INCREASING CONSUMER CONFIDENCE IN HEAT PUMPS

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ABSTRACT

Over 50 years ago an electric utility company located in the southern part of the United States had the vision, and they have maintained efforts to sustain it, of promoting electric heat pumps as a load management tool. Various programs and incentives have been utilized to do this in a manner that would be mutually beneficial to this company and its customers. This paper will discuss some of those initiatives that have led to increasing consumer confidence in heat pumps not only for this company's customers, but has influenced the entire market for electric heat pumps.

Key Words: heat pumps, load management, reliability, HVAC training

BACKGROUND

Alabama Power Company, a Southern Company, recognized the heat pump's potential in the 1940's when the equipment was used only for cooling. In brief, the company's involvement in the research development and marketing of this electric appliance included

- Co-sponsoring a grant in 1946 with Southern Research Institute in Birmingham, Alabama to develop the heat pump's heating capability.
- Installing Alabama's first commercial heat pump in the company's General Office in 1949.
- Promoting water source heat pumps in residential and commercial application in coastal Alabama in 1950.
- Installing heat pumps in four company offices around the state in the early 1950's.
- Documenting sales of 1275 residential, 443 commercial, and 26 industrial heat pumps by 1959.
- Initiating a Certified Dealer Program in 1964 to encourage support from builders.
- Initiating the Assured Service Heat Pump Program in 1967 whereby the company would offer a ten- year service maintenance program to customers provided the units met certain criteria.
- Initiating marketing incentive programs in the 1980's for builders and financing programs for customers that have been refined and enhanced for today's market.
- Opening the HVAC Training Center to train HVAC contractors on installation and service for heat pumps in 1986.

In the early sixties, the company had thought a "Certified Dealer" initiative would solve the problems with heat pumps being promoted in the marketplace. Dealers signed an "agreement" whereby they would install the units per manufacturer's instructions; however problems did not go away. Many installing contractors did not live up to expectations and installations continued to be substandard. Many products were also substandard, though proof was to come later. Enter the Assured Service Heat Pump Program (ASP) in 1967. The ASP had binding agreements with manufacturers, wholesale distributors and "Certified" dealers, with all agreeing to abide by published, "Manufacturer's Standards", "Standards for Application and Installation of Heat Pump Systems" and "Service to Heat Pump Systems", each of which was jointly developed by subject matter experts. Each dealer had to be recommended by a wholesale distributor, meaning partnerships existed if problems developed. Each installation was checked by a utility company "specialist" to ensure conformance to the aforementioned standards. If the installation did not pass the inspection, the installing dealer was asked to correct the deficiencies. If he refused, the wholesale

distributor stepped in to assist and "bye-bye, Mr. Dealer". If the installation passed an inspection for performance and conformance, the customer was offered a Ten Year Assured Service Maintenance Contract. The Contract provided for the customer to pay the utility a fixed amount each month and the dealer would perform necessary repairs for up to ten years. (Significant point: No entire units would be replaced under contract.)

Concurrently, the utility hired an engineer from a manufacturer who was intimately familiar with heat pump installation, service, and repair. He laid out a system to code each invoice to include the Reason for the Call, the Servicer's Analysis, the Corrective Actions taken and a Defect Code for each defect noted. This individual coded every invoice for over 20 years so consistency was present. From these codes computer programs were designed to cumulate records by Manufacturer, breaking down further by Package or Split system, and Model number. Major cost items were identified and compressor failure rates and costs were at the top of the list. These records provided a methodology to analyze each manufacturer's units, reliability-wise, to determine the types of problems, the frequency of occurrence, and the cost to repair.

The program sounds simple in 2005, but this was definitely "breaking new ground" in 1971 when the first verifiable computer reports were presented to manufacturers. History says you forget some things but some of the stories are indelibly etched in my mind and of others who worked closely with the ASP. Manufacturers were never told how to correct their problems; however, problems were pointed out regularly. Most manufacturers knew when they had problems, however some manufacturers appeared to be in denial.

