Final Report

Prepared April 2009

MaxR 100

Performance Test

Clark County School District
July through August, 2008

Four each, Three-Ton Rooftop Heat Pumps Treated with MaxR 100 at Silverado High School in Las Vegas, Nevada

1650 Silver Hawk Ave., Las Vegas, NV 89123

Executive Summary

The CCSD test of the MaxR100 product was performed in the summer of 2008. The initial data analyses and reporting did not make a complete connection from the measured electrical savings to the equipment performance on the refrigeration side. Clearly there were considerable electrical usage reductions but this was not supported by data analyses showing a comparable improvement in the cooling performance in kWh per ton of cooling. This most recent analyses has accomplished the task of supporting the measured electrical savings with a demonstrated improvement in the delivered cooling capacity per unit of power consumption.

This report summarizes the results of the latest data analysis of the subject test. Previous analysis focused primarily on Pre and Post Treatment comparisons of data sorted by ambient temperature only. This analysis goes further and compares data by ambient temperature and return air, room air, and supply air relative humidity. This resulted in a demonstration of performance improvement that is nearly twice that from previous "temperature only" reviews. The data analysis in this process was extensive and revealed a number of issues and results overlooked by the earlier reviews. The overall result showed that the performance improvement Pre-to-Post installation of the MaxR 100 product was **greater than 15%.** This results in a significant energy use savings that has a simple payback period (SPP) of **less than one peak cooling season (June through September).**

Measured Electrical Savings Improvement .... **22.6% to 34.9%**
Measured Coeff. Of Performance (COP) Improvement .... **15.1% to 16.9%**
Measured Supply Air Temperature Decrease .... **0.8 to 1.2 deg F**
Expected Simple Pay Back Term .... **Less than one year**

The addition of humidity to the analysis is important in the case that conditions exist for latent cooling. In cases of relatively high humidity, the air conditioning equipment will cool the air such that water condenses out of the air as it passes by the cold refrigerant coil. This cold water is collected and drained and represents a considerable amount of energy not used to cool the interior space. The test period contained numerous days of relatively high humidity where condensate water formed. Condensate was observed occasionally and CR4 had a clogged condensate pan that required a service call to clean and repair the condensate drain. The data for all classrooms indicates that latent cooling occurred over numerous ambient high humidity periods.

If the data collection had resulted in very accurate relative humidity recordings the energy expended for latent cooling could be accounted for and used for Pre/Post Treatment comparison. What this analysis found was that the recorded relative humidity data was not accurate enough to account for energy expended for latent cooling. This is covered in greater detail in the body of the report. As a result, the data was filtered to use only data where condensation could not have occurred. This data is used to demonstrate that an improvement in heat transfer at the coil does occur as purported by the MaxR manufacturer and to conservatively quantify the improvement in package Dx equipment Coefficient of Performance (COP) and overall reduction in electrical usage.

The use of data with sensible cooling only produced a considerably different result from previous reviews. Results from earlier data studies were clouded by the energy expended for de-humidification. By separating data by humidity level first, and then checking performance by temperature range, "like-conditions" where identified and compared separately. This report compares the performance of Pre-to-Post for "dry days" and then separately, Pre-to-Post for relatively "humid days". The separation of dry and humid data occurrs based on the return air relative humidity (RA RH) above and below approximately 40%. Given the temperature range of the return and supply air (77 deg. F to 50 deg), below 40% RH will always be sensible cooling only, with no chance for latent cooling and condensation/dehumidification. Above 40% RH, the humid data could possibly involve some latent cooling. This data was filtered differently given this focus.

The results from classrooms 3, 4, and 5 yielded COP improvements between 10.5 and 21.2% for "fan-on" increments. This was then used to estimate the overall electrical usage benefit. The results from classroom 6 are unclear. Although there is selective comparative data that shows a significant efficiency improvement, the overall data actually shows a decrease. This is most likely due to rooftop unit (RTU) mechanical/control malfunctions.

This performance improvement supports the measured reduction in electrical usage after application of the MaxR 100. If only a 10% improvement is recognized, it still results in a very quick simple payback period of less than one year. The electrical savings could actually pay for the installed cost of the MaxR 100 in less than one summer cooling season.

The products reliability and extended performance are considered to be good based on CCSD's limited 2-year experience with MaxR 100. To date the District has applied MaxR 100 on four 3-ton RTU's, three 40 to 50-ton split RTU's and one 370-ton chiller with no reported adverse affects. CCSD is not aware of any adverse affects by any other MaxR 100 product user or application.

This review revealed several other conditions that should be addressed by CCSD Facilities staff. First, each classroom has a supply air diffuser within just a few feet of each of two return air grills. A significant portion of the supply air (SA) was mixing directly with the return air instead of mixing with room air and contributing to the comfort of the occupants. These two SA diffusers could easily be relocated and the diffusers replaced to improve mixing and eliminate the SA short cycling.

It is recommended that CCSD install MaxR 100 on other RTU's of the five-to-ten year old vintage throughout the district including the many portable classrooms as part of a preventative or scheduled maintenance check on each unit to insure proper equipment operation and control. Air flow issues should be addressed as part of this overall system check. CCSD should start with year round applications that require summer cooling. Heat pumps on portables as well as other installations should also be given a high priority as the heat transfer benefit of MaxR100 should carry over into the heating season.

As the District develops a history and comfort level with the product, the application could be expanded to new or newer equipment. This should significantly reduce the efficiency degradation of heat transfer surfaces and would still result in an attractive SPP. This will help the machine run more efficiently, thus reduce maintenance, increase equipment service life, as well as improving the comfort level in the served spaces.

