclosure, there is virtually a 100% efficiency gained on the energy that is consumed to maintain a positive level of pressure within a conventionally built facility. This expense, along with the installation of vapor barriers within conventional walls, is a common practice used to maintain as “humidity free” an environment as possible for data centers, as well as reduce the infiltration of dirt and dust from adjacent spaces. Because the iFortress panels are engineered to withstand elements such as humidity and the assemblies are sealed, including all utility penetrations through the use of the iPortal panel, the pressure established within the assemblies is constant, and therefore, there is no need for these pressurization efforts. As such, this consumption of energy, used as a form of standard operating procedure in data centers, is entirely eliminated, thereby netting a 100% efficiency gain.

Higher Thermostat Settings

Finally, an additional cost savings can be recognized by constructing a data center within a MCF Series iFortress™ sealed enclosure by increasing the thermostat settings for the air conditioning equipment. Practice has indicated thermostat settings can be raised from 68^0F to 75^0F. The analysis below determines the annual energy cost savings, which results from this 7^0F difference. The analysis is performed on a facility with a 146 KW load, which equals approximately 500,000 BTUH.

Analysis: Maintain 75^0F in data center vs. maintain 68^0F in data center.

1 TON of cooling = 12,000 BTUH

Standard Design: CFM/TON = 12,000 BTUH / (1.08 x (75^0 – 55^0)) = 555 CFM/TON

CFM_1 = 500,000 BTUH / (1.08 x (75^0 – 55^0)) = 23,200 CFM

23,200 CFM / 555 CFM/TON = 42 TONS

CFM_2 = 500,000 BTUH / (1.08 x (68^0 – 55^0)) = 35,612 CFM

35,612 CFM / 555 CFM/TON = 64 TONS

Difference in Cooling Capacity = 64 TONS – 42 TONS = 22 TONS

Assume A.C. unit electrical consumption is 0.9 KW/TON for a chilled water system

Assume uniform cooling load of 500,000 BTUH, 24 hrs/day, 365 days/year (8760 hrs)

Assume an electrical cost of $0.12/KWH

Annual Savings in Electrical Energy Cost =

22 TONS x 0.9 KW/TON x 8760 hrs x $0.12/KWH = $20,814

Approximate savings of $21,000 per year