On the positive side, however, some manufacturer's decision makers came to visit with us or invited our team to visit their facilities to openly discuss the issues being experienced in the field. While never breaking a confidence of discussing specific problems of other participants, a mutual trust was established that remains even today. One manufacturer built a test facility to test incoming components to be used in his products. Virtually all manufacturers came to appreciate the candor and validity and realized what they were being provided was valuable and unavailable from other sources.

Several heat pump models and some complete product lines were removed from the Company's list of "Units Approved for Service Contract". When this happened to one manufacturer, he took his units under his own "manufacturer's" contract. One who was removed later told us "it was the best thing that ever happened to us". "We had problems, but were not facing up to them until "removal" forced the issue." The manufacturer with the largest market share (40%) had his entire product line removed for poor reliability and his failure to do anything about them. . Talk about problems: when our utility's field sales personnel saw their main product line disappear, they began to hedge and considered not backing our own ASP. More importantly, however, management, including the CEO of the utility company saw a "bigger picture" and the vision his Marketing Management had for the future sales of off-peak loads. More than once, we met in the Company's Board Room to hear from executives of HVAC manufacturers who thought they were being mistreated. Our position was steadfast, "let the records speak for themselves". Management did not retreat or ask us to re-evaluate some special situation to take off some political pressure.

Major improvements were made in the quality of products in the 1970's and 1980's and installations improved dramatically. The "list" of units being offered under the ASP became less volatile. Some manufacturers saw new market opportunities for heat pump sales particularly with the oil embargo of the 70's and went to less expensive and lower quality products in hopes of capturing market share. The ASP records captured these deficiencies and some of the major manufacturers were again affected by having certain models removed.

In the early 1980's, after almost 20 years in the ASP, additional marketing initiatives were beginning to have a positive impact on heat pump sales. Consumer financing programs for employees and the public

were put into place that had a positive impact on the replacement market. Dealer and builder incentives were also initiated. Each had an immediate and positive impact on heat pump sales.

It was time for another major decision: end the ASP; "Let's see if heat pumps can stand on their own merit". Some might say, "Let the Customer Beware'! The Rational: Resources were being reduced, making checking all installations not possible. Random checks by utility specialists or asking dealers to check their own units proved to be impractical. On the positive side, however, product reliability was much improved, and installations were significantly improved. Customer acceptance of heat pumps was improving. Dealers were doing good work! Heat pump products were reliable.

With a cadre of trained electric utility "specialists", valued relationships with manufacturers and wholesale distributors, a decision was made to phase out the Assured Service Program and open the "Heat Pump Training Center", later re-named the "HVAC Training Center". Some saw the utility as taking off the "black hat" and putting on a "white hat"; meaning we were going to be "proactive" and teach proper service and installation up front rather than be "reactive". The analogy may not be totally accurate because manufacturing problems would not have been pointed out as quickly or with the same degree of accuracy without the records. The decision was made, however, and it was the right decision. In 1985 resources were deployed to form the HPTC with the first class offering in 1986.

EPRI Involvement in Heat Pump Reliability

The Electric Power Research Institute (EPRI) became interested in heat pump reliability in the mid-eighties and initiated a series of studies aimed at publishing reliability results from various regions of the United States. Six studies were done (see references), four of which were in Alabama. This paper will address two, one published in 1985 and one published in 2001. These two focus on Heat Pump Service Life in a southern climate of the United States.

While the 1985 heat pump life study provided the first scientifically verifiable information on heat pump service life, it was clear that the heat pump industry was still maturing because of the great increase in number of heat pumps installed during the 1970's and 1980's compared to prior years. The follow-up heat pump life study published in 2001 was intended to reexamine heat pump service life after a greater number of units had been replaced (Lovvorn, Hiller, Bartolucci, 2001).