Data Analysis Objective
The primary objective of the analysis has been to show a performance improvement on the refrigeration side of the data that supports the measured performance improvement indicated by the power consumption data. This result is then used to equate what portion of the reduction in electrical usage is due to the MaxR product and what portion is a result of cooler ambient conditions and shorter days with slightly less solar insolation.

Method
The data for each classroom is treated separately, as if each were an independent test. This was the intent of the test sponsors to reduce the impact of equipment problems that could possibly occur during the data collection period.

This was indeed the case with the RTU on CR 6 which has experienced control problems. The initial review found that the collective CR 6 data indicates no benefit from the product application. Subsequent site visits lead to interviews with the school building engineer, which indicated the control issues but did not produce specific details. Further data analyses may indicate when and how the problems affected the data. Also, isolated comparative data (brief periods of similar conditions Pre-to-Post), does indicate that the product may have produced a positive benefit for some time prior to the occurrence of control problems.

The building engineer stated that the CR 6 unit had experienced problems since before the test period. He said that both equipment problems and control (thermostat) problems have affected the performance of the RTU since the spring season prior to the test. This unit required some work as a result of the pre-test functionality check. The unit required a blower motor relay replacement/repair and replacement of burned wires connected to the power supply.

The collective dry and humid data from CR 6 is not used in the analyses as a result of the initial review and evidence of mechanical/control issues. The report relies on the data from the remaining three class rooms; CR's 3, 4 & 5. This data was carefully reviewed in an attempt to understand the processes occurring within each run-cycle. The review examined trends associated with airflow, temperature changes, humidity and power consumption. This review revealed several interesting and useful occurrences. One, that in each classroom, a significant portion of the supply air from two each of the four total diffusers (nearest to the return grills) is passing directly into the return air flow without first mixing into the room air.

These diffusers are only a few feet from the return grills and they direct a quarter of the air flow right at each return. This results in return air temperatures that are a few degrees less than the room temperature instead of a few degrees more as would be expected. This is an inefficient condition that should be addressed by the District in the future, but for the sake of the test, a drop in the return temperature from one five-minute increment to the next is a clear indication of supply air flow. This is one data-check used in the analyses to determine when and if the unit was moving air over the coils and not just running the compressor without air flow as occurs at the beginning of each cycle.

Another observed effect was that some latent cooling occurred during certain humid periods. This can be demonstrated by plotting conditions on a psychrometric chart. Latent cooling is quite evident in portions of the collected data. Sensible heat transfer calculations use an equation based on the difference between the return air (RA) and supply air (SA) temperature and cannot be used to check latent cooling data. An equation based on RA and SA enthalpy must be used which requires an accurate measure of RA and SA relative humidity.

This review revealed that the measured supply air relative humidity was quite often either significantly higher or lower than one would expect. This indicates that the SA RH sensor may have malfunctioned, responded slowly to change, or could possibly even had moisture condensing on the transducer. In any case, this data is deemed to be unreliable and not useable. Thus, data increments in periods of high humidity must be treated separately.

The data for each classroom is separated into two groups; Humid Data & Dry Data. Dry data included incremental data during ranges with return air relative humidity (RA RH) predominately less than about 40%. The humid data is that for over 40% RA RH. This was chosen based on psychrometric analysis of typical conditions at which latent cooling may begin to occur. (See charts on page 8)

The data is then further analyzed and filtered to separate the increments that contain sensible cooling only from the increments which may have combined sensible and latent cooling. This is a conservative approach but is considered required since without accurate SA RH data, the latent cooling cannot be determined without making several assumptions. This was attempted and the result was inconsistent. Thus, the data increments with the potential for latent cooling are omitted from the analysis.

Results

Previous data reviews demonstrated a significant power use reduction but this could not be supported by an equivalent or proportional improvement on the refrigeration side. This dual result is critical with a complete body of data occurring over a two month period experiencing gradual ambient cooling conditions which could account for some of the power use reduction. With the Pre-treatment in July and the Post in August, the Post data is taken during slightly cooler days on average, and somewhat less solar gain than the Pre data (shorter days and lower solar altitudes).

Detailed data analyses revealed some important distinctions which were overlooked in previous reviews. Several macro views of data matrices revealed a critical distinction between dry and humid data and also indicated data ranges were data was likely "affected" by occupancy. Psychrometric analyses of the data revealed inaccuracies in various relative humidity measurements. This review compensates for these discrepancies by sorting and separating the data in order to adjust to these conditions. This in effect allows for an "apples-to-apples" comparison of the data. See the Data Summary Table on page 7.

This "sort and separate" approach results in a significant body of data using sensible heat transfer only (no data with latent cooling) which accurately and reliably measures the performance improvement resulting from the MaxR product application to the RTU. It also results in a significant body of data not to be used, other than to demonstrate the measured RH data problem and to indicate performance improvement characteristics but which cannot be used to accurately measure the improvement.

The dry data from classrooms 3, 4 & 5 include over 17,000 five minute data increments having more than 3100 occurrences with sensible heat transfer. This quantity of data is essential to the statistical analyses when each increment is an average of conditions occurring over a five minute period. A macro overview of the data reveals varying conditions throughout the testing period. The Humidity Matrix (Appendix A3 & A4) clearly shows opposing data ranges with relatively dry conditions and others with relatively humid conditions. The "line" drawn between dry & humid is drawn just slightly below the psychrometric conditions for return and supply air in which latent cooling

(cooling with moisture condensation) can occur. This is a critical point of distinction since only the data with sensible cooling only can be used to accurately determine the extent of performance improvement resulting from the application of the MaxR 100 product.

