



Energy Saving Analysis in a Big Box Retail Store using the Honeywell Service Assistant

This is an example of how using the Honeywell Service Assistant saves energy through the proper service of rooftop air conditioners in a big box retail store. Attached is a spreadsheet providing estimated energy savings. The store considered is in Northern Philadelphia and the measurements and service were performed between May 21 and June 4, 2001.

Each line in the report is a snapshot of the performance of a stage of cooling, as specified in the first two columns, at a particular time. It is common for one commercial roof top unit to have multiple yet nearly independent refrigeration cycles for staging its cooling capacity. Notice that each stage that required service has two adjacent rows of data corresponding to before and after servicing. The nominal capacity of the stage is shown in the next column.

The five columns following date and time are cycle performance indices calculated by the ACRx Handtool from its measurements. They are:

ET = evaporating temperature, °F

SH = suction line superheat, °F

SC = liquid line subcooling, °F

PD = high-to-low side pressure difference, psia

CTOA = condensing temperature over ambient, °F

The next column indicates what service the Honeywell Service Assistant recommends. After service, the diagnostic expected is “No service required.” However, for many units in this particular location, further service needs to be performed to clear all the faults. Apparently, many units analyzed have a flow restriction problem that prevents them from working properly. We are analyzing the data with the manufacturer to find a solution.

The next two columns present the Efficiency Index (EI) and Capacity Index (CI) as calculated by the Honeywell Service Assistant. The Efficiency Index (EI) is a ratio between the coefficient of performance of the cycle at the actual conditions and the coefficient of performance of the cycle at desired conditions. The Capacity Index (CI) is the ratio between the capacity of the cycle at the actual conditions and the capacity of the cycle at goal conditions.

The actual capacity of the stage is presented at the next column. Due to degradation, the actual capacity of the stage is lower than the nominal capacity.

The next column presents the calculated electric power consumed (kW) by each stage of cooling while it is running. These calculations were performed based on the following assumptions:

1. The nominal capacity of each stage is half that of the unit.
2. The nominal EER of the units is 10.
3. 20% of the total power has other uses rather than to compress the refrigerant.

The next two columns present the number of hours the stage has to run to perform the desired cooling and the yearly cost of running each stage based on the following assumptions, which apply to the remaining columns in the spreadsheet:

1. The first stage runs 2000 hours in a year when running in nominal conditions.
2. Cost of energy is US\$ 0.10 per kWh.
3. The second stage runs only 25% of the running time of the first stage.

Note that, although the first and second stages were designed to run for 2000 and 500 hours, respectively, at nominal conditions, due to degradation the stages have to run for longer hours to provide the same cooling effect.

The last column shows the cost savings based on the before and after service snapshots, reflecting the lower cost for running the unit after service. The cumulative costs and savings for the entire site are provided at the bottom of the report.

In summary, this report shows that, from an investment of US\$4,300 in service, the following results can be obtained:

1. The estimated savings in electricity bill for the customer amount to US\$21,000.
2. When all the stages are running, the power savings are approximately equal to 50 kW.

Since the units still present problems after service, additional savings can be obtained in this site when the Efficiency Index (EI) and Capacity Index (CI) are near 100.

Address inquiries to: Mark Barraclough
Alpine Mechanical Services, LLC
(215) 489-0500 ext. 11, (215) 489-0840 (fax)
mbarraclough@alpinems.com