Survey Methodology

A telephone survey was performed on locations where records indicated that heat pumps had once been installed. A telephone survey was deemed to be the most cost-effect method of gathering the needed information in a timely manner. The survey questionnaire was developed based on experience gained with the previous heat pump life study. An independent market research firm performed the actual survey. The survey was structured as a general heating and cooling survey to avoid biasing results, and the sponsor was not identified.

This maintenance contract program provided researchers with a list of known locations where heat pumps had once been installed, and confirmed their installation dates. While participants were allowed to remain under the maintenance contract program for up to 10 years, not all did. This study drew its survey sample from the complete list of former maintenance program homes, whether or not they remained under the program for the full 10 years. Additionally, the program stopped accepting new participants in 1985. All heat pumps in the survey installed after 1985 had never been under the maintenance contract program, although the home had once had a heat pump that had been.

Survey Sample

The survey sample pool was divided into five groups. The first four groups corresponded to the same installation time frames as in the 1985 survey. The fifth group consisted of heat pumps installed after 1985, the date when no new units were accepted under the maintenance contract program.

A total potential survey population of 12,566 heat pumps was identified for units in the first 4 groups. Table 1 summarizes the numbers of target and actual successfully completed heat pump surveys.

TABLE 1
SURVEY POPULATION

Group	Year Installed	Total Population	Target Number o Surveys	Number of Successfully Completed Surveys
1	1964-1967	663	50	71
2	1967-1971	3449	361	183
3	1972-1974	1943	201	108
4	1974-1985	6511	989	660
5	1986 and later			796
Total		12566	1601	1818

To assure a high level of randomness, the listing of homeowner names was reordered to be alphabetical before selecting the subsets. However, the small number of the earliest installation date locations that could be successfully contacted limited the ability to randomly subdivide the sample of those units, and attempts were made to contact most of that group.

Total System Service Life

Figure 1 shows the total heat pump system service life distribution (percent survival vs. age) for all brands as a group. The median service life (the age at which 50% of units have been removed from service and 50% remain in use) for all heat pumps as a group was found to be approximately 20.5 years. This result is very similar to the findings of the 1985 study. However, figure 1 is valid to a much greater total age than in the 1985 study because of the greater number of older heat pumps now available in the sample.

No significant differences in service life distribution were observed for units of different vintages (installed in different time periods). This is most likely due to the kinds of factors that were found to most heavily influence heat pump replacement decisions (see later discussion).

Heat Pump Service Life by Brand

More than 20 different heat pump brands are represented in the data, however five manufacturers dominate the database. Figures 2 through 7 show the survival curves for different manufacturers, identified as A, B, C, D, E, and O, where all heat pumps other than A-E are included in O. The manufacturer identifiers used here are intentionally different than those used in the 1985 work.

Manufacturer D heat pumps showed the longest median service life at between 24 and 25 years. Manufacturers A, B, C, and E all had median service lives in the 19-21 year range. The median service life of all other brands as a group (shown as manufacturer O) was around 18 years.

All the equipment life curves have been truncated when remaining sample size becomes small, typically with less than 25- 30 units remaining in use in the sample.

Replaced at Failure Heat Pump Service Life

Results of the 1985 study in Alabama showed that nearly 50 % of heat pumps that had been removed from service were still operational when removed. The current study shows that the number of units still operational when removed has increased to 63%. More insight on this difference is given later in the discussion on reasons found for replacing units.

Figure 8 shows the total heat pump system survival curve that results if we eliminate from the sample units that had been still operational when removed, thus producing a "replaced only due to failure" equipment service life distribution. The observed median service life of heat pumps if only removed due to failure was approximately 26 years. See the section on reasons for replacement for more discussion of this result.

Average Age At Replacement

When a comprehensive equipment life study is performed, it is possible to determine percent survival vs. age, as well as the average age at which units that have been removed from service (usually a small percentage of the total number of units) have been removed. It can be shown mathematically that average age at replacement is always less than median service life, and that it asymptotically approaches median service life as age of the sample increases.