The data summary shows the measured savings using all the power drawn and heat transfer calculated when air flow is detected. The result is clear and consistent, ranging from 15 to 17% improvement, Pre-to-Post. It also indicates consistent power reduction taken over unoccupied periods (undisturbed by occupants), 22 to 35%. Some of this power savings is a result of the lesser ambient conditions, but the COP's account for this variation. The data also demonstrates the effect of the "occupied periods" where doors were likely left open. This gives the expected result of longer run times and greater power usage, but also demonstrates that the units ran more efficiently in spite of the rigorous conditions. It is important to read the Data Summary Notes (this page, below), to fully comprehend the content.

The humid data also contains tens of thousands of data increments and thousands of occurrences with cooling. The overwhelming majority of these events include sensible and latent cooling. The quantity of heat transfer could be calculated using reliable temperature and relative humidity data to determine the difference between the RA and SA enthalpy. Unfortunately, the measured relative humidity recordings are not accurate enough to produce reliable results.

This was determined by two separate methods, both using psychrometric properties. The first is graphic and is depicted below (see page 8). The cooling process from RA to SA is charted on a psychrometric chart. One event depicts the measured data plotted with a higher than expected SA RH where moisture would have had to be introduced/injected into the airflow to attain the measured result. Another event depicts the opposite, where air would have been cooled below the dew point to condense moisture and then warmed again to reduce relative humidity. Normally, one would expect the SA RH to be high, certainly above 90% as it left the refrigerant coils and traveled five feet down the SA duct toward the SA diffuser.

This indicates events where the measured SA RH is significantly higher than expected and again where it is much lower than expected. This is confirmed using the second approach which uses psychrometric calculations performed with KW-Engineering add-in software. In this case, the SA RH is calculated based on the RA temperature and RH. This is accomplished by first calculating the RA dew point. This is then assigned to the SA and the SA RH is then calculated. If condensation were to occur, the SA RH would be high, likely over 95%. This calculated SA RH is equated against the measured version in each spreadsheet and the difference ranges from over 30 percentage points low to nearly 30 points high. A difference of only 5 points produces a significant enthalpy difference that could adversely affect the accuracy of the heat transfer calculation.

Data Summary Notes

Note 1) Overall Data – All Days

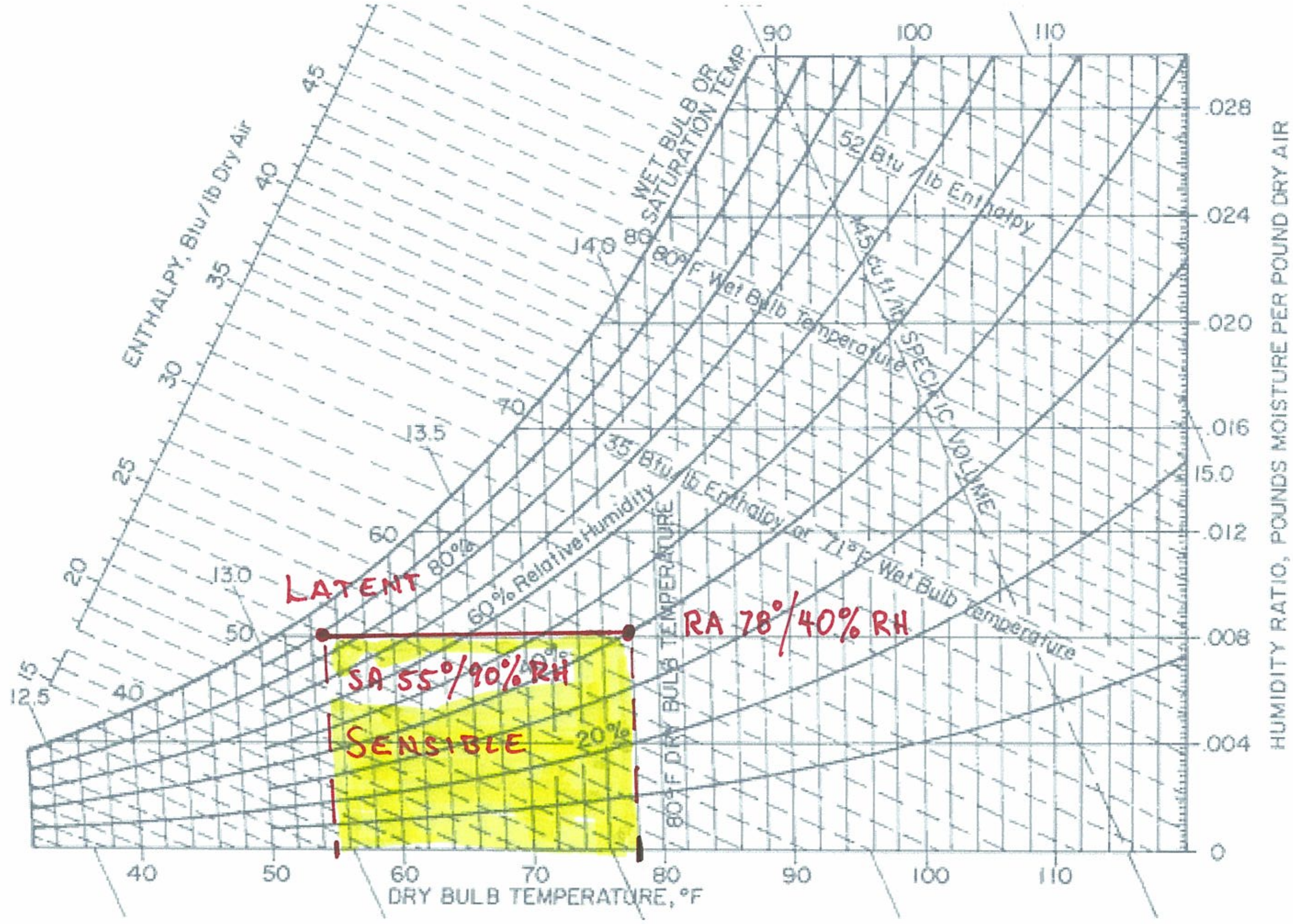
This block includes results for Dry data and Humid data, using either of all dry or all humid data increments Pre & Post from July 1 through the 20th and August 4th through the 24th respectively. Note that the school year began on August 25th. Return air relative humidity data for each classroom was evaluated and separated into "DRY" and "HUMID" ranges. In general, time ranges with data increments predominantly having RA RH less than 40% are included in the DRY DATA.

