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United Illuminating Company "Cool Cash Credit" Program Review

Prepared for:
United Illuminating Company

Final Report
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Creators of CheckMe!®

I. Introduction

In September 1992, United Illuminating Company (UI) commissioned Proctor Engineering Group (PEG) to perform a review of their "Cool Cash Credit" program. This review examined the current "Cool Cash Credit" program in light of recent field research on AC tune ups. The objectives of this review are a "tuned" impact estimate and information to improve program implementation and optimize DSM resource acquisition. John Proctor, P.E., the president of Proctor Engineering Group, performed the review.

The "Cool Cash Credit" program (CCC) is a residential air conditioner tune up program that currently serves over 6500 households a year. In this program United Illuminating Company (UI) supplies promotional brochures to listed contractors. These brochures offer a $25 credit on the customer's utility bill if they have a twelve point tune up completed by the contractor. Customer and contractor response has grown every year, and UI initiated this assessment of the program.

The field reports used to make this assessment are listed in the Bibliography and References section.

II. Methodology

This investigation includes structured surveys of program contractors, a review of program records and customer rebate files, a review of the 1990 customer satisfaction survey (Mount Vernon Associates, 1990), and structured, open-ended interviews with UI program staff. Proctor Engineering Group (PEG) also examined UI documentation on costs and impact calculations.

INTERVIEWS

Contractor surveys were directed at seven contractors who delivered a high percentage of the rebated tune ups in 1992. On the basis of their estimated figures, these contractors performed well over half of the tune ups in the 1992 CCC program.

PEG's plan was to interview one person from management (preferably the service manager) and one technician. Technicians were only made available for two of the interviews.

Interviews concentrated on four areas:

- Technical -- What tasks do the technicians undertake in a tune up? How do they accomplish these tasks? What was the rate of diagnosis and repair of each problem?
- Quality Assurance -- What quality assurance procedures were used?
- Marketing -- How many units did each contractor complete? How did the UI program affect the number of tune ups done?
- Future Improvements -- From the contractor's perspective, how could the program be improved in the future?

DATA ANALYSIS

Self reported data on actions and perceptions are subject to several inherent biases. Necessary care must be taken to insure that the findings are both valid and reliable. In order to reduce the possibility of incorrect conclusions, we have adopted the common approach of insisting that reported results must be supported by two different sources. If a seemingly significant piece of information is not supported by a second source, it will be flagged as a single source item.

The savings and peak reduction estimates were calculated based on three scenarios: maximum, minimum, and most likely. Wherever possible, each parameter is estimated for all three of these situations. The discussion in this report concentrates on the most likely of these.

III. Results

The average contractor reported time to complete a tune up ranged from 45 minutes to 1.5 hours. Work that produces energy savings was accomplished on nearly all the units. Contractor work concentrated on the easiest tasks and in most cases did not address more difficult, but effective items. Energy savings and peak reduction from this program are estimated to be a credible 50% of the potential for programs of this design. Substantial amounts of the energy savings would have occurred without the program since a majority of the units in the program are tuned up annually without any incentive.

TUNE UP COMPONENTS

United Illuminating currently estimates the "Cool Cash Credit" program savings by engineering calculations. These calculations are based on the results of applying of the following items to the residential air conditioner:

1) Check voltage and amperage
2) Check refrigerant charge, leaks, pressure and temperature
3) Check and clean evaporator coil
4) Lubricate all moving parts including shaft bearings
5) Check belts and adjust tension
6) Replace filters
7) Check pressure switch settings
8) Check and clean electrical circuits
9) Clean and adjust thermostat
10) Check air temperature across condenser
11) Check and clean condenser coil
12) Check condensate drain

Several of these items affect the efficiency of the air conditioner. Some items are directed at the durability and dependability of the unit. Items 1, 4, 5, 7, and 8 predominantly affect durability, not efficiency.

Nine items have been identified by the author as likely to alter efficiency. These effective items include: replace air filter, clean outside coil, clean evaporator drain, repair undercharge, repair refrigerant leak, clean inside coil, turn off humidifier, repair overcharge, and repair duct leaks. The energy savings effect of each of these is estimated in the Energy Savings and Peak Reduction section of this report.

Every contractor mentioned the UI check list, and one contractor has added cleaning coils to his standard procedure as a result of the program. Nevertheless contractors were far more likely to perform one of the items if it also occurred in their own multi-point check list. The customer files and interviews confirm that items on contractor's check list are at least twice as likely to be completed than items that are only on UI's check list. The program influenced but did not substantially change what was undertaken in tune ups in their service area.

