

Validation Report
HVFT and Annular Flow System Operation – Air-Conditioning Validation

Educational Facility
January through October, 2004

**Reporting the final findings of Commercial Air Conditioning System overview of:
Trane Commercial Air-Conditioning Systems**

**Baseline Operational Comparison to X-Stream® and A.R.M.E.D. ® Technologies
from XDX Innovative Refrigeration, LLC;**

**‘Before and After’ and ‘Side by Side’ Comparisons in Various Ambient Conditions
were Analyzed.**

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Executive Briefing:

Abstract:

Review of package air conditioning equipment was conducted with the effort to identify the possibility of utilizing the patented XSTREAM[®] technology from XDX[®] and achieve improved temperature and humidity, capacity increase, or energy savings. The test protocol ran baseline with the unit as existing and, upon confirmation of satisfactory operation, XDX[®] was then retrofitted and monitored, using temperature, humidity and power monitors.

This report is intended to:

- *Identify baseline system operation
- *Identify XDX[®] XSTREAM[®] operation
- *Identify improved performance and capacity
- *Identify operation during extreme conditions
- *Move toward better understanding of product capabilities
- *Open dialogue toward utilization of product / technology

Summary:

The goal is to demonstrate operation under all conditions to instill confidence in XDX[®] technologies used with XSTREAM[®] technology, with regard to improved performance and reliability. Equipment was found to be in good and operational condition.

Comparisons between baseline and XDX[®] are done mindful of matching like for like ambient temperatures and equipment.

The patented XSTREAM[®] technology from XDX[®] performed to expectation and is a desirable solution for the Air-Conditioning equipment.

An annualized energy reduction of **133,677.8 kWh, 72 kW Average, and 213.12 Maximum kW** were realized during this validation process.

Substantial energy and performance benefits were experienced. The report data supports that greater savings will be realized when Chicago experiences typical summer weather. An annualized energy reduction of 145,077.8 kWh, with a peak reduction of 213.12 kW Average may be experienced.

Results:

An annualized energy reduction of **133,677.8 kWh**, **72 kW Average**, and **213.12 Maximum kW** were realized during this validation process.

Realized savings are identified in the charts below, and are assessed with consideration to metered data collection and the recorded local Annual Ambient Temperatures.

ACTUAL METERED ENERGY RESULT BREAKDOWN - AMBIENT – ASHRAE DATA									
AMBIENT RANGE	DAYS	SYSTEM TONNAGE	24-HR KWH SAVINGS PER DAY	24-HR KWH SAVINGS PER TON	24-HR KWH ANNUAL SAVINGS	KW AVERAGE SAVINGS PER DAY	KW AVERAGE SAVINGS PER TON	MAXIMUM KW SAVINGS PER TON	MAXIMUM KW SAVINGS PER DAY
Below 7.2C	90	Heating	0	0	0	0	0	0	0
7.2C to 18.3C	124	360	180	.5	22,320	0	0	N/A	N/A
18.8C to 23.9	34	360	187.2	.52	6,364.8	5.04	.014	N/A	N/A
24.4C to 29.4C	49	360	705	1.96	34,545	18	.05	N/A	N/A
Above 29.4C	68	360	1,036	2.88	70,448	72	.2	.59	213.12
Total Annualized	365	360			kWh 133,677.8				

Substantial energy and performance benefits were experienced. The report data supports that greater savings will be realized with typical summer weather. An annualized energy reduction of 145,077.8 kWh, with a peak reduction of 213.12 kW Average may be experienced.

ENERGY BREAKDOWN FOR AMBIENT – FACTORING TYPICAL SUMMER EXTREME AMBIENT TEMPERATURES									
AMBIENT RANGE	DAYS	SYSTEM TONNAGE	24-HR KWH SAVINGS PER DAY	24-HR KWH SAVINGS PER TON	24-HR KWH ANNUAL SAVINGS	KW AVERAGE SAVINGS PER DAY	KW AVERAGE SAVINGS PER TON	MAXIMUM KW SAVINGS PER TON	MAXIMUM KW SAVINGS PER DAY
Below 7.2C	124	360	180	.5	22,320	0	0	N/A	N/A
7.2C to 18.3C	34	360	187.2	.52	6,364.8	5.04	.014	N/A	N/A
18.8C to 23.9	49	360	705	1.96	34,545	18	.05	N/A	N/A
24.4C to 29.4C	53	360	1,036	2.88	54,908	72	.2	.59	213.12
Above 29.4C	15	360	1,796*	4.99*	26,940*	213.12*	.59*		Estimated*
Total Annualized	275	360			kWh 145,077.8				

Specifics:

Validation Protocol:

Monitoring of the fourth and eighth floors for baseline and XDX® Comparisons.