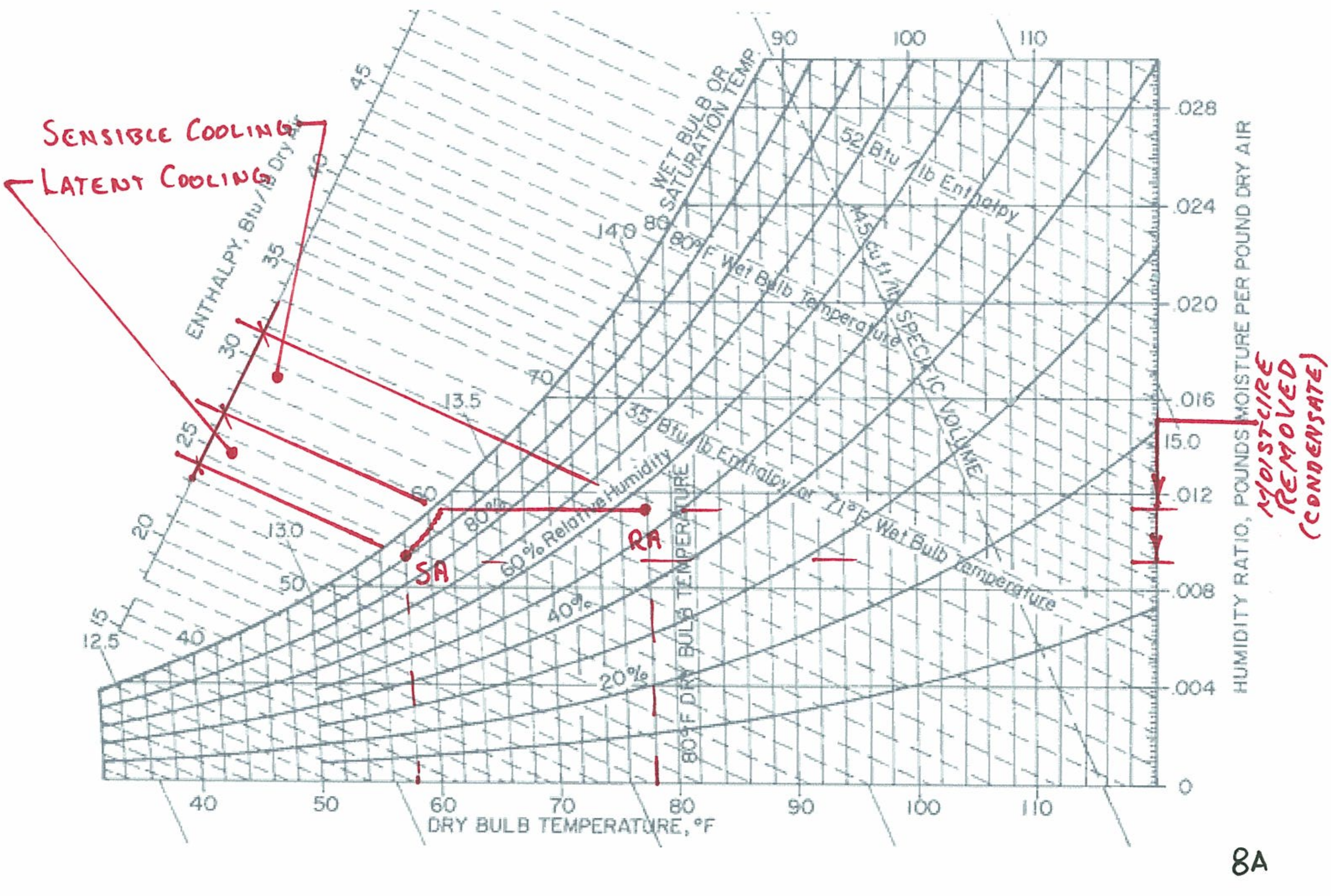
CCSD **Summer 2008**

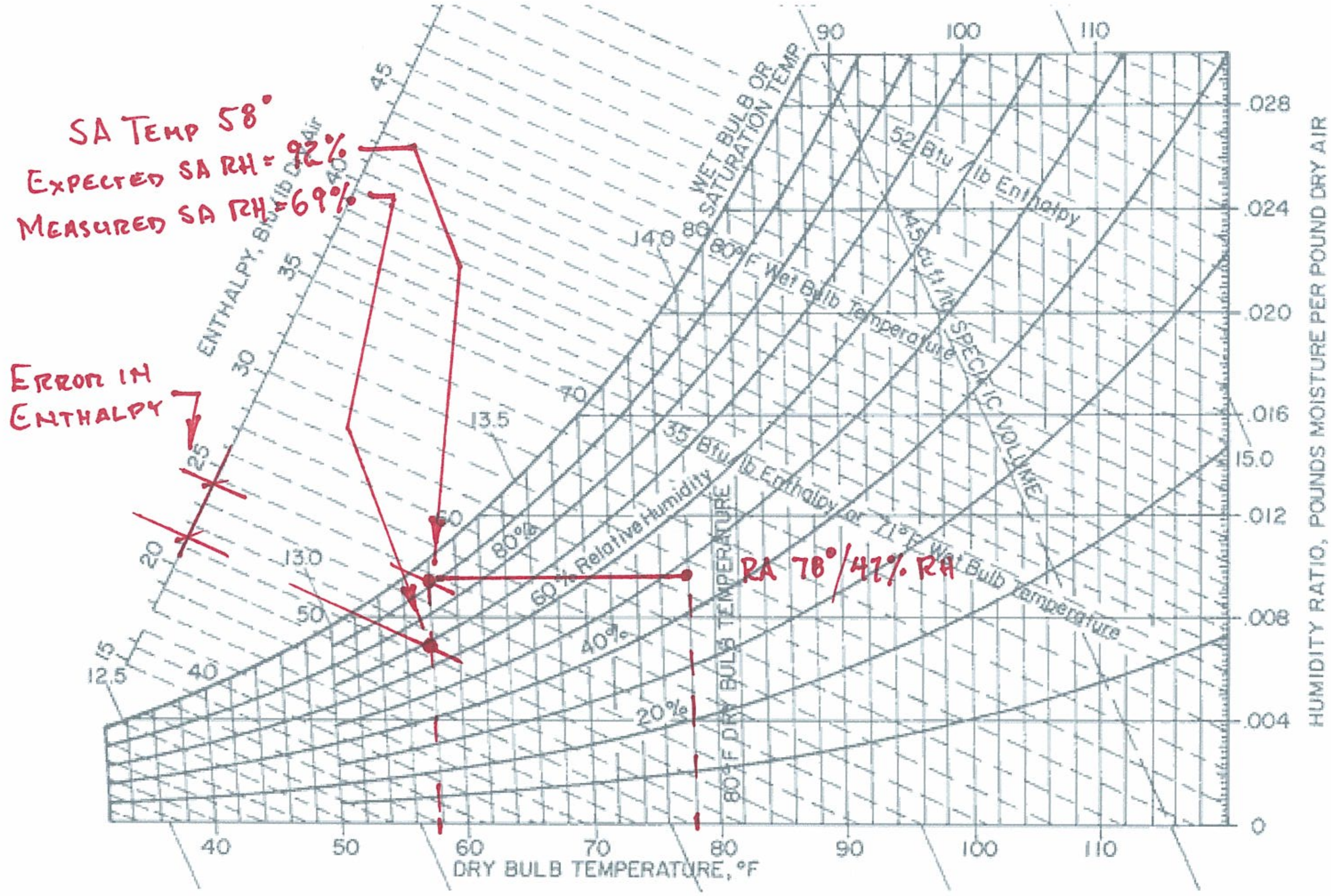
MaxR 100 Test on 3-ton Heat Pumps

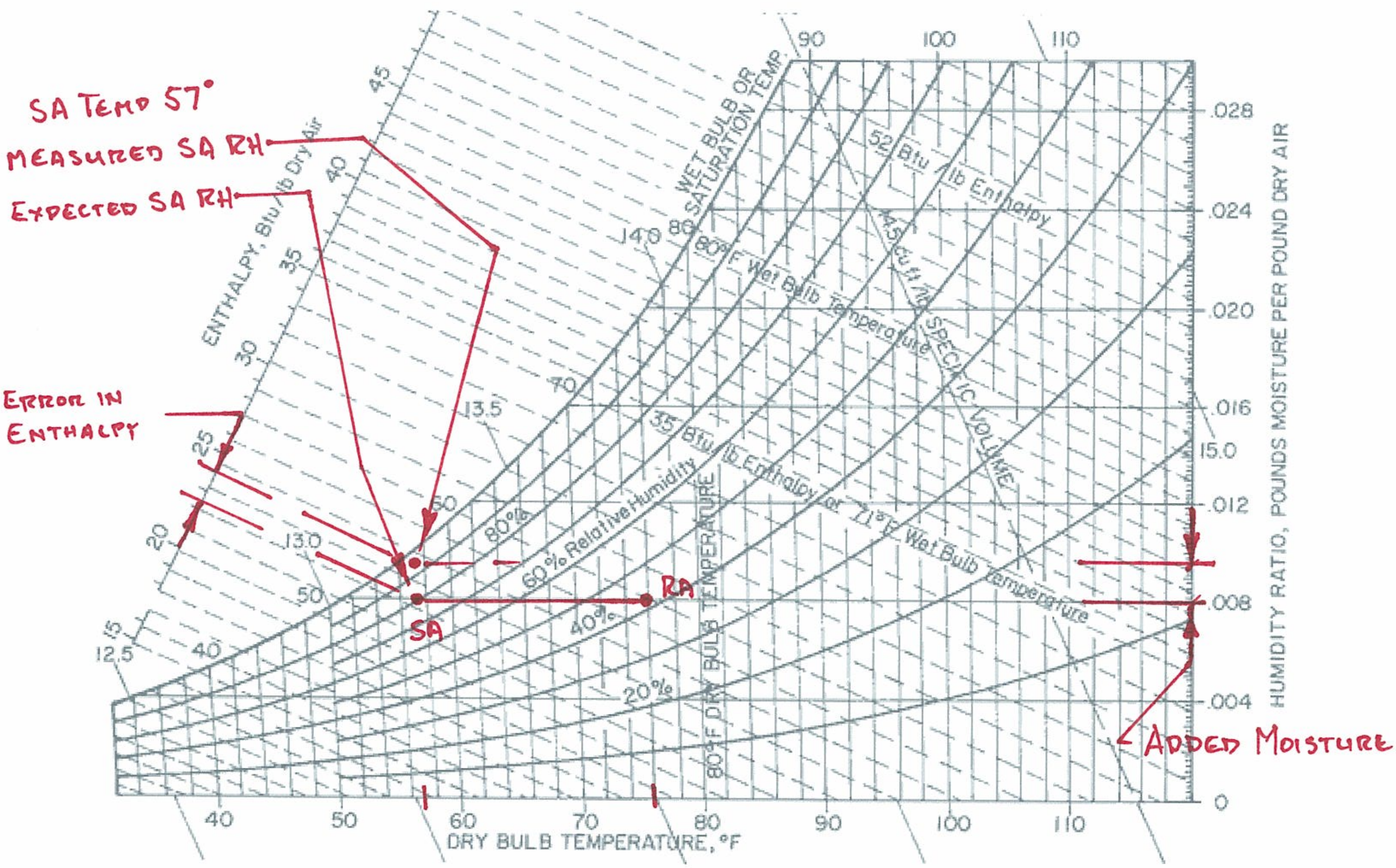
Summary of Performance Improvement

Post Period Results	Overall Data - Note 1)				UnOccupied Data - Note 2)			
	Supply Air Temperature Decrease - Running Deg F	Full Period Power Reduction Note 3)	Period COP Improvement - Cooling Increments Only Note 4)	Period COP Improvement - All Power Consumption Note 5)	Supply Air Temperature Decrease - Running	Full Period Power Reduction Note 6)	Period COP Improvement - Cooling Increments Only Note 7)	Period COP Improvement - All Power Consumption Note 8)
CR 3 Dry	1.59	1.80% Note 9)	19.59%	14.00%	0.97	22.63%	21.24%	15.94%
CR 4 Dry Note 10)	1.11	30.00%	14.31%	13.35%	1.15	34.90%	16.82%	16.93%
CR 5 Dry	0.63	30.78%	14.27%	13.13%	0.82	23.76%	10.47%	15.10% Note 11)
CR 3 Humid Note 12)	Increase Sensible Only 2.2 overall	Increase	9.81%	8.56%	Overall 1.20	Increase	20.84%	59.88%
		69% of Cooling Increments have **Latent Cooling** - With only 31% sensible increments, the **data is not statistically reliable** and is insufficient to draw a conclusion.						
CR 4 Humid Note 12)	0.5	Increase	Decrease		1.0	Increase	Decrease	