For all the contractors a tune up consists of:

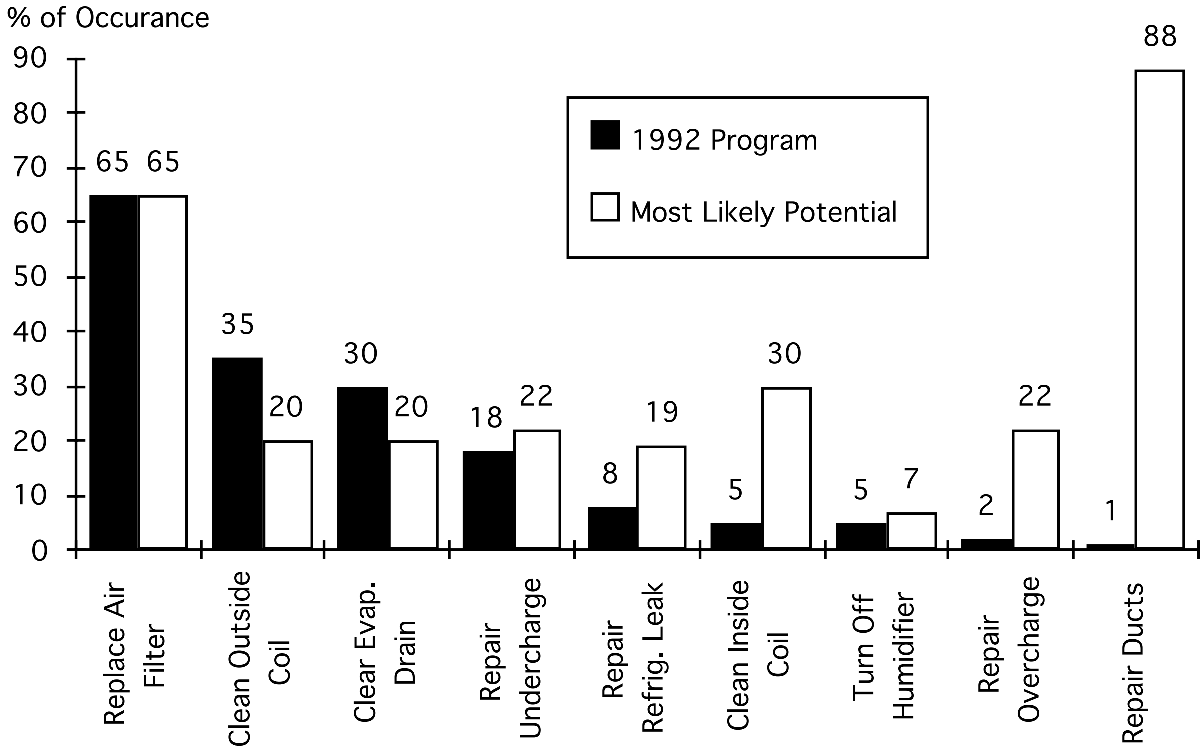
1) Checking amperage of the compressor.
2) Running the unit and checking the high and low side pressures with a gauge set. Contractors use this as the primary diagnostic tool of the status of the unit, especially with respect to charge.
3) Informing the customer if the charge is low.
4) Lubricating moving parts, if not permanently lubed.
5) Inspecting and often replacing the air filter.
6) Checking the electrical contractor to see if it is pitted or burnt.
7) Clearing the condensate drain.

The company we identified as doing the most effective tune up included the following items in their procedure:

1) Measuring the superheat or subcooling of the unit to determine proper charge.
2) Leak detection and repair on 75% of the undercharged units.
3) Removal of excess charge on overcharged units.
4) Cleaning the evaporator coil.
5) Cleaning the blower.
6) Draining and turning off humidifier.
7) Checking pressure drop across filter dryer.

The percentages of occurrence of the nine effective items (listed on page 4) in the 1992 program are compared to their probable potential occurrence rate. This comparison is displayed in Figure 1.

Figure 1. Occurrence of Effective Tune Up Components



While the first four components were very likely to be accomplished in the 1992 CCC program, the last five were not.

Air Filter -- Replacing the air filter is an effective an easily accomplished repair. It is most effective when it is coupled with customer education on the need to replace it monthly.

Outside Coil -- Cleaning the outside coil is easily accomplished and is necessary about 20 percent of the time. One contractor noted however that they, “Only clean it if there happens to be a hose handy.”

