



U.S. Chiller Services

# Palm District Cooling 19XR Chiller Energy Optimization Kwh saving test

Smartcool

Liquid Chiller controls

November 20, 2009



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# Background

- U.S. Chillers (USCS) was requested by Smartcool technologies to test and evaluate the Smartcool Liquid chiller controls technology on a large tonnage Centrifugal chiller serving the District Cooling industry. USCS approached Palm District Cooling company in Dubai UAE and requested if the testing could be performed on one of its chillers. The site selected was Gardens Plant 1 a 8,750 ton chilled water plant with (7) 19 XR Carrier 1,250 Ton centrifugal chillers. The chiller selected was chiller number 3.



# Equipment

Equipment	MFG	Model
• Water Cooled Centrifugal Chiller	Carrier	19XR8585
• Water flow meter	Endress+Hauser	Proline Prosonic Flow 91
• BTU Energy Manager	Endress+Hauser	RMS621
• Electrical Power Logger	Fluke	1735



# Method

- USCS installed water flow meter, BTU energy manager, and electrical power loggers.
- Chiller had complete annual services performed prior to the testing, refrigerant charge weighed, condenser and chilled water flow set as per chiller design data using ultrasonic flow equipment and chiller checked for proper operation.
- Condenser and evaporator was cleaned by mechanical rotary specialist cleaning equipment.



# Method-cont.

- Test commenced on 7<sup>th</sup> July at 1300 hours.
- First readings recorded on 8<sup>th</sup> July at 1300 and every day after at exactly 1300.
- Recorded readings Ton Hr-Kw Hr-Daily Ton Hr-Daily Kw Hr- Kw per ton-%chiller RLA- Chw in- Chw out- Cw in- Cw out- Cw and CHW Delta-T.



# Method-cont.

- 14 days of readings were taken pre-activation of “Smartcool”,.
- 14 days of readings were taken with the “Smartcool” activated.
- 14 days of readings were taken with “Smartcool” on and off alternate days.



# Data Collected, Pre Smartcool

Date	Tn Hrs	Kw Hrs	Daily Tn Hrs	Daily Kw Hrs	Kw/Tn	%RLA	Chw in	Chw out	Delta T	Cond in	Cond out	Delta T
									0			0
6/7									0			0
7/7	423813.9	0	423813.9	0	<b>0</b>	90.3	52.5	41.7	10.8	89.7	97.1	7.4
8/7	447890.22	16396.3	24076.32	16396.3	<b>0.681</b>	87.6	52.1	41.3	10.8	89.5	96.8	7.3
9/7	462541.02	26320.9	14650.8	9924.6	<b>0.677</b>	85.5	51.9	41.2	10.7	88.1	95.2	7.1
10/7	489194.7	43499.5	26653.68	17178.6	<b>0.645</b>	85.5	52	41.4	10.6	88.8	95.7	6.9
11/7	516123.9	61292.5	26929.2	17793	<b>0.661</b>	85.5	52.3	41.4	10.9	88.2	95.5	7.3
12/7	543119.23	79134.7	26995.33	17842.2	<b>0.661</b>	72.1	51.2	41.2	10	82.3	88.8	6.5
13/7	568581.44	95191	25462.21	16056.3	<b>0.631</b>	69.6	50.6	41	9.6	82.3	88.6	6.3
14/7	594439.15	111935.5	25857.71	16744.5	<b>0.648</b>	80.3	51.5	41.2	10.3	88.8	95.7	6.9
15/7	620440.64	128876.5	26001.49	16941	<b>0.652</b>	80.1	51.6	41.4	10.2	88.3	95.1	6.8
16/7	647640.9	146931.7	27200.26	18055.2	<b>0.664</b>	85.5	52.4	41.8	10.6	91.6	98.7	7.1
17/7	673864.29	164757.5	26223.39	17825.8	<b>0.680</b>	90.1	53	42.2	10.8	90.4	97.8	7.4
18/7	701297.54	182845.4	27433.25	18087.9	<b>0.659</b>	85.5	52.4	41.8	10.6	91.2	98.4	7.2
19/7	728637.25	200998.9	27339.71	18153.5	<b>0.664</b>	85.5	52	41.4	10.6	90.4	97.6	7.2
20/7	755764.91	219086.8	27127.66	18087.9	<b>0.667</b>	87.1	52.2	41.3	10.9	89.6	96.8	7.2
21/7	777902.45	234225.7	22137.54	15138.9	<b>0.684</b>	0	52.1	52.1	0	90.6	90.6	0
<b>Save Start</b>			<b>25292.04</b>	<b>16730.4</b>	<b>0.662</b>	<b>83.1</b>	<b>51.9</b>	<b>41.4</b>	<b>10.5</b>	<b>88.4</b>	<b>95.4</b>	<b>7.0</b>