Average age at replacement of total heat pump systems found in the 1985 study was approximately 13.5 years. Average age at replacement found in the current study was 18.2 years. This increase was expected, since average age of the sample had increased and more units have now been replaced. Note that in 1985, average age at replacement was less than 70 % of the median service life. This percentage has now increased to almost 90%.

Compressor Life

A compressor life study was performed by EPRI in the 1980's (Lovvorn, Hiller, 1987), using information from the heat pump maintenance contract program database. While only 10 years of information was present in the database, a reasonable projection showed that the median service life of original factory installed compressors was approximately 13.5 years.

The 2001 heat pump life study attempted to collect information on compressor replacements directly from homeowners. Analysis of the results showed that due to many of the homes having changed ownership, information on component replacements was not reliably obtained from many of the earliest units installed, and thus compressor service life could not be definitively determined. It was possible to determine that compressor service life was at least 13.5 years, but how much more could not be determined. Compressor replacements were relatively rare in newer vintage units.

Factors Affecting Heat Pump Replacement Decisions

Between 88 and 92% of removed heat pumps were replaced with new heat pumps in this study. Figure 9 shows the most frequently cited reasons for heat pump replacements. Note that since respondents could give more than one reason, the results are shown in terms of percentage of responses rather than percentage of units. The most frequently cited reason for replacing units was that the unit was simply getting old in the view of the owner (33% of responses) "Failure" was the second most cited reason, at 31 % of responses. All other reasons were cited considerably less frequently. When analyzed in terms of number of units, failure was a factor in only 38% of replacements, and when combined with operational problems still totaled less than 50%.

Comments on Homeowner Perceptions

Since more than 50% of units were still operational when replaced and the foremost reason for replacement was the homeowner's perception that a unit was "getting old", survey results suggest that many replacements are done proactively in anticipation of a failure that may or may not occur in the near future.

Respondent comments clearly indicated that maintenance requirements were down for newer vintage units, while satisfaction was up. This suggests that equipment improvements have improved heat pump performance and reliability, but have not yet increased service life. The reason little service life increase has been observed is probably because replacements are mostly not failure induced, but rather are due to perceptions of anticipated life on the part of the owner. It appears likely that heat pump median service life would increase if owners simply let them continue to operate instead of replacing them.

Customer Attitudes Toward Heat Pumps

Respondents were given the opportunity at the end of the survey to provide additional unstructured comments. Both positive and negative comments about their satisfaction with their heat pump were received. However, neutral-to-positive comments outnumbered negative comments by a 4-to-1 margin (79 % positive to 21% negative). The "other/general negative" comments were mostly general statements, such as "I don't like heat pumps", or were a replacement of a heat pump with an alternative heating system with no comment.