Monitoring equipment per floor includes:

Sample Points per System:

- Supply Air Temperature
- Supply Air Relative Humidity
- Duplicate Supply Air Temperature
- Return Air Temperature
- Return Air Relative Humidity
- Duplicate Return Air Temperature
- Duplicate Return Air Relative Humidity
- Ambient Utilization of *Weather Underground* Record
- Three Phase Voltage
- Three Phase Amperage
- System Power Factor
- System kWh
- System kW Average
- System Maximum peak kW

Monitoring Criteria:

Sensitech Temperature Recorders (N.I.S.T.)

* See Addendum

Sensitech Relative Humidity Recorders (N.I.S.T.)

* See Addendum

Hawkeye 'E-Server' Power Monitors

* See Addendum

Equipment:

Air-Conditioning Unit:

Trane

Commercial Packaged

Intellipak Series

SCWD058

T99B04469

R22



Overview parameters:

XDX[®] entered into this evaluation with a unified positive approach to the resolution of air conditioning system issues. Performance concerns relating to the new building, capacities, and classrooms were discussed and the spirit of cooperation was evident.

The focus was placed upon achieving increased improved temperatures, increased performance, and energy savings, while using the XDX[®] system with XSTREAM[®] technology.

Challenges:

Having purchased an existing building with existing equipment, there were comments and concerns about the addition of kitchens and classrooms. Load differences from the previous buildings may have created the need for additional equipment.

With the implementation of the XDX[®] system, according to the validation findings and data, the Educational Facility will be able to rely on their existing equipment to achieve an additional capacity increase. This increase, along with improved equipment oil return and temperature, will extend the life of the existing equipment without additional capital expense for new systems.

Performance and Safety:

Efforts were taken to monitor actual operational conditions both during baseline and XDX[®] operation. The baseline system was exposed to the same conditions as XDX[®] as both experienced differing ambient and load changes.

Normal operating conditions were used to demonstrate reliability, dependability, and performance during conditions that might be faced by the Educational Facility.

XDX[®] performed within satisfactory compressor FLA and superheat tolerances. Determination is made that the XSTREAM[®] technology from XDX[®] will operate safely and satisfactorily under all load conditions.

XDX[®] products meet all requirements and are registered and listed by Underwriter's Laboratories.

Direct Energy Comparisons:

The Data shown on the two charts on this page compares like days of the week and like ambient comparisons, and is broken down into eight (8) and twenty-four (24) hour periods.

							AMBIENT TEMPERATURE		
Date		System	8 Hr kWh	24 Hr kWh	8 Hr kW Average	24-Hr kW Average	Daily High	Daily Low	Description
Same floor comparison of the pre-retrofit Baseline and post-retrofit XDX Equipped System									
4E11	Tuesday	Non-XDX	298.56	861.25	37.7	37.86	27.8°C 82°F	12.78°C 55°F	Baseline Pre-Retrofit
4F29	Tuesday	XDX	268.32	769.31	36.55	36.59	27.3°C 81°F	13.89°C 57°F	XDX Post-Retrofit
Change			-10%	-10.5%					
Measured Daily Reduction					1.15 kW	1.27 kW			
Same floor comparison of the pre-retrofit Baseline and post-retrofit XDX Equipped System									
4F12	Saturday	Non-XDX	302.03	893.02	38.08	38.08	26.67°C 80°F	16.67°C 62°F	Baseline Pre-Retrofit
4G10	Saturday	XDX	262.09	723.94	34.78	34.78	27.8°C 82°F	17.78°C 64°F	XDX Post-Retrofit
Change			-13%	-19.00%					
Measured Daily Reduction					3.3 kW	3.3 kW			
Same floor comparison of the pre-retrofit Baseline and post-retrofit XDX Equipped System									
4F11	Friday	Non-XDX	303.71	898.75	38.86	38.86	27.8°C 82°F	18.8°C 66°F	Baseline Pre-Retrofit
4G16	Friday	XDX	276.91	818.60	35.09	35.09	28.8°C 84°F	18.8°C 66°F	XDX Post-Retrofit
Change			-9%	-8.9%					
Measured Daily Reduction					3.77 kW	3.77 kW			