	95% of Cooling Increments have **Latent Cooling** - With only 5% sensible increments, the **data is not statistically reliable** and is insufficient to draw a conclusion.				**95%** of Cooling Increments have **Latent Cooling** - With only 5% sensible increments, the **data is not statistically reliable** and is insufficient to draw a conclusion.			
CR 5 Humid	negligible Sensible Only 1.02 overall Note 13)	-18.28% Increase	13.78%	2.99%	**No significant Impact due to Occupancy**			
		78% of Cooling Increments have **Latent Cooling** - With only 22% sensible increments, the **data is not statistically reliable** and is insufficient to draw a conclusion.						


ENTHALPY, Btu/lb Dry Air
WET BULB OR SATURATION TEMP.
52 Btu/lb Enthalpy
80°F Wet Bulb Temperature
14.5 cu ft/lb SPECIFIC VOLUME
35 Btu/lb Enthalpy or 71°F Wet Bulb Temperature
80% 60% Relative Humidity
40% 20%
80°F DRY BULB TEMPERATURE
DRY BULB TEMPERATURE, °F
HUMIDITY RATIO, POUNDS MOISTURE PER POUND DRY AIR
LATENT
RA 78°/40% RH
SA 55°/90% RH
SENSIBLE


SENSIBLE COOLING
LATENT COOLING
ENTHALPY, Btu/lb Dry Air
WET BULB OR SATURATION TEMP.
52 Btu/lb Enthalpy
80°F Wet Bulb Temperature
14.5 cu ft/lb SPECIFIC VOLUME
35 Btu/lb Enthalpy or 71°F Wet Bulb Temperature
80% 60% Relative Humidity
40% 20%
80°F DRY BULB TEMPERATURE
DRY BULB TEMPERATURE, °F
HUMIDITY RATIO, POUNDS MOISTURE PER POUND DRY AIR
SA
RA
MOISTURE REMOVED (CONDENSATE)


SA Temp 58°
Expected SA RH = 92%
Measured SA RH = 69%
Error in Enthalpy
RA 78°/47% RH
ENTHALPY, Btu/lb Dry Air