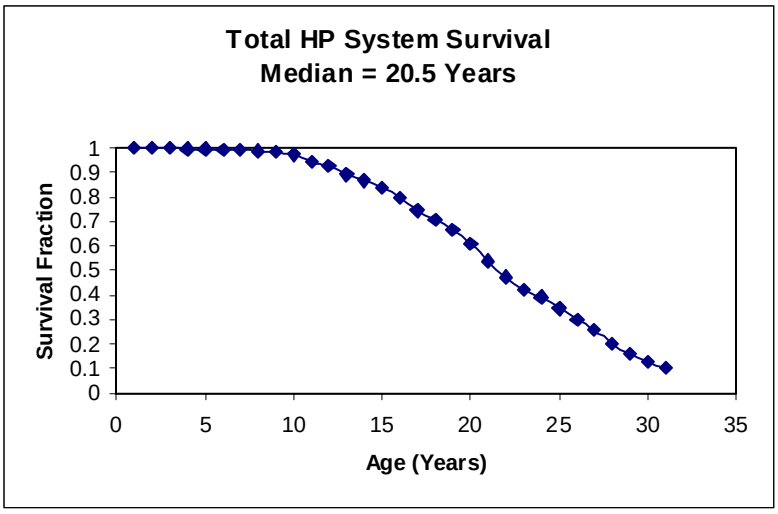


Figure 1

Total Heat Pump System Survival vs. Age

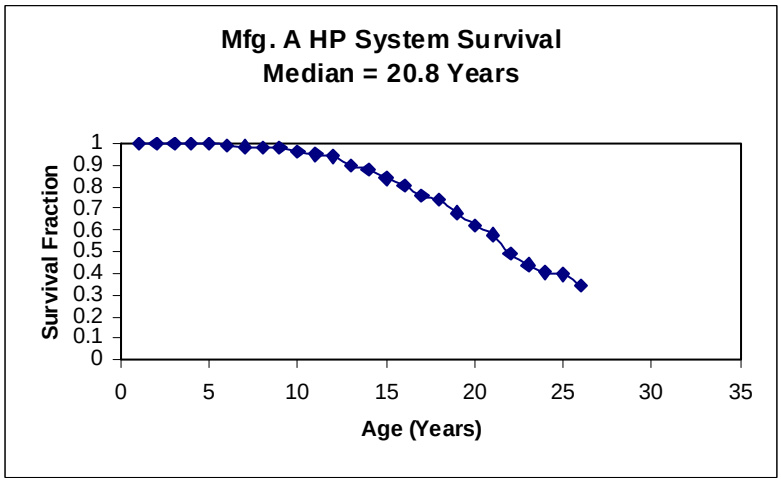


Figure 2

Manufacturer A Heat Pump System Survival vs. Age

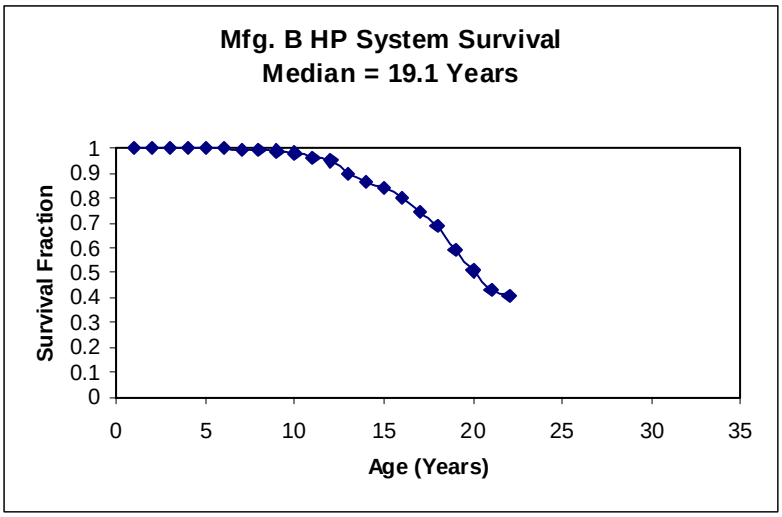


Figure 3
Manufacturer B Heat Pump System Survival vs. Age

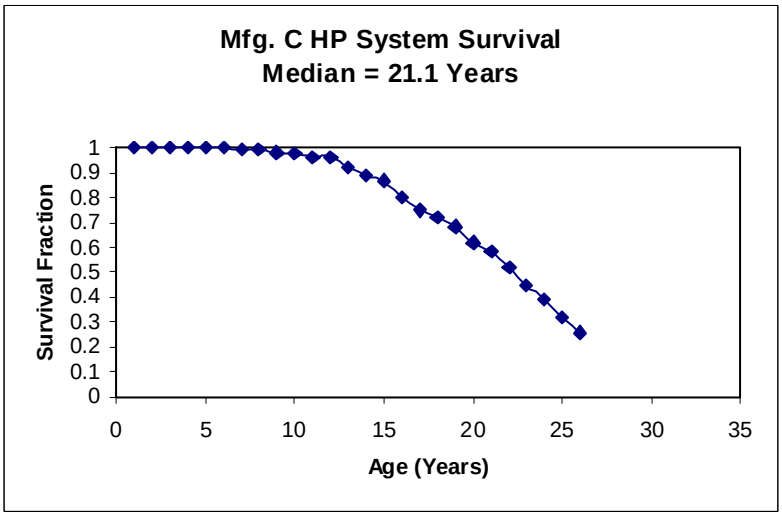


Figure 4