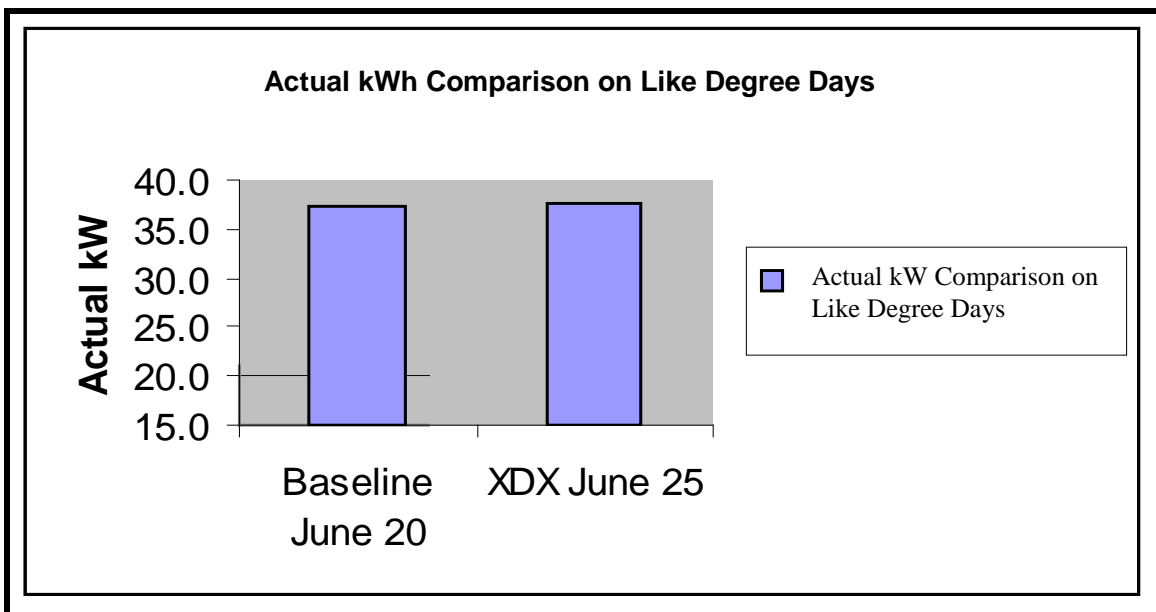
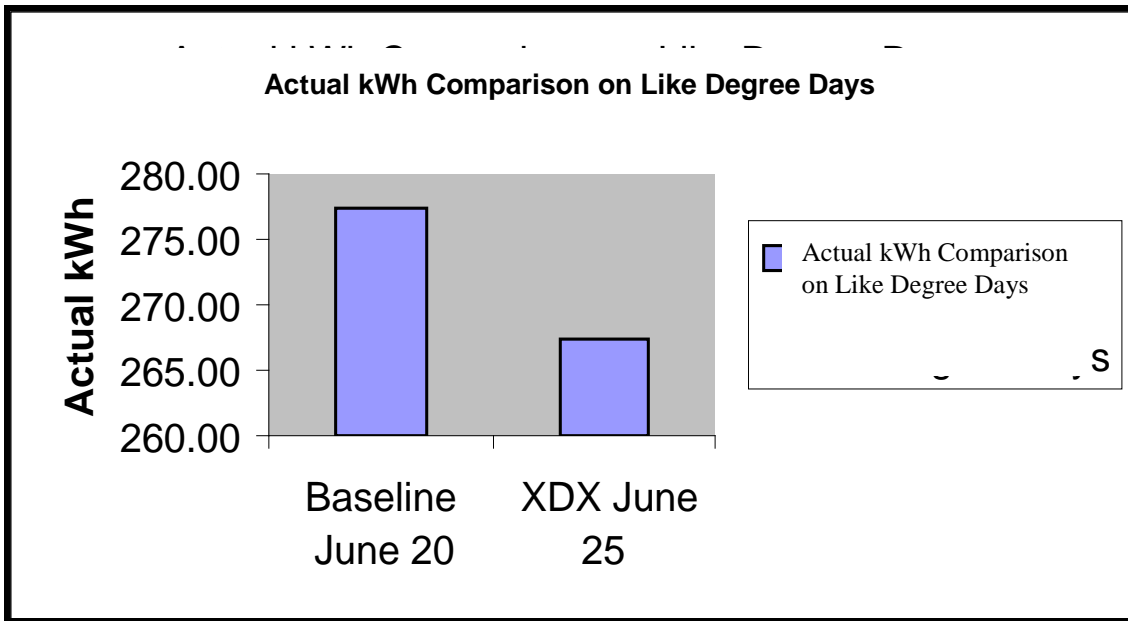
The Maximum kW column identifies that on High Ambient Days, the XDX equipped operation did not require the final compressor stage.