| Unit | Stage | Nominal Capacity | Date | Time | ET | SH | SC | PD | CTOA | Diagnosis | EI | CI | Actual Capacity | Consumption (kW) | Run Time (h) | Cost per year | Savings per year |
|--------|-------|------------------|---------|-------|----|----|-----|-----|----------------------|---|----|------|-----------------|------------------|--------------|---------------|------------------|
| 1 | 1 | 10 | 5/21/01 | 8:41 | 31 | 7 | 14 | 90 | 32 | Clean condenser. | 62 | 71 | 7.10 | 13.39 | 2817 | \$3,773 | \$807.99 |
| | | | 5/31/01 | 10:05 | 29 | 11 | 5 | 74 | 14 | Fix low side heat transfer problem then add charge. | 82 | 77 | 7.70 | 11.41 | 2597 | \$2,965 | |
| | 2 | 10 | 5/21/01 | 8:50 | 25 | 18 | 29 | 133 | 47 | Fix low side heat transfer problem then add charge. | 45 | 54 | 5.44 | 14.00 | 919 | \$1,287 | \$419.76 |
| | | | 5/31/01 | 10:15 | 26 | 30 | 17 | 123 | 24 | Fix low side heat transfer problem | 70 | 66 | 6.60 | 11.45 | 758 | \$868 | |
| 2 | 1 | 10 | 5/21/01 | 9:05 | 28 | 18 | 13 | 97 | 35 | Clean condenser. | 56 | 65 | 6.53 | 13.60 | 3061 | \$4,163 | \$947.42 |
| | | | 5/31/01 | 10:42 | 25 | 29 | 9 | 90 | 16 | Fix low side heat transfer problem then add charge. | 76 | 70 | 6.96 | 11.19 | 2873 | \$3,216 | |
| | 2 | 10 | 5/21/01 | 9:13 | 28 | 22 | 24 | 127 | 46 | Fix low side heat transfer problem then add charge. | 48 | 59 | 5.94 | 14.27 | 842 | \$1,202 | \$424.82 |
| | | | 5/31/01 | 11:06 | 29 | 33 | 13 | 113 | 20 | Check for flow restriction. | 78 | 74 | 7.41 | 11.52 | 675 | \$777 | |
| 3 | 1 | 10 | 5/21/01 | 9:35 | 28 | 18 | 36 | 170 | 61 | Fix low side heat transfer problem then add charge. | 39 | 54 | 5.36 | 15.60 | 3730 | \$5,818 | \$2,287.99 |
| | | | 5/31/01 | 11:19 | 24 | 30 | 12 | 95 | 20 | Fix low side heat transfer problem then add charge. | 69 | 64 | 6.42 | 11.33 | 3115 | \$3,530 | |
| | 2 | 10 | 5/21/01 | 9:42 | 26 | 27 | 10 | 81 | 27 | Fix low side heat transfer problem then add charge. | 62 | 65 | 6.51 | 12.48 | 768 | \$958 | \$199.64 |
| | | | 5/31/01 | 12:09 | 29 | 31 | 18 | 117 | 20 | Check for flow restriction. | 80 | 76 | 7.55 | 11.46 | 662 | \$759 | |
| 4 | 1 | 10 | 5/21/01 | 9:51 | 26 | 22 | 21 | 93 | 32 | Remove charge. | 59 | 65 | 6.49 | 12.96 | 3081 | \$3,994 | \$980.41 |
| | | | 5/31/01 | 14:08 | 28 | 33 | 13 | 106 | 17 | Check for flow restriction. | 81 | 75 | 7.47 | 11.25 | 2678 | \$3,013 | |
| | 2 | 10 | 5/21/01 | 9:58 | 26 | 23 | 22 | 94 | 33 | Remove charge. | 58 | 64 | 6.43 | 13.03 | 778 | \$1,014 | \$264.18 |
| | | | 5/31/01 | 12:35 | 29 | 36 | 14 | 114 | 20 | Check for flow restriction. | 81 | 76 | 7.62 | 11.43 | 657 | \$750 | |
| 5 | 1 | 10 | 6/4/01 | 13:09 | 36 | 19 | 14 | 112 | 26 | No service required. | 79 | 85 | 8.45 | 12.67 | 2366 | \$2,998 | |
| | 2 | 10 | 6/4/01 | 14:37 | 36 | 26 | 15 | 130 | 29 | No service required. | 77 | 84 | 8.41 | 12.88 | 595 | \$766 | |
| 6 | 1 | 10 | 6/5/01 | 14:26 | 34 | 17 | 15 | 131 | 24 | No service required. | 82 | 85 | 8.48 | 12.33 | 2358 | \$2,907 | |
| | 2 | 10 | 5/21/01 | 10:39 | 27 | 25 | 13 | 84 | 27 | Fix low side heat transfer problem then add charge. | 64 | 68 | 6.76 | 12.54 | 740 | \$927 | \$219.76 |
| 6/5/01 | | | 14:17 | 37 | 26 | 14 | 133 | 25 | No service required. | 84 | 88 | 8.80 | 12.46 | 568 | \$708 | | |
| 7 | 1 | 10 | 5/21/01 | 10:51 | 27 | 25 | 15 | 132 | 47 | Clean condenser | 47 | 57 | 5.73 | 14.09 | 3493 | \$4,924 | \$1,898.53 |
| | | | 5/31/01 | 15:17 | 30 | 27 | 11 | 117 | 20 | No service required. | 80 | 77 | 7.68 | 11.62 | 2604 | \$3,025 | |
| | 2 | 10 | 5/21/01 | 10:55 | 29 | 18 | 31 | 115 | 42 | Fix low side heat transfer problem then add charge. | 55 | 66 | 6.64 | 13.99 | 753 | \$1,053 | \$279.10 |
| | | | 5/31/01 | 15:40 | 34 | 35 | 18 | 136 | 30 | Check for flow restriction. | 77 | 79 | 7.95 | 12.31 | 629 | \$774 | |