Manufacturer C Heat Pump System Survival vs. Age

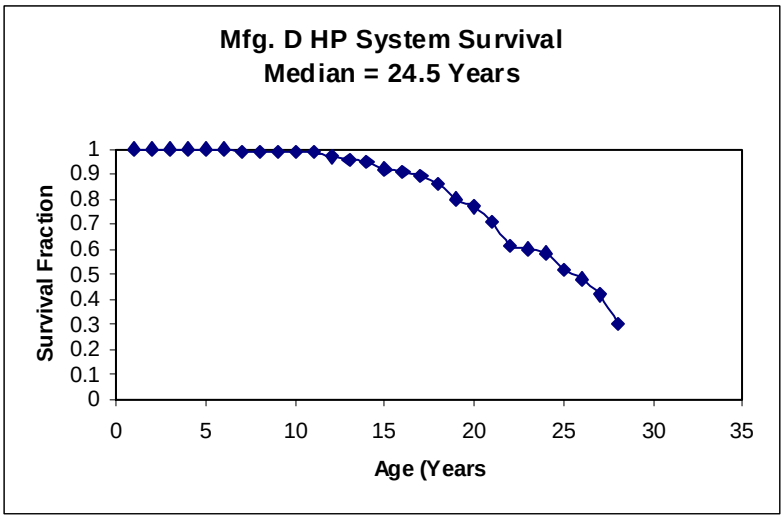


Figure 5

Manufacturer D Heat Pump System Survival vs. Age

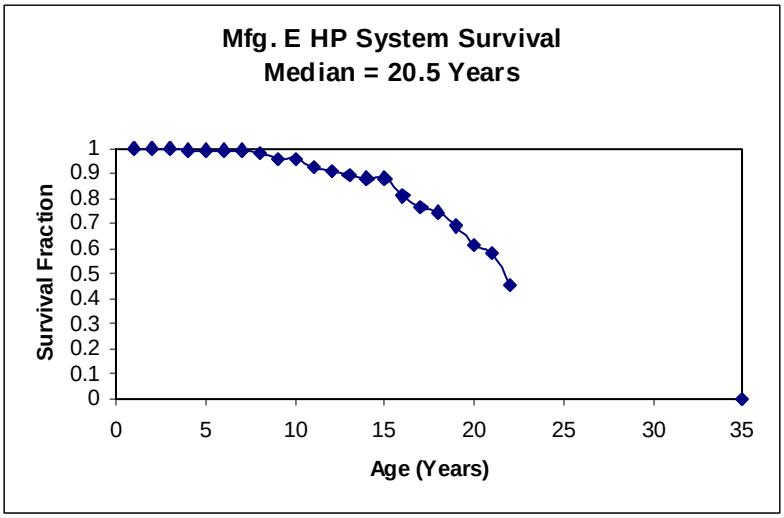


Figure 6

Manufacturer E Heat Pump System Survival vs. Age

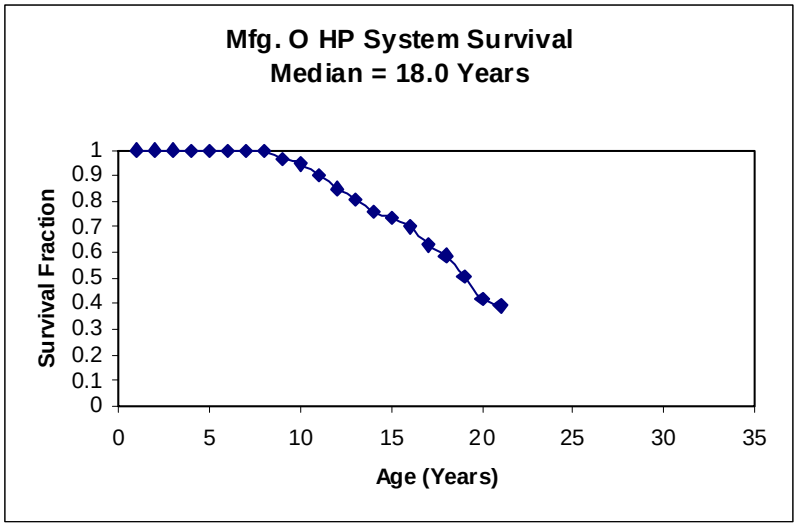


Figure 7
Manufacturer O Heat Pump System Survival vs. Age