							AMBIENT TEMPERATURE			
Date		System	8-Hr kWh	24-Hr kWh	8-Hr kW Average	24-Hr kW Average	Max kW	Daily High	Daily Low	Description
High ambient comparisons with like systems with one as Baseline and one retrofitted to XDX										
4H03	Tues.	Non-XDX	332.1	955.78	45.34	45.34	71.97	31.6°C 89°F	20°C 68°F	Baseline
4H03	Tues.	XDX	284.9	843	35.88	35.88	36.52	31.6°C 89°F	20°C 68°F	XDX Post-Retrofit
Change			-14%	-12%			-50%			
Measured Daily Reduction					9.46 kW	9.46 kW				
High ambient comparisons with like systems with one as Baseline and one retrofitted to XDX										
4G20	Tues.	Non-XDX	335.03	949.44	45.39	45.41	70.67	32.2°C 90°F	22.2°C 72°F	Baseline
4G20	Tues.	XDX	282.75	831.82	35.58	35.84	36.33	32.2°C 90°F	22.2°C 72°F	XDX Post-Retrofit
Change			-15%	-12%			-48%			
Measured Daily Reduction					9.81 kW	9.91 kW				
High ambient comparisons with like systems with one as Baseline and one retrofitted to XDX										
4G22	Thurs.	Non-XDX	329.78	972.4	47.48	47.48	73.7	32.7°C 91°F	20.5°C 69°F	Baseline
4G22	Thurs.	XDX	282.28	839.4	36	36	36.67	32.7°C 91°F	20.5°C 69°F	XDX Post-Retrofit
Change			-14%	-13%			-50%			
Measured Daily Reduction					11.48 kW	11.48 kW				

Additional Before and After Same Floor Comparisons

Energy savings comparing baseline with XDX[®] on like Low Ambient Days.

DATE	MEAN	MAXIMUM	MINIMUM	DEWPOINT
4F20	16 °C / 62 °F	22 °C / 73 °F	10 °C / 51 °F	7 °C / 45 °F
4F25	15 °C / 60 °F	22 °C / 72 °F	10 °C / 50 °F	8 °C / 48 °F

