

Prepared by:  
Proctor Engineering Group, Ltd.  
San Rafael, CA 94901  
(415) 451-2480

# **Residential New Construction AC Installation Using CheckMe!<sup>TM</sup> Final Report**

Prepared for:  
ConSol and San Diego Gas and Electric Company

**Final Report**  
December 28, 1999

Author:  
John Proctor P.E.

Creators of CheckMe!<sup>®</sup>



## EXECUTIVE SUMMARY

---

Traditional approaches to transforming the installation market include education, training, and marketing. Experience has shown that these three items alone have not transformed the way residential air conditioners perform immediately after installation. The Residential New Construction AC CheckMe!™ project was designed to address this problem from a market transformation perspective.

Air conditioners and heat pumps perform well below their designed efficiency and capacity because of low airflow through the inside coil and incorrect refrigerant charge. This project was a field test of a computer expert system (CES). **It was designed to ensure that the two critical parameters of airflow and charge are properly tested and set by the installer.** In addition, a number of other installation items are addressed:

Nine technicians working for two contractors were trained on the system.

One of the contractors jumped on the system with enthusiasm and used it religiously. It helped them improve the quality of their installations and caught problems such as crossed refrigerant lines between two units. This contractor was highly successful in obtaining properly installed equipment. The specific results were:

- Refrigerant charge was correct on ***100 % of the units.*** By comparison, on average, less than 35% of new installations have correct charge.<sup>1</sup>
- Only 8% of the units installed under CheckMe!™ showed low air flow, while normal installation practice would result in over 70% with low air flow.
- The program spotted problems that could be costly to the contractor including three units with low capacity.

The start-up technician at the participating contractor had a number of suggestions to improve software usefulness. A number of these suggestions are being built into the next version.

The primary conclusion of the study is that the computer expert system in combination with training and strong marketing support has strong potential to produce a sustainable transformation of the AC installation market. This study showed that the keystones are the visibility, ongoing feedback, and discipline supplied by the CES along with a market push that establishes a properly installed AC as the expectation of the builder and homebuyer.

---

<sup>1</sup> "National Energy Savings Potential from Addressing Residential HVAC Installation Problems" Chris Neme, J. Proctor, and S. Nadel. February 1999 Vermont Energy Investment Corporation for United States Environmental Protection Agency.

## INTRODUCTION

---

Traditional approaches to transforming the installation market include education, training, and marketing. Experience has shown that these three items alone have not transformed the way residential air conditioners perform immediately after installation. The Residential New Construction AC CheckMe!<sup>TM</sup> (CheckMe!) project was designed to address this problem from a market transformation perspective.

Air conditioners and heat pumps perform well below their designed efficiency and capacity because of low airflow through the inside coil and incorrect refrigerant charge. The pertinent question is: "How can we change the way air conditioners are installed to obtain the designed performance?" This project was a field test of a computer expert system (CES). **It was designed to ensure that the two critical parameters of airflow and charge are properly tested and set by the installer.** In addition, a number of other installation items are addressed:

- Setting the outdoor unit (condenser)
- Proper refrigerant line brazing
- Leak testing refrigerant lines
- Proper evacuation of lines and evaporator coil
- Charge testing and correction
- Air flow testing and correction
- Duct system static pressures

Nine technicians working for two contractors were trained on the system.

The primary conclusion of the study is that the computer expert system in combination with training and strong marketing support has strong potential to produce a sustainable transformation of the AC installation market. This study showed that the keystones are the visibility, ongoing feedback, and discipline supplied by the CES along with a market push that establishes a properly installed AC as the expectation of the builder and homebuyer.

## DISCUSSION

---

Air conditioners and heat pumps perform well below their designed efficiency and capacity because of low airflow through the inside coil and incorrect refrigerant charge.

This program was able to address a portion of the market interaction between the installing HVAC Contractor and the Builder. It brings the contractors and technicians past initial market barriers of performance uncertainties as well as inadequate infrastructure and organization practices. Implementing an air conditioner installation that meets the manufacturers' standards results in positive benefits to the contractors, the builder, and the homebuyer.

### ***Desired Market Effects:***

The first desired market effect is integration of proper AC installation into widespread building practice. The usual installation does not include checking refrigerant charge and airflow with the manufacturers' specified methods. The prevailing methods are only effective in extreme situations. This is evidenced in national studies which show: refrigerant charge off by more than 5% on 60+% of the units, airflow low by more than 50 cfm per ton on 70+% of the units, and an average estimated achievable savings between 24% and 35% depending on the local situation<sup>2</sup>. Installation according to the manufacturers' specified methods can lead to sustainable change when the contractor and builder can reduce call backs and customer dissatisfaction.

This project successfully moved one of the two contractors to use proper installation procedures. This change is sustainable if the technician and contractor are brought beyond existing barriers:

- Performance uncertainty: Will the builder respond favorably to the improvements and will they be willing to pay the additional costs?
- Inadequate infrastructure and organization practices: Technicians have not practiced these techniques.