# Data Collected

## Smartcool Alternate Days (on/off)

	Date	Tn Hrs	Kw Hrs	Daily Tn Hrs	Daily Kw Hrs	Kw/Tn	%RLA	Chw in	Chw out	Delta T	Cond in	Cond out	Delta T
ON	6/8	1133071.3	36208.6	21001.18	13189.1	<b>0.628</b>	66.3	50.2	41.3	8.9	81.4	87.2	5.8
OFF	7/8	1155086.95	50151.4	22015.65	13942.8	<b>0.633</b>	75.7	51.1	41.2	9.9	87.8	94.7	6.9
ON	8/8	1176527.41	63832.1	21440.46	13680.7	<b>0.638</b>	85.5	52.4	41.9	10.5	88.4	95.7	7.3
OFF	9/8	1203222.8	81592.3	26695.39	17760.2	<b>0.665</b>	84.1	49.5	40.9	8.6	82.2	87.9	5.7
ON	10/8	1212001.41	87392.3	8778.61	5800	<b>0.661</b>	0	51.5	51.5	0	93.6	93.6	0
OFF	11/8	1227019.59	97255.4	15018.18	9863.1	<b>0.657</b>	72.1	51.7	42.4	9.3	87.4	93.6	6.2
ON	12/8	NA	NA	N/A	N/A	N/A	NA	NA	NA	N/A	NA	NA	N/A
ON	13/8	1246116.92	110034.9	19097.33	12779.5	<b>0.669</b>	74.1	50.7	41.4	9.3	87.4	93.6	6.2
OFF	14/8	1272237.21	128057.3	26120.29	18022.4	<b>0.690</b>	74.8	50.8	41.2	9.6	87.2	93.6	6.4
ON	15/8	1294630.28	143458.3	22393.07	15401	<b>0.688</b>	91.2	55.1	44.1	11	93.6	101.3	7.7
OFF	16/8	1319088.57	160235.5	24458.29	16777.2	<b>0.686</b>	74.8	53.1	43.9	9.2	92.5	98.7	6.2
ON	17/8	1341084.92	175112.2	21996.35	14876.7	<b>0.676</b>	70.7	52.3	43.3	9	88.6	94.7	6.1
OFF	18/8	1365743.26	191561.7	24658.34	16449.5	<b>0.667</b>	74.8	51.2	41.7	9.5	89	95.4	6.4
ON	19/8	1387625.07	206111.7	21881.81	14550	<b>0.665</b>	85	51.8	41.3	10.5	88.2	95.3	7.1
<b>OFF AVG</b>		1257066.40	118142.3	23161.02	15469.2	<b>0.666</b>	72.7	51.2	41.9	9.4	87.7	94.0	6.3
<b>ON AVG</b>		1255865.33	117450.0	19512.69	12896.7	<b>0.661</b>	67.5	52.0	43.5	8.5	88.7	94.5	5.7



# Dubai Data Collection Summary Results

<b>Daily Ton Hrs</b>	<b>Daily KWH</b>	<b>KW per Ton</b>	<b>Status</b>
25292.04	16730.4	.662	OFF (C) 14 days
22272.17	14528.2	.652	ON (C) 14 days
23161.02	15469.2	.666	OFF (A) 7 days
19512.69	12896.7	.661	ON (A) 7 days



# Savings

- 2,202.20 KWH per day 14 days on vs off (726.73 Dh per day savings). 13.16% energy savings
- 3,648.33 KWH per day 14 Alt. days on vs off (1,203.95 Dh per day savings). 16.63% energy savings
- Average per day Savings 2,925.26 Kwh 14.89%
- Average per day CO2 Savings 2.0 Tons



# Executive Summary

The Testing was conducted as close to ARI witness testing conditions and standards as possible in the field, under actual operating conditions. The terms and condition of testing was that the chillers leaving chilled water temperature remain within the chillers set point dead band, which the technology was able to achieve. The 42 days of testing under the peak Dubai summer conditions resulted in some impressive results, not only did the Smartcool energy saving control technology save substantial Kwh input power to the chiller, it was also able to maintain and slightly improve the chillers Kw per ton Efficiency. Although the testing was performed on only one chiller of a common 7 chiller DC loop, we did confirm the technology can be integrated to multiple chillers, all controlling and communicating together, so the technology performs a common and equal optimization algorithm within all chillers ,allowing all chillers to share the common load equally, save energy equally and distribute the common load equally. Our firm conclusion is the Smartcool technology is a powerful energy saving technology on single or multiple chiller installations