Evaporator Condensate Drain -- Clearing the condensate drain is important in hot and humid climates. If the drain is clogged, the air conditioner will remove less moisture from the indoor air. The increased indoor humidity can result in reduced comfort, lower thermostat settings, and higher use. It is likely that the drain is clogged less than 30 percent of the time.

Undercharge -- Repairing undercharge will improve the efficiency of the air conditioner. There are a number of unfortunate aspects to repairing undercharged units. Customers are less likely to use a unit that is undercharged, since it is not an effective cooling device. When the unit is recharged, it is common for the customer to use it more, increasing energy use.

Refrigerant Leaks -- Unfortunately, it is not standard practice to find and repair the leaks that cause the undercharge. It is safe to estimate that half of the units with leaks were not repaired in the past. It was common for these contractors to look for leaks only if the unit was "more than 1 1/2 pounds low." Without leak repair the unit will just return to its undercharged state.

Inside Coil -- It is difficult to access the dirty side of the coil. For this reason it is unlikely that it will be cleaned. The UI program has increased the awareness of these contractors about the importance of coil cleaning. However most of the technicians do not clean the coil unless the effects of reduced air flow are very apparent.

Humidifier -- A humidifier adds moisture to the indoor air. This increased moisture reduces comfort and requires additional dehumidification by the air conditioner. It is common for these contractors to drain and turn off humidifiers.

Overcharge -- An overcharged unit is inefficient, less durable, and has a higher watt draw at peak. Overcharged units are unlikely to be diagnosed by most of these contractors. It is possible that some of the units are overcharged in the process of the tune up. While only one contractor reported that they found overcharged units ("New customers often have overcharged units"), research in numerous locations has shown that overcharged units are as prevalent as undercharged ones. Proper diagnosis of charge requires that the proper air flow be established across the coil (a procedure that none of these contractors employed) and that superheat be measured on capillary tube units (a procedure regularly used by only one contractor).

Ducts -- Repairing disconnected and leaky ducts is a very effective repair. Only two contractors reported that they visually check ductwork. Studies by Proctor Engineering Group and others have shown that catastrophic duct leakage occurs in a substantial portion of the homes.

ENERGY SAVINGS AND PEAK REDUCTION

United Illuminating currently estimates that energy savings and peak reduction averaged 13.5 percent in the first year. This investigation indicates that average energy savings per unit is closer to 3 percent.

Peak reduction (as a percentage) will always be less than the energy savings. The cause for this is illustrated by four examples:

Not Home -- Some percentage of people will not be home at system peak and will have either turned their air conditioner off or raised the thermostat setting so high that it is not running on peak. Tune ups and other technologies designed to reduce load will have no peak reduction effect on these units. This effect is automatically accounted for when diversified load is used in the calculation.

Full On -- Some percentage of people will have just arrived home or will have decided to set their thermostats as low as it will go (believing it will speed up cooling on the hottest day). These units will be running full out regardless of the work performed. The expected drop in diversity will not occur on these units.

Effectively Undersized -- Some percentage of the units are effectively undersized, because of customer behavior, distribution system failure, or true undersizing. On a peak day these run continuously but the customer cannot maintain comfort. When the efficiency of these units is improved, a number of them will continue to run nearly continuously. While customer comfort will improve, the expected drop in diversity will not occur.

Oversized Constant Thermostat Setting -- Only oversized units with a constant thermostat setting will actually achieve a 1% peak reduction for every 1% energy savings.

Based on the field and laboratory data listed in the Bibliography and References section, the item by item estimates of energy savings and peak reduction are:

Air Filter -- Based on 4.4% savings for a 10% increase in air flow, the average increase in air flow is estimated at 5% for an energy savings of 2.2%. The peak reduction is estimated to be .15% of the diversified load. The average life expectancy is one half a season.

Outside Coil -- We have estimated the energy savings from cleaning the outside coil to be 2%, with a life of 2 years. The estimated peak reduction is 1.4% of the diversified load.

Evaporator Condensate Drain -- This investigator knows of no data for increased use due to clogged condensate drains. We have estimated this as a 4% energy savings, a 1.4% reduction in peak, and a life of 3 years.

Undercharge -- In field studies conducted by PEG using submeters on central air conditioners, repairing undercharged units resulted in an increase in energy use of 20%. The repair also increased the peak watt draw. For this analysis the increase in energy use is estimated at 4%, with an increase in peak draw of 1.4%. Since refrigerant leaks were not generally repaired, the life of this item is one half a season.

Refrigerant Leaks -- Repairing a refrigerant leak enables the charge to remain constant. Any effect is captured in the change in charge, the effect for repairing a leak is calculated as zero.

