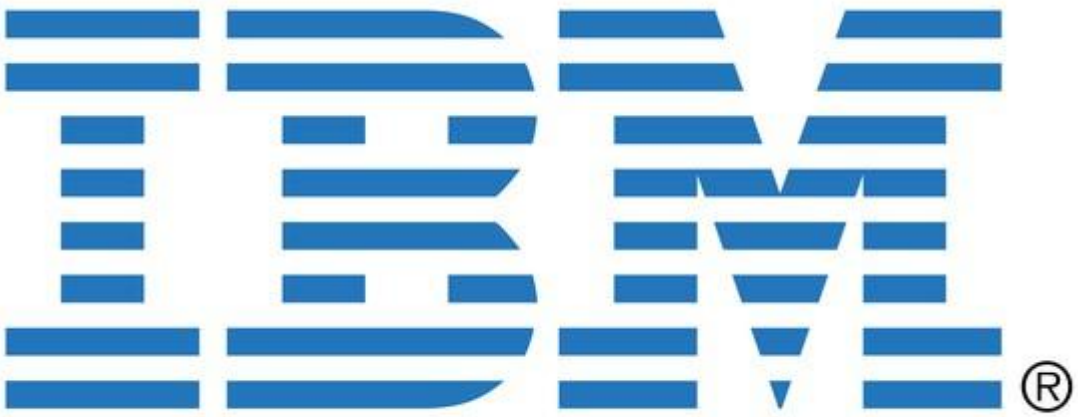
Technology Connection LLC:



Case Study: A New Style of "Samurai Containment™" for Raised Floor Environments in the Data Center Space

Location: IBM China System Center – DC1, Beijing

Objective:

Reduce Energy Cost & To Ensure Row A With IBM Mainframes Inlet Temperature Is Below 27.0°C

Performed by:

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Data Center Science (TC Exclusive Distributor) Partner

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Executive Summary and Project Overview

Technology Connection was engaged by Data Center Science (DCS) and Kequn Computer Technology (SH) Ltd (Kequn) to provide an energy savings solution to the data center space utilizing Samurai Containment™ (SC). This project was started on Monday December 3rd, 2018 and finished on Friday December 7th, 2018. The objective was to install TC Samurai Containment™ airflow tiles with subfloor air balancers (AB) to break down thermal layers in the cold aisle which creates a Containment Affect and provides cooler rack intake temperatures along with dialing up set points at the CRAH units and chilled water plant by a total of 3.0°C (16.0°C to 19.0°C) and to reduce CRAH EC fans speed to achieve energy savings with specific requirement to ensure Row A with IBM Mainframes inlet temperature is below 27.0°C. The entire process was documented and data points were taken by Technology Connection, Kequn and IBM to verify the success of the project and the energy efficiencies achieved.

Based on TC recommendation on August 18, 2018, after a Site Audit on August 1, 2018, chilled water temperature was increased by IBM in two (2) stages:-

1. **IBM raised the chilled water temperature by 2°C from 16°C to 18°C on November 18, 2018 prior to SC implementation in December, 2018.**

2. **On December 18, IBM raised the chilled water temperature from 18°C to 19°C.**

Results:

Average Inlet Temperature Pre-Install at the 1.52M Level:	**28.7° C**
Average Inlet Temperature Post Install at the 1.52M Level:	**26.6° C**
Average Drop of:	**2.1°C**

Annual Energy Savings Achieved: **CNY 230,582.29 (Objective was CNY 217,538.11)**

Project Cost (purchased reference site): **CNY 461,165.00**

Simple Payback: **24 Months**

SC Implementation For IBM DC 1 In December, 2018

Date	IBM Monitor/Time	IT (DC1+DC2) kW	DC1 EC Fans kW	Row A Average Inlet Temperature*	McQuay Chiller kW	Magnetic Bearing Chiller kW
3-Dec	9.59am Prior to SC	300.7	8.18	26.2°C/IBM 26.0°C	30	0
5-Dec	9.09am After TC Samurai Containment™ Tiles on 4-Dec	299.4	8.43	23.6°C/IBM 25.0°C	41	0
6-Dec	8.45am After AB on 5-Dec	300	10.1	25.3°C/IBM 24.1°C	44	6 (Heater on)
8-Dec	7.36am After RAT/EC Fans Speed Adjustments on Dec 7, 2018, CW = 18°C	300.15	8.72	25.7°C/IBM 25.0°C	43	8 (Heater on)
27-Dec	5.57am After CW adjustment on Dec 18, 2018 CW = 19°C	309.7	14.45	26.6°C/IBM 25.0°C	24	21

- **RAT – Return Air Temperature**
- **CW – Chilled Water**
- **AB – Air Balancers**
- **Average (DC 1 + DC 2) IT Load in December, 2018 = 302kW**
- *** Row A Average Inlet Temperature – From Testo 410-2 meter at 1.52m level / From IBM temperature sensor at Row A**

Results & Achievements:

Key Point # 1	**Row A Average Inlet Temperature Prior To SC at 1.52m Level on Aug 1**	**28.7°C**
	Row A Average Inlet Temperature After SC at 1.52m Level on Dec 27	**26.6°C (Target <27.0°C)**
	Average Temperature Drop	**2.1°C**
Key Point # 2	**Chiller Leaving Water Temperature Prior to SC on Aug 1**	**16.0°C**
	Chiller Leaving Water Temperature After SC on Dec 18	**19.0°C**
	Chiller Leaving Water Temperature Increase	**3.0°C (Target: 3.0°C)**
Key Point # 3	**CRAH #1, #2, #3 Fan Speed Prior to SC on Aug 1**	**65%, 70%, 55%**
	CRAH #1, #2, #3 Fan Speed After SC on Dec 27	**70%, 60%, 45%**
Key Point # 4	**CRAH #1, #2, #3 Return Air Temperature Set Point Prior to SC on Aug 1**	**24.0°C, 26.0°C, 26.0°C**
	CRAH #1, #2, #3 Return Air Temperature Set Point After SC on Dec 27	**26.0°C, 28.0°C, 28.0°C**
Key Point # 5	**PUE Prior to SC (August 1, 2018)**	**1.591**
	PUE After SC (January 3, 2019)	**1.222**
Key Point # 6	**TC Estimated Energy Savings After SC (Based on 101kW IT Load in DC 1 on August 18, 2018, CNY1.00/kWh & McQuay Chiller)** **Hence Estimated Yearly Energy Savings After SC (Based on 105kW IT Load in DC 1 & McQuay Chiller) on December 27, 2018**	**CNY217,538.11** **CNY230,582.29**

Additional Result & Achievement:

DC 1 InRow with Hot Aisle Containment	**After SC Implementation, CW = 18C, InRow Return Air Temperature Set Point @ 29.4°C on Dec 3**	**After SC Implementation, CW = 19C, InRow Return Air Temperature Set Point @ 35.0°C on Dec 27**	**InRow Fans Input Power Saved**
InRow Average Return Air Temperature	**29.6°C**	**34.9°C**	
InRow Fans Input Power	**3.01kW**	**2.45kW**	**0.56kW (18.6%)**

Annual Energy Savings for InRow Fans = 0.56kW*8760Hrs*CNY1.00/kWh = <u>CNY4,905.60</u>

Summary of Procedure

Current Site Conditions:

Upon arrival on August 1, 2018, this site had a total of 82 High Flow vented tiles to cool 73 IT racks – 28 IT racks cooled by traditional Cold Aisle Containment (excluding 26 IT racks cooled by InRow units with Hot Aisle Containment) that were placed in front of equipment racks. The temperatures throughout the cold aisles varied widely. The warmest recorded inlet temperature was 29.2° C at Row # A when a Site Audit was performed.

There was a significant amount of warm air mixing with cold air throughout the environment that was caused by several factors:

- **Large openings in unused rack space allowing hot air return fans to penetrate the cold aisle**
- **Equipment rows varied in length and some rows with voids allowing hot air to recirculate into the cold aisle**

This data center consists of traditional Cold Aisle/Hot Aisle arrangement, with Two (2) Rows in traditional Cold Aisle Containment and Two (2) Rows with Hot Aisle Containment using APC InRow 300mm units.

Hot air (apart from the two rows with Hot Aisle Containment) to the three CRAH units is using free common room return.

SC Implementation:

The installation process involved the installation of 45 TC Samurai Containment™ Tiles and the removal of 45 existing High Flow tiles in the cold aisles, 8 Air Balancers placed in the sub floor, and the relocation of some existing High Flow tiles. The placement of the TC Samurai Containment™ Tiles and Air Balancers had previously been determined by the software analysis from the initial assessment and current conditions found.

As part of the Installation process, a post installation report was prepared using temperature data points collected from the site before and after the solution was installed. These data points are used to document the airflow performance and efficiency of the current datacenter arrangement.

Airflow efficiency is directly correlated to the temperature and its ability to cool equipment. The cooler the airflow, the better it will be able to cool equipment. Temperature readings were collected using a Testo 410-2 meter at 1.52m level.

Before installation was started, our trained installation team recorded temperature readings from 22 established locations within the site, on December 3, 2018 at 10:00AM. After installation of TC Samurai Containment™ Tiles on December 4 and Air Balancers on December 5, these 22 readings were taken the next morning, allowing the entire data center to settle properly. The trend showed in improvement throughout the installation process as well as a baseline at the beginning and an established improvement summary at the end of the installation. Of the 22 daily readings taken, improvements were recorded from Pre-Install all the way through Post Install after the set point was raised for CRAH and chiller and EC fans speed adjustment. Of these 22 improvement points, an average improvement of 2.1°C in Row A was recorded. Client focus was to keep Row A inlet temperature to below 27.0°C.

Videos were taken after installing TC Samurai Containment™ Tiles & AB on December 6 to demonstrate the advantages of TC Samurai Containment™ Tile Vs traditional 25% Laminar Airflow tile.

TC Samurai Containment™ Tile shows the dollar note swirls in 360 degree while the 25% Laminar Airflow tile next to TC Samurai Containment™ Tile shows the dollar note remains idle on top of the tile, even though the under floor static pressure is the same.

TC Samurai Containment™ Tile moves the air upwards in 360 degree motion at low velocity and requires less static pressure than Laminar tile. The slow velocity allows server fans to suck in the cold air for cooling easily without having to increase fan speed, saving energy provided the inlet temperature is above 26.5°C.

January 15, 2019, Beijing