WET BULB OR SATURATION TEMP.
52 Btu/lb Enthalpy
80°F Wet Bulb Temperature
SPECIFIC VOLUME
35 Btu/lb Enthalpy or 71°F Wet Bulb Temperature
Relative Humidity
80°F DRY BULB TEMPERATURE
DRY BULB TEMPERATURE, °F
HUMIDITY RATIO, POUNDS MOISTURE PER POUND DRY AIR


SA Temp 57°
Measured SA RH
Expected SA RH
Error in Enthalpy
SA
RA
Added Moisture
ENTHALPY, Btu/lb Dry Air
WET BULB OR SATURATION TEMP.
52 Btu/lb Enthalpy
80°F Wet Bulb Temperature
SPECIFIC VOLUME
35 Btu/lb Enthalpy or 71°F Wet Bulb Temperature
Relative Humidity
80°F DRY BULB TEMPERATURE
DRY BULB TEMPERATURE, °F
HUMIDITY RATIO, POUNDS MOISTURE PER POUND DRY AIR

Note 2) Unoccupied Data
Data indicates occupancy occurred and that very likely the door(s) were left open while RTU was running for several ranges of time during the POST PERIOD (App. A6). These ranges include August 4th & 5th from approx. 10:00 am to 4:00 pm, and numerous ranges from Aug 13th through the 24th. The data for the Aug 4/5th events are not included in the dry data (less than about 40% relative humidity – return air). The Aug 4/5 events were likely from a cleaning crew while the events occurring after
the 12th were likely returning teachers who were setting up their classrooms. Each classroom is affected somewhat differently by the occupancy due to each individual teacher's schedule and activity related to keeping doors open.