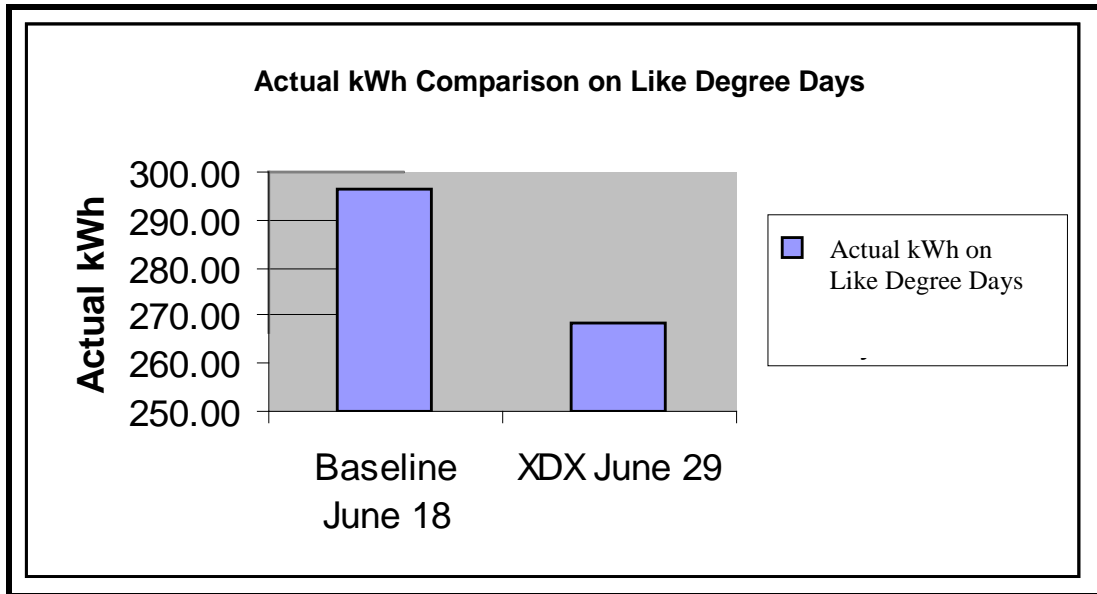


Similar kW readings during 24-Hour Period per system under Overnight Low Ambient Conditions are realized. System load reduction often prevents kW of the second stage unit from operation.

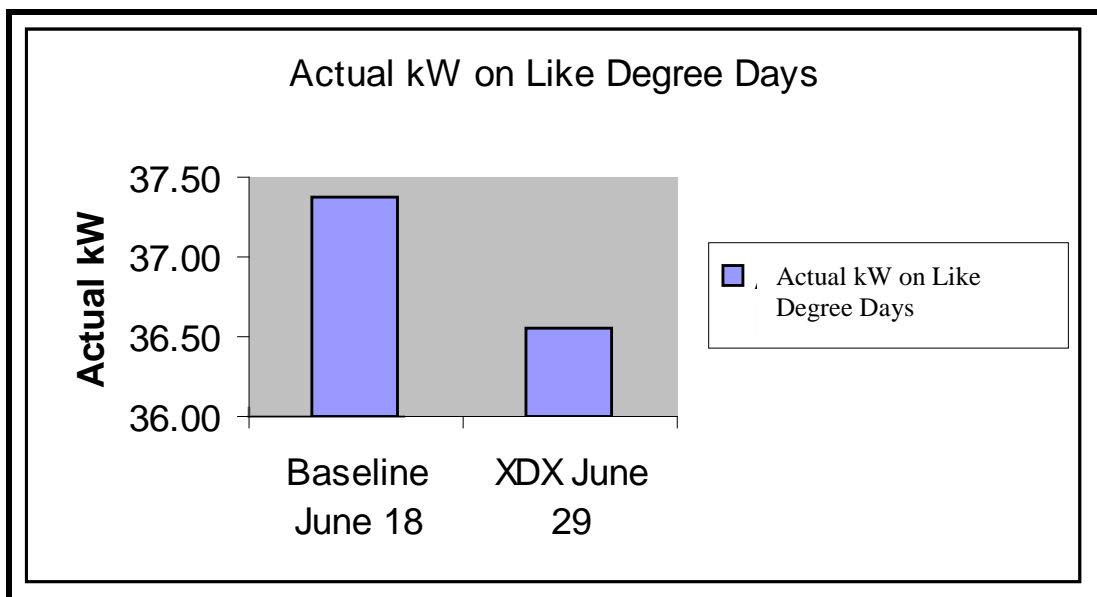
Energy savings comparing baseline to XDX[®] on Warm Like Ambient Days:

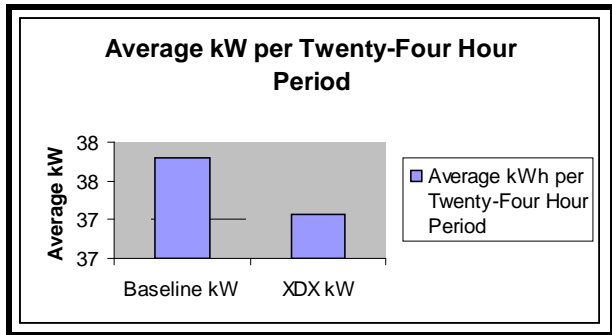
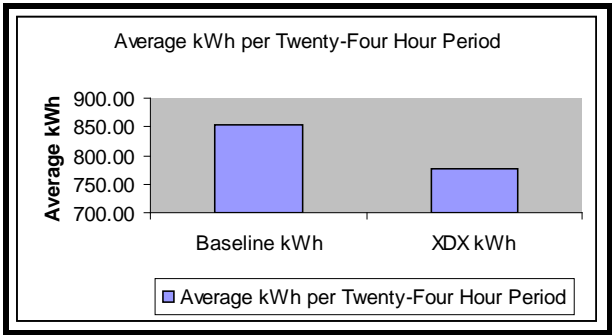
Comparisons are shown where the increased heat transfer capacity of the XDX[®] equipment is often able to prevent the operation of the second stage compressor.