| Unit | Stage | Nominal Capacity | Date | Time | ET | SH | SC | PD | CTOA | Diagnosis | EI | CI | Actual Capacity | Consumption (kW) | Run Time (h) | Cost per year | Savings per year | |
|------|-------|------------------|---------|-------|----|----|----|-----|------|---|----|----|-----------------|------------------|--------------|---------------|------------------|----------|
| 8 | 1 | 10 | 5/21/01 | 11:07 | 29 | 25 | 19 | 116 | 42 | Clean condenser | 53 | 64 | 6.40 | 14.00 | 3124 | \$4,372 | \$1,370.59 | |
| | | | 6/1/01 | 11:17 | 30 | 35 | 17 | 135 | 20 | Check for flow restriction. | 81 | 76 | 7.60 | 11.41 | 2631 | \$3,002 | | |
| | 2 | 10 | 5/21/01 | 11:11 | 27 | 23 | 27 | 109 | 38 | Fix low side heat transfer problem then add charge. | 55 | 64 | 6.39 | 13.56 | 782 | \$1,060 | | \$304.92 |
| | | | 6/1/01 | 11:25 | 32 | 43 | 14 | 139 | 25 | Check for flow restriction. | 80 | 77 | 7.72 | 11.66 | 648 | \$755 | | |
| 9 | 1 | 10 | 5/21/01 | 11:20 | 30 | 21 | 28 | 123 | 43 | Remove charge. | 54 | 66 | 6.63 | 14.18 | 3017 | \$4,280 | \$1,626.82 | |
| | | | 6/1/01 | 11:34 | 30 | 35 | 10 | 107 | 11 | Check for flow restriction. | 93 | 82 | 8.16 | 10.82 | 2451 | \$2,653 | | |
| | 2 | 10 | 5/21/01 | 11:27 | 29 | 19 | 27 | 114 | 41 | Fix low side heat transfer problem then add charge. | 55 | 65 | 6.52 | 13.77 | 767 | \$1,057 | \$356.01 | |
| | | | 6/1/01 | 11:40 | 33 | 27 | 13 | 130 | 20 | No service required. | 86 | 84 | 8.41 | 11.78 | 595 | \$701 | | |
| 10 | 1 | 10 | 5/21/01 | 11:38 | 27 | 25 | 37 | 148 | 53 | Fix low side heat transfer problem then add charge. | 45 | 58 | 5.82 | 14.81 | 3439 | \$5,092 | \$2,311.30 | |
| | | | 6/1/01 | 11:59 | 27 | 40 | 17 | 126 | 13 | Check for flow restriction. | 89 | 77 | 7.70 | 10.71 | 2597 | \$2,781 | | |
| | 2 | 10 | 5/21/01 | 11:43 | 28 | 21 | 31 | 125 | 45 | Fix low side heat transfer problem then add charge. | 51 | 62 | 6.21 | 14.09 | 805 | \$1,134 | \$335.31 | |
| | | | 6/1/01 | 12:03 | 31 | 32 | 16 | 133 | 26 | Check for flow restriction. | 75 | 75 | 7.55 | 12.06 | 663 | \$799 | | |
| 11 | 1 | 10 | 5/21/01 | 11:53 | 27 | 22 | 47 | 191 | 66 | Fix low side heat transfer problem then add charge. | 38 | 53 | 5.28 | 15.73 | 3791 | \$5,962 | \$2,878.07 | |
| | | | 6/1/01 | 12:14 | 26 | 28 | 10 | 113 | 14 | Fix low side heat transfer problem then add charge. | 80 | 70 | 7.01 | 10.82 | 2851 | \$3,084 | | |
| | 2 | 10 | 5/21/01 | 11:58 | 26 | 19 | 26 | 126 | 44 | Fix low side heat transfer problem then add charge. | 48 | 59 | 5.86 | 14.11 | 854 | \$1,205 | \$378.71 | |
| | | | 6/1/01 | 12:17 | 28 | 31 | 13 | 126 | 24 | Check for flow restriction. | 73 | 71 | 7.11 | 11.75 | 703 | \$826 | | |
| 12 | 1 | 3 | 5/21/01 | 12:26 | 32 | 23 | 31 | 192 | 67 | Remove charge. | 39 | 55 | 1.65 | 4.79 | 3628 | \$1,738 | \$854.62 | |
| | | | 5/31/01 | 9:38 | 27 | 21 | 11 | 84 | 12 | Fix low side heat transfer problem then add charge. | 83 | 76 | 2.28 | 3.36 | 2632 | \$883 | | |
| 13 | 1 | 3 | 5/21/01 | 12:16 | 39 | 13 | 34 | 149 | 57 | Remove charge. | 51 | 74 | 2.23 | 4.91 | 2694 | \$1,323 | \$583.78 | |
| | | | 6/1/01 | 12:36 | 36 | 16 | 13 | 105 | 14 | No service required. | 98 | 95 | 2.84 | 3.51 | 2109 | \$740 | | |
| 14 | 1 | 4 | 5/21/01 | 12:08 | 34 | 11 | 36 | 163 | 60 | Remove charge. | 45 | 66 | 2.64 | 6.59 | 3034 | \$1,998 | \$993.53 | |
| | | | 6/28/01 | 13:22 | 39 | 10 | 10 | 169 | 18 | No service required. | 95 | 98 | 3.92 | 4.92 | 2041 | \$1,004 | | |

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|-----------------------------------|-----------------|-----------------|
| Whole store before service | 318.40 kW | \$58,337 |
| Whole store after service | 268.11 kW | \$37,614 |
| Total savings | 50.28 kW | \$20,723 |
| Actual service cost | | \$4,300 |