Note 3) Full Period Power Consumption for Dry Data – All Days
This compares the power consumption of the RTU for the entire Pre & Post periods. It includes all power usage including power not used in the cooling performance calculations (data increments showing power consumption without room, RA, or significant SA temperature drops). This power is ultimately used in the overall performance calculations for COP.

Note 4) Period COP Improvement - Cooling Increments Only– All Days
This is the ratio of cooling energy delivered and electrical energy consumed by the RTU for actual cooling increments only. This is the time that MaxR is most effective since it affects heat transfer surfaces. All data increments are filtered by the spread sheet functions to find just the data increments that demonstrate that cooling of the classroom is occurring. The filter looks for temperature drops in the supply, return, and room air temperatures.

Increments using power without indications of cooling are excluded. These increments represent compressor run time without the fan energized as occurs at the beginning of each cooling cycle.

Note 5) Period COP Improvement - All Power Consumption– All Days
This is the measure of the improvement in the RTU's coefficient of performance (COP) from Pre-to-Post using all the power consumption and all the calculated cooling delivered to the room based on sensible heat transfer. The sensible heat transfer at the RTU is based on the RA and SA delta T and includes all data ranges, even those where doors had been propped open. Note that even though the RTU is running nearly non-stop with the doors open, the efficiency (COP) is still much improved.

Note 6) Full Period Power Consumption for Dry Data – Unoccupied Days
This compares the power consumption of the RTU for the Pre & Post periods with the exclusion of the apparently occupied periods in the Post. It includes all power usage including power not used in the cooling performance calculations (data increments showing power consumption without room, RA, or significant SA temperature drops). This power is ultimately used in the overall performance calculations for COP. See the power consumption matrices for identification of these occupied/door open periods (App. A6).

Note 7) Period COP Improvement - Cooling Increments Only– Unoccupied Days
This is the ratio of cooling energy delivered and electrical energy consumed by the RTU for actual cooling increments only. This is the time that MaxR is most effective since it affects heat transfer surfaces. All data increments excluding the occupied ranges, are filtered by the spread sheet functions to find just the data increments that demonstrate that cooling of the classroom is occurring. The filter looks for temperature drops in the supply, return, and room air temperatures.

Increments using power without indications of cooling are excluded. These increments represent compressor run time without the fan energized as occurs at the beginning of each cooling cycle.

Note 8) Period COP Improvement - All Power Consumption– Unoccupied Days
This is the measure of the improvement in the RTU's coefficient of performance (COP) from Pre-to-Post using all the power consumption but only the calculated cooling delivered to the room during apparent unoccupied periods. This is the best comparison of Pre-to-Post performance as the conditions are similarly controlled to the greatest extent possible. The sensible heat transfer at the RTU is based on the RA and SA delta T.

Note 9) Full Period Power Consumption for CR 3 Dry Data – All Days
The power consumption increased by 1.8% from Pre-to-Post due to additional cooling loads placed on the RTU during the POST period when the room was occupied and doors opened and/or left open for periods of time. The data also indicates that while the RTU was running for longer periods (longer cycle time), it was operating much more efficiently as the kW/ton of cooling decreased by over 16%.

Also in the case of CR 3, there was some "background" power were there was no apparent activity with the RTU, yet the power was 0.14 kwh for the increment. Data from the other classrooms showed a power level of zero for similar increments. This power was totaled and excluded from the performance calculations.

Note 10) CR 4 Dry Data
Data increment ranges for the CR 4 dry period were selected based on the room air relative humidity instead of the RA RH. This is due to an apparent problem with the RA RH sensor. It inconsistently shows RA RH much higher than the room air RH and this data is deemed to be unusable. The room air RH is consistent with the operation of the RTU and delivery of the SA and is considered to be accurate. Calculations for cooling performance (sensible heat transfer) are not affected by the problems with the RH sensor as the RA temperature data also appears to be accurate and consistent with RTU operations.

Note 11) CR 5 Dry Data - Period COP Improvement - All Power Consumption
At first glance the seemingly disproportionate increase in all power, unoccupied COP appears to contradict the smaller increases in power consumption and COP for cooling increments only. This apparent contradiction is indeed accurate. The increase in COP is a result of a greater than proportional decrease in power consumption without cooling and power consumption with little cooling, columns Q and R (See Data File Summary, App. B1).

Note 12) All Humid Data
The overwhelming majority of data increments with cooling involve some amount of latent cooling. The quantity of sensible only data is statistically insufficient to draw any conclusion. Most of the sensible data indicates greater power consumption Pre-to-Post, but without a reliable method to analyze all the data, sensible and latent cooling, no clear conclusion can be drawn. This reinforces the decision to separate dry/humid data ranges for the analyses.

Note 13) CR 5 Humid Data
Data indicates occupancy and likely door(s) left open while RTU was running for the periods of Aug 4th & 5th from approx. 10:00 am to 4:00 pm, possibly over brief periods on Aug 15th, 16th &17th, and for numerous periods from Aug 20th through the 23rd. Much of the data for the Aug

4/5th, and 15th through the 17th, is blocked by the humidity filter (high humidity) so that the result is not impacted by the occupancy and thus, these periods are inclusive to this run of data. The data after Aug 20th and onward is part of the "DRY" data. Thus, there is **no significant impact from open doors on the CR5 Humid data**.

Simple Pay Back

The Simple payback Period (SPP) for any installation is quite likely less than one full summer cooling season for any installation with summertime operation. The installation cost for a 3-ton unit is in the $150 to $175 range depending on the economy of scale. The single cooling season savings benefit at 15% improvement upon MaxR 100 application, ranges from about $333 for a moderately occupied portable classroom (PCR) under a 9-month operating schedule (Summer operation, less than 20,000 kwh/year), to over $400 for a summer high occupancy PCR.