DATE	MEAN	MAXIMUM	MINIMUM	DEWPOINT
4F18	21 °C / 71 °F	27 °C / 81 °F	17 °C / 63 °F	16 °C / 61 °F
4F29	21 °C / 70 °F	27 °C / 82 °F	12 °C / 55 °F	11 °C / 53 °F



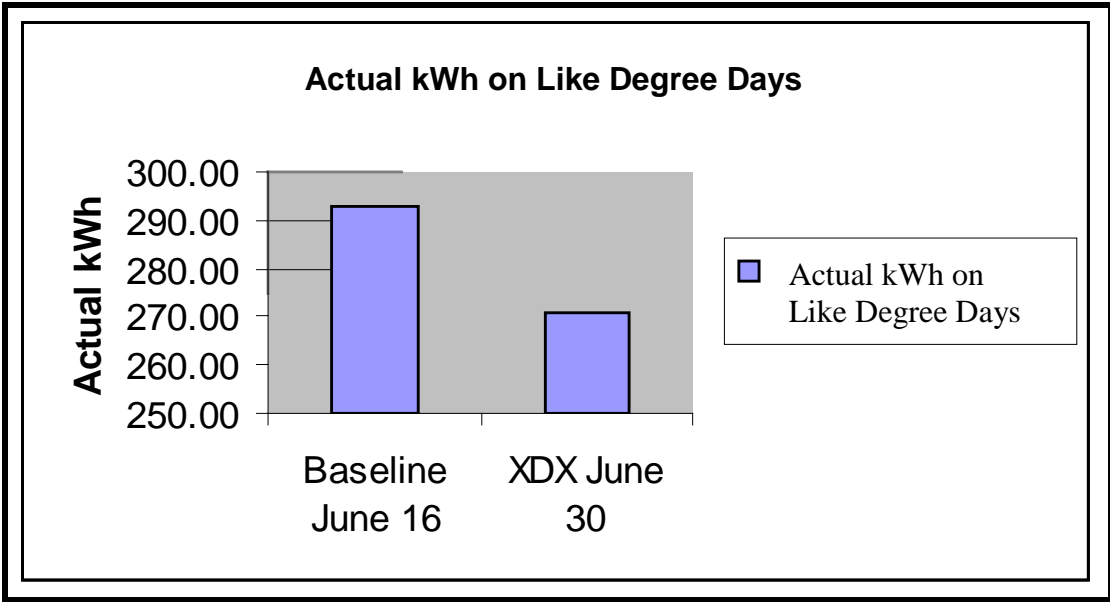
10% Average Reduction kWh during 24-Hour Period per system under Warm Ambient Conditions.