Inside Coil -- The increase in air flow from cleaning a dirty inside coil is estimated the be 11%. Energy savings is calculated as 4.8%, with a peak reduction of .4% and a life expectancy of 5 years.

Humidifier -- Since these tune ups occur all through the summer the life of this item is one half a season. It is estimated to reduce peak watt draw by 1.4% and reduce energy consumption by 5%

Overcharge -- Repairing overcharge is both long term (life of 5 years) and a substantial energy saver (11.5% savings). Since removing excess charge lowers the head pressure it also plays a substantial role in reducing peak (3.6% reduction).

Ducts -- Repairing ductwork is not an official component of the current program. However the small amount of duct repair done in this program contributes substantially to the total energy savings. This is due to the long life of these repairs (15 years) and the significant savings (estimated at 8% for the amount of work done). The peak reduction on homes in this program that had disconnected ducts reconnected is 1.4%. In programs utilizing duct repairs on air conditioners, a cooling energy savings of 17% is predicted for houses with ducts predominantly in the attic or crawlspace.

We have calculated the total energy savings as the weighted sum of these components with interactions taken into account. The savings estimate range for the 1992 program is 2% to 6%.

Figures 2 and 3 compare the revised estimate of energy savings and peak reduction to the potential for a program with this structure.

Figure 2 Energy Savings

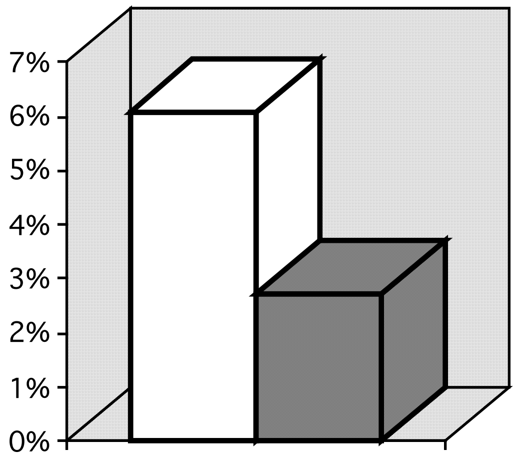
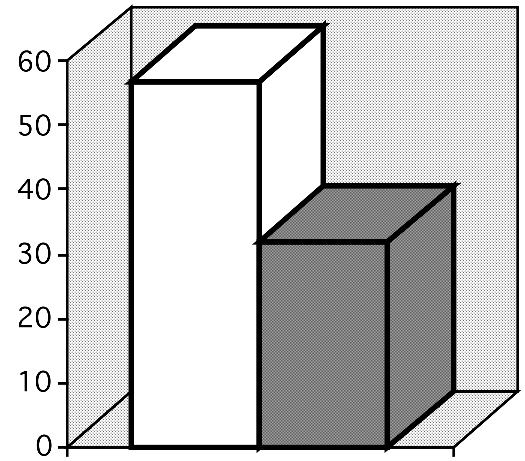
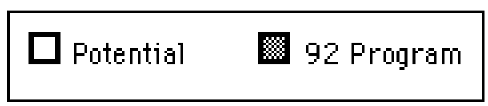


Figure 3 Peak Reduction (watts)





AVERAGE SEASONAL COOLING USE AND PEAK AC LOAD

United Illuminating estimated the average annual use of central air conditioners in the CCC program as 2,314 kWh. This number is based on a bill disaggregation study by UI at selected homes with central AC use in 1986 and 1987. We do not have sufficient data to determine the accuracy of this estimate. A use of 2,314 kWh would represent an average 3 ton unit running at an average EER (at ≈ 85°F) of 7 for 450 hours per season. This amount of hours is not high compared to the ARI estimate for New Haven. On the other hand, the average EER during running (at ≈ 85°F) is likely to be higher than 7. Additionally, the average AC use in Fresno, California, which has over twice the cooling degree days, is less than 1700 kWh (it should also be noted that Fresno has lower humidity than New Haven). We recommend that an updated study be performed on billing data from a sample of participants. The updated study could use the same disaggregation method as was used on the 1986-87 data.

Proctor Engineering Group suggests the following peak AC load estimation technique:

1) Estimate from nameplate data, the average rated EER of the participant units. The rated EER is applicable here since peak day temperature in New Haven is very near 95°F and ARI ratings are for 95°F.
2) Estimate from nameplate data, the average rated capacity.

3) Calculate the connected load at 95°F by dividing the rated capacity (in BTU/hr) by the rated EER.