A second desired market effect is that builders realize the benefit from a proper installation and that this realization results in increasing market for the contractor. One item that needs to be addressed is the perceptions of the builder. They need to be sold on the value (monetary) of hiring a contractor that uses the proper technique. This could be a media campaign directed at the homebuyer (thus to the builders), direct presentations to builders, follow-up analyses and presentations to the builders, or a combination of all of these.

---

<sup>2</sup> "National Energy Savings Potential from Addressing Residential HVAC Installation Problems" Chris Neme, J. Proctor, and S. Nadel. February 1999 Vermont Energy Investment Corporation for United States Environmental Protection Agency.

### ***Intervention***

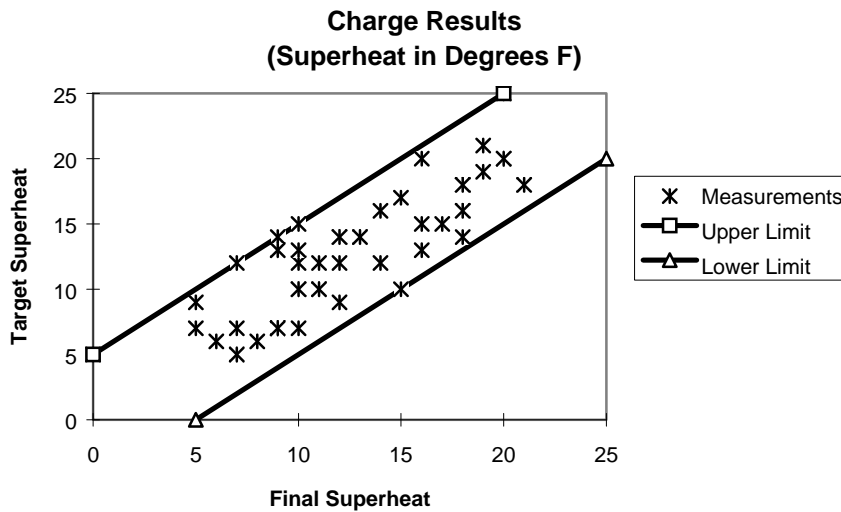
The intervention consisted of training technicians in the proper technique for installing air conditioners. This training was followed by field consulting with the technicians and immediate feedback to the technicians via the CheckMe!<sup>TM</sup> computer program running on the technician's laptop computer on site. Data from each installation were captured and analyzed at Proctor Engineering Group (PEG). PEG shared the results with the contractor and their technician. A results certificate for each unit was produced and mailed to the contractor.

## RESULTS

Nine individuals were trained at two different HVAC contractors. All but one of the installations completed under CheckMe were done by one individual. This individual was responsible for all the “start-ups” for the participating contractor.

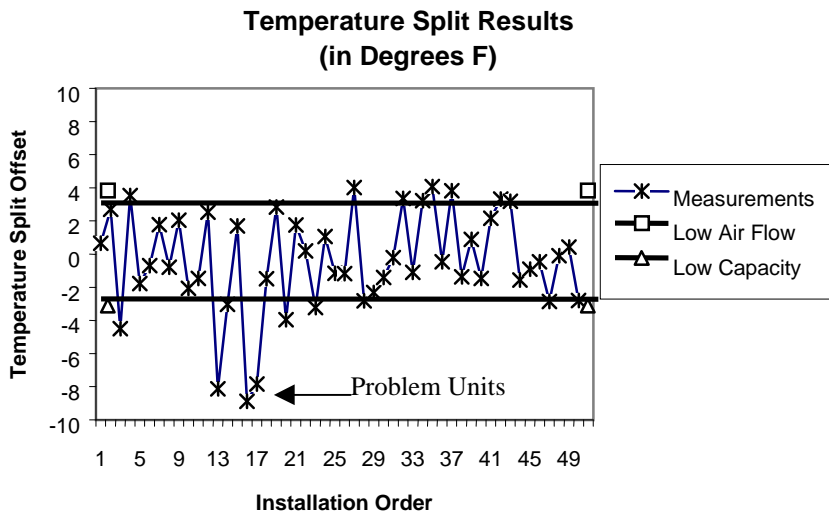
CheckMe caused the technician to continue working on the installation until the refrigerant charge was correct. One hundred percent of the units showed correct charge using the manufacturer’s preferred method of test at completion. This compares with a less than 40% showing correct charge on normal installations. Figure 1 shows that the units were always left with superheat within 5°F of the target superheat.

**Figure 1. Refrigerant Charge Results**



Only 8% of the units installed under CheckMe!™ showed low air flow, while normal installation practice would result in over 70% with low air flow. At the same time the program showed the viability of spotting problems that could be costly to the contractor. The data displayed in Figure 2 show three units that have low capacity. These are potentially call back units or units that may result in customer dissatisfaction. The program spotted these problem units immediately.

**Figure 2. Air Flow and Capacity Results**



Further analysis of the CheckMe data directed us to the duct static pressures. The technician was not effectively using static pressure measurements to diagnose the causes of low air flow. This was discussed with the technician at a follow-up visit to the contractor’s office.

There is evidence that the change may be sustainable. The sole participating contractor has approached Proctor Engineering Group about using CheckMe in all their installations, they have hired an individual to be their quality assurance person, and enthusiastically embraced the process.