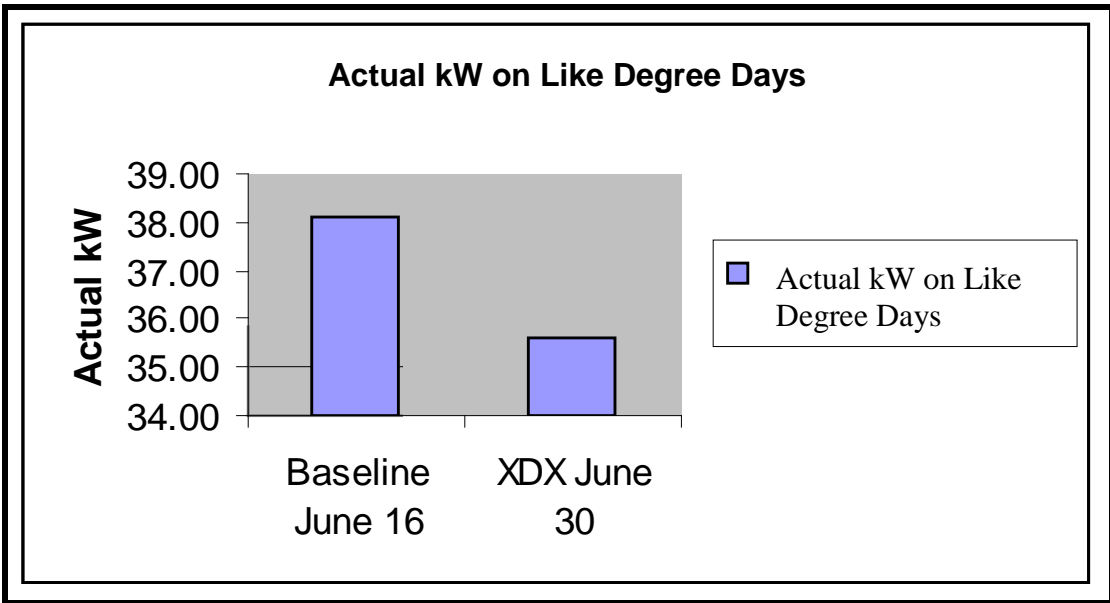


Energy savings comparing baseline to XDX[®] on like Medium-High Ambient Days:

DATE	MEAN	MAXIMUM	MINIMUM	DEW-POINT
4F16	22 °C / 72 °F	28 °C / 84 °F	15 °C / 60 °F	17 °C / 64 °F
4F30	21 °C / 71 °F	28 °C / 84 °F	13 °C / 57 °F	13 °C / 57 °F