Even the most conservative schedule for a PCR with the RTU turned off for the summer break results in a –less than one year SPP. For a 9-month schedule, OFF during the summer break, and only 10,000 kWh/year usage, the payback is still less than 1 year.

These results do not account for any possible Nevada Power Sure Bet Rebate. The rebate amount could be significant and greatly offset a large portion of the installed cost.

Conclusions

The installation of MaxR 100 is an excellent energy conservation measure and should be applied to any PCR heat pump over the age of 5 years. Application should be considered for all packaged Dx equipment over the age of five on a case-by-case basis until further experience is attained.

The performance improvement is significant and will likely pay for itself in less than one cooling season regardless of the NV Energy Sure Bet rebate. The product has no evidence of causing adverse conditions or significant diminishing performance. Application could also improve comfort in units struggling to keep up with large summer loads, could reduce maintenance costs and increase RTU service life.

As priorities and budgets permit, the application of MaxR100 could be extended to new equipment and equipment less than 5-years old. This would help to maintain the efficiency of the unit and would still produce an attractive SPP. There is no reason to wait until the unit becomes less efficient to apply the treatment. Early application will keep SA temps at "like new" performance, reduce run-time, maintenance and extend the service life of the equipment.

There is no evidence, experience or testimonial found to date to indicate that the effect of MaxR100 treatment diminishes or has adverse affects on the performance of the equipment. CCSD should continue to track the performance of treated equipment to develop a comfort level with the product.

Simple Payback Cost Analyses — Max R 100

Summer Use - High Occupancy

Schedule		Daily Use kwh	Daily Peak	Mid Peak	Off Peak	Cost per day	Period days	Net kWh	Cost per year	Savings 10%	Savings 12%	Savings 15%
Cooling	Jun - Sep	100	50	30	20	$22.70	122	12200	$2,769.40	$276.94	$332.33	$415.41
Cooling	Oct - Nov	40			40	$5.20	61	2440	$317.20	$31.72	$38.06	$47.58
Heating	Dec - Feb	60			60	$7.80	90	5400	$702.00	$70.20	$84.24	$105.30
Cooling	Mar - May	50			50	$6.50	92	4600	$598.00	$59.80	$71.76	$89.70
Rate			0.30	0.17	0.13							
Cost	per day	Jun - Sep	$16.50	$5.10	$2.60		365	**24,640**	$4,386.60	$438.66	$526.39	$657.99

Simple Payback Cost Analyses
Summer Use - Moderate Occupancy

		Daily Use kwh	Daily Peak	Mid Peak	Off Peak	Cost per day	Period days	Net kWh	Cost per year	Savings 10%	Savings 12%	Savings 15%
Cooling	Jun - Sep	80	40	25	15	$18.20	122	9760	$2,220.40	$222.04	$266.45	$333.06
Cooling	Oct - Nov	30			30	$3.90	61	1830	$237.90	$23.79	$28.55	$35.69
Heating	Dec - Feb	50			50	$6.50	90	4500	$585.00	$58.50	$70.20	$87.75
Cooling	Mar - May	40			40	$5.20	92	3680	$478.40	$47.84	$57.41	$71.76
Rate			0.30	0.17	0.13							
Cost	per day	Jun - Sep	$16.50	$5.10	$2.60		365	**19,770**	$3,521.70	$352.17	$422.60	$528.26

Simple Payback Cost Analyses
9-Month Use - Moderate Occupancy - Off During Summer Break

		Daily Use kwh	Daily Peak	Mid Peak	Off Peak	Cost per day	Period days	Net kWh	Cost per year	Savings 10%	Savings 12%	Savings 15%
Cooling	Jun - Sep	80	40	25	15	$18.20	30	2400	$546.00	$54.60	$65.52	$81.90
Cooling	Oct - Nov	30			30	$3.90	61	1830	$237.90	$23.79	$28.55	$35.69
Heating	Dec - Feb	30			30	$3.90	90	2700	$351.00	$35.10	$42.12	$52.65
Cooling	Mar - May	40			40	$5.20	92	3680	$478.40	$47.84	$57.41	$71.76
Rate			0.30	0.17	0.13							
Cost	per day	Jun - Sep	$16.50	$5.10	$2.60		365	**10,610**	$1,613.30	$161.33	$193.60	$242.00

Simple Payback Cost Analyses
9-Month Use - Low Occupancy - Off During Summer Break

		Daily Use kwh	Daily Peak	Mid Peak	Off Peak	Cost per day	Period days	Net kWh	Cost per year	Savings 10%	Savings 12%	Savings 15%
Cooling	Jun - Sep	60	30	20	10	$13.70	30	1800	$411.00	$41.10	$49.32	$61.65
Cooling	Oct - Nov	30			30	$3.90	61	1830	$237.90	$23.79	$28.55	$35.69
Heating	Dec - Feb	30			30	$3.90	90	2700	$351.00	$35.10	$42.12	$52.65
Cooling	Mar - May	40			40	$5.20	92	3680	$478.40	$47.84	$57.41	$71.76
Rate			0.30	0.17	0.13							
Cost	per day	Jun - Sep	$16.50	$5.10	$2.60		365	**10,010**	$1,478.30	$147.83	$177.40	$221.75

Certifications

By the signature below, Eric Heinicke, PE, CEM, CCSD Mechanical Engineering Manager, Clark Co. School District Engineering Services Dept., certifies that he has reviewed all the recorded data, results, and conclusions contained or addressed in this report and agrees that the report is a fair and accurate summary of the test as described by the test procedure and as supported by the collected data.

______________________________ Apr 16, 2009
Eric Heinicke, PE, CEM — Date
Mechanical Engineering Manager
CCSD Engineering Services

CCSD
4292 S. Maryland Pkwy
Las Vegas, NV 89119
702-799-1195 (Office

Appendices