4) Estimate the average load at 95°F by multiplying the connected load by the diversity at peak (both peak hour and temperature in that hour). If the peak occurs at a temperature other than 95°F, the average load will have to be adjusted based on the connected load at that temperature.

5) Whenever field data is available on actual EER, capacity, input, or diversity, that information would be preferred to the above estimates.

ADDITIONAL BENEFITS

This program has provided additional benefits to United Illuminating's customers. These benefits include more durable and reliable air conditioners. Proctor Engineering also investigated the possibility that a significant energy savings might occur due to AC replacements accomplished because of the program. Based on the interviews very few replacements were done as a result of this program. The replacements that did take place were usually due to some failure in the unit that would require replacement anyway.

LIFETIME

The lifetime of a tune up is currently estimated at 1.3 years. Lifetime is related to the elements contained in a tune up. For example, if the only repair is replacing a filter the effective life of that repair is less than a year for units that obtain regular maintenance. If the repair is cleaning an indoor coil however, the effectiveness is maintained for a long period (up to 5 years). There is therefore no single "lifetime" for a tune up. However the effective savings over time can be calculated.

If the program was a one time only program, the effective savings from the program would be twice the first year savings. This ignores the net to gross issues outlined below.

QUALITY ASSURANCE

The primary quality assurance designed into this program was UI's initial training on proper documentation and the financial bookkeeping associated with the rebates. Some contractors mentioned visits by UI field personnel early in the program. They clarified individual check list items.

Quality assurance at the contractor level varied from, "our technicians are experienced and do it right" to "the paperwork and measured numbers from every job are reviewed by the service manager." The latter contractor has a better than average quality assurance program and the field work appears to reflect increased quality.

CONTRACTORS' VIEW OF THE PROGRAM

The contractors universally loved the program. They felt that UI staff were helpful and that the program increased the number of tune ups they did in the program years. Most felt that the biggest improvement would be to insist on a higher level of quality from all contractors that participate in the program. One interviewee stated, "United Illuminating is endorsing the participating contractors whether they know it or not."

NET TO GROSS ISSUES

The results of this study suggest that the net to gross ratio for this program is close to 29% for the first year.

The customer survey indicates that 68% of the customers have tune ups every year without the rebate. The same survey indicates that 12% would have tune ups every other year without the rebate. Our review of the customer files and interviews confirm that a high percentage of these customers are on annual service contracts. The estimated total free ridership in the first year is approximately 68% + 12%/2 = 71% The amount of free ridership will increase year after year as more homeowners view annual tune ups as their normal course of action. The customer survey found that the number of participant households that intended to have annual tune ups increased from 68% to 83% in the first year of the CCC program.

There are also individuals who were motivated to tune up their air conditioner because of the program but did not return the rebate coupon to United Illuminating. The number of these individuals cannot be estimated from the data we have collected.

If the incentive is withdrawn there will be an ongoing effect. The customer survey indicates that approximately 14% of the customers who previously did not get annual tune ups would continue to get them. This effect would be medium to long term and would decay year after year.

Customer behavior may be different if the program is marketed in another manner that brings in a different mix of socioeconomic groups.

IV. Recommendations

If the “Cool Cash Credit” program is continued or used at a later date, Proctor Engineering Group recommends consideration of the following changes:

1) Target high use customers -- High use customers represent the highest potential for energy savings and peak reduction. This is true not only because of their high use but also because their air conditioning systems have a higher percentage of problems.

2) Target customers that do not regularly tune up their system -- Approximately 35,000 air conditioners in UI’s territory were not tuned-up in 1992. Most of these units are chronically ignored and represent a higher potential for savings than the current participants. Customers could be targeted through direct mail on a rotating basis.

   The estimated 35,000 is derived as follows. United Illuminating has an estimated 45,000 residential customers with central air conditioning. The contractors participating in this program probably provide over half of the tune ups in UI service territory (6500 air conditioners).

3) Employ an expanded quality assurance system -- This QA system should include:
   a) Step by step protocols for technicians -- These protocols should include improved air flow and charge testing
   b) Technician training on the procedure
   c) Forms containing the critical measured parameters should be returned to UI for examination
   d) A low cost review of this data via a computer expert system
   e) Sufficient inspections to insure that data on forms is correct
   f) Involvement of the service manager in this process, possibly moving the computer expert system into the contractor’s shop

4) Incorporation of duct repair as a long term and effective energy savings mechanism.

5) Insist on leak detection and repair on undercharged systems.

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