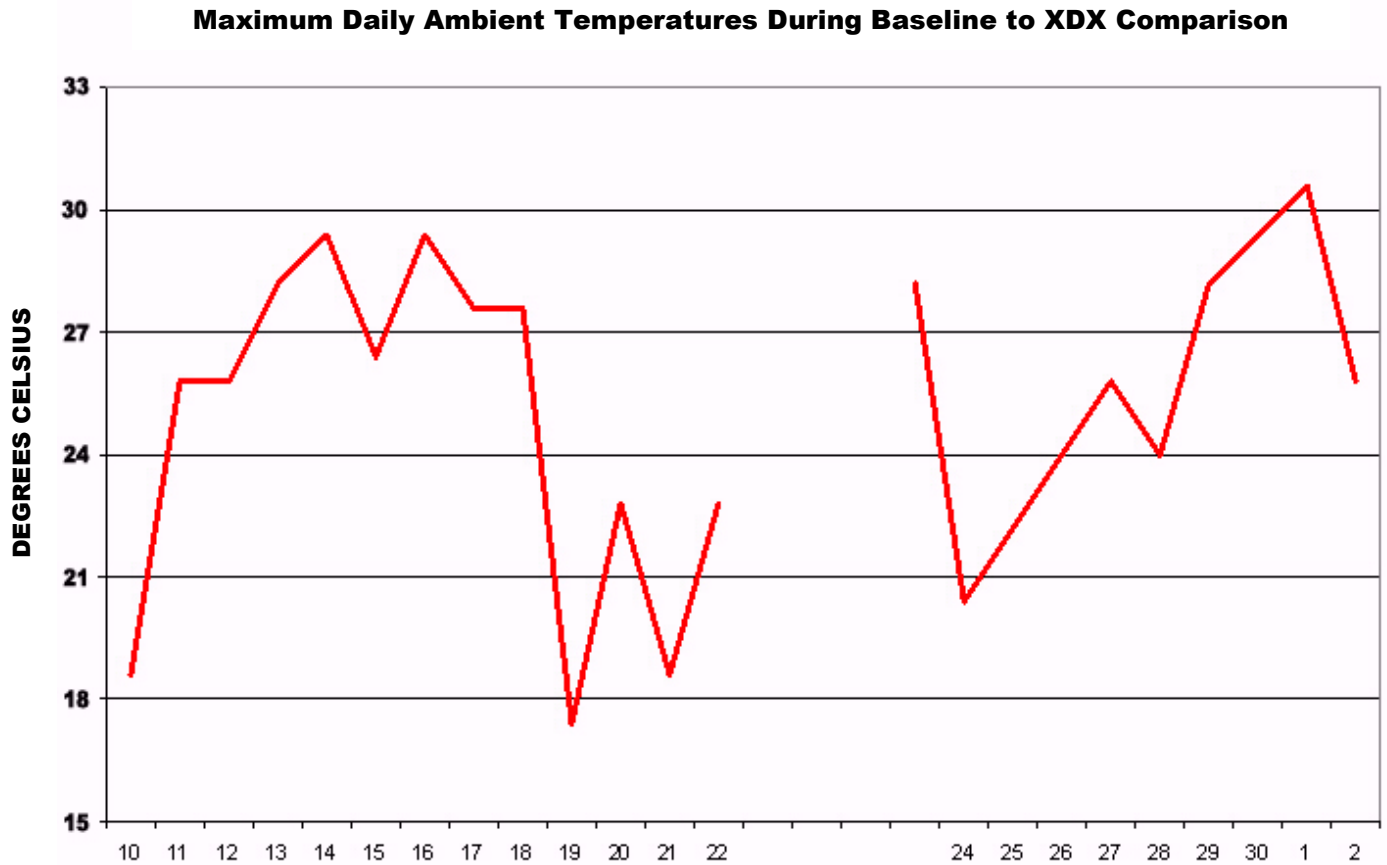


Ambient Conditions.



Actual 2.5 Reduction in kW during 24-Hour Period per system under Medium-High Ambient Conditions.

Ambient Temperature Comparison



The temperature comparison demonstrates similar average temperatures throughout the baseline and XDX[®] monitoring to this point. This graph also shows the absence of any extreme ambient days for comparison. This limited data pool mandated the necessity for Comparisons to the eighth floor after high ambient temperatures were experienced.

8th FLOOR COMPARISONS

The eighth floor was monitored with the intention to use the eighth floor as the comparison for high ambient conditions, and while the summer of 2004 experienced unseasonably low ambient temperatures, this strategy allowed for comparisons of the few days that saw temperatures in the low thirtys (30°C).

This inadvertently served as a comparison of baseline to baseline operation of an unaltered system with the steadily increasing building use and subsequent load increase. During the monitoring period, both kWh and kW have increased, unlike the XDX[®] retrofitted systems in the comparative time period, which have been able to reduce energy consumption during the increased building usage.

The baseline system that was not yet retrofitted saw an increase in kWh of 6% and an increase in kW of 1%.

This increase of 6% due to increased building usage and load supports the overall load increase, and subsequently evidenced the capacity increase through use of the improved evaporator TD, lower average building temperature and lower stable humidity of the other systems that have been retrofitted to XDX[®]. This data has been directly analyzed the comparative charts of the report summary and results.

The calculated capacity increase and the evidence of the reduced energy consumption in the XDX[®] retrofitted systems, supports that the future summers that will see typical seasonal extreme temperatures will most likely show the benefits of this capacity increase combined with energy savings for a total savings in line with 25% savings on days that have more extreme ambient conditions, as has been experienced in other validations.

In addition to the power data, temperature data has been collected. The report indicates some substantial improvements in performance and operation.

Dual supply air and dual return air temperature and relative humidity sensors recorded data throughout the validation period.

The baseline performance demonstrated average supply air temperatures of 11.2°C and 11.1°C with a standard deviation of 3.2 and 3.3. The post retrofit performance demonstrated colder supply air temperatures of 10.83° and 10.66°C with standard deviation of 2.1 and 2.0, indicating more steady performance with the XDX[®] operation. A portion of these summary sheets have been included as addendums to this document.

More significantly, the increased cooling effect was demonstrated in that the XDX[®] system, while subject to greater return air load which is consistent with the steadily increasing usage on the floors, was able to achieve a 8.8°C and 9.1°C temperature drop across the evaporator coil. The baseline temperature drop was only 8.1°F and 8.3°F.

Control of conditions is key to energy savings and system effectiveness. Air-conditioning is intended to do just that, condition the air for the comfort of the occupant. Also, substantial to the performance with XDX[®] was the reduction in humidity to the conditioned space. The baseline performance demonstrated average supply air humidity deviation of 12.7% and 12.5%, while the steady operation with XDX[®] reduced this fluctuation by more than half for a standard deviation of 6.1% and 5.8%.

Additionally, analysis of this actual work being done across the coil demonstrates at least a 10 % average capacity increase on top of any reductions already shown.

This 10% percent average capacity increase along with a 9% percent average kWh reduction will eliminate the need for additional equipment to handle increase load and prevent power consumption increases.

SUMMARY

The following benefits were experienced and can be related to each system retrofitted:

- Reduction in kWh of **133,677.8** (8.9 to 19%)
- Reduction of kW of as much as 72 per day
- Lower humidity
- Tighter control of operational temperatures
- Consistent humidity
- Increased capacity
- Improved compressor temperatures
- Improved Oil Return was experienced

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COMPARATIVE REPORT PHOTOS