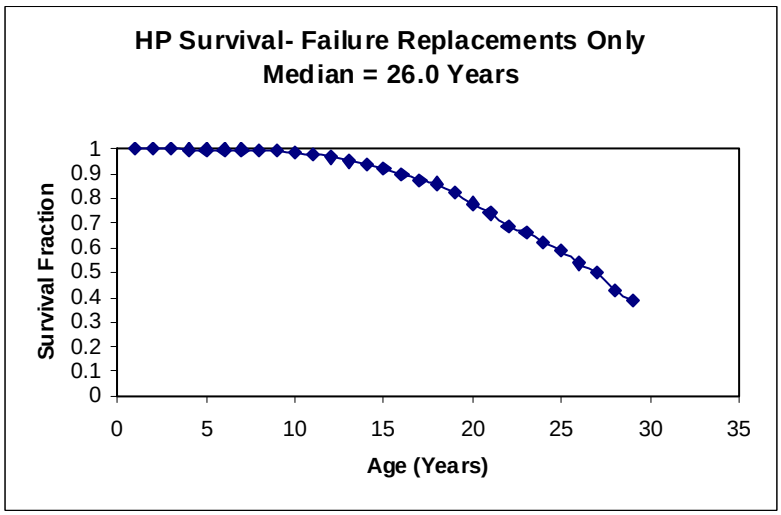


Figure 8

Heat Pump System Survival-to-Failure vs. Age

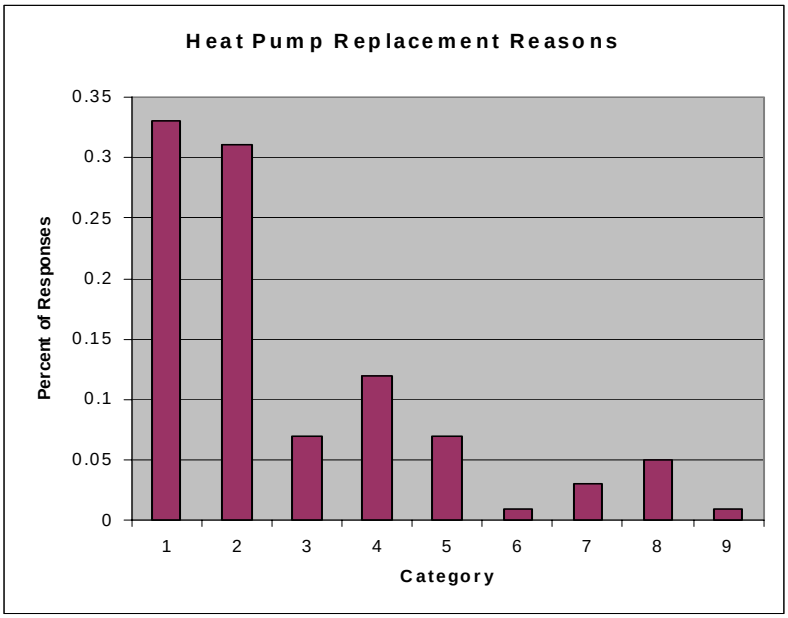


Figure 9
Heat Pump Replacement Reasons

1. Unit getting old
2. Unit Failed
3. Unit Having Operational Problems
4. Efficiency or Comfort Upgrade
5. Excessive Repair Costs
6. Advertising and promotion
7. Natural Disaster
8. Other
9. Don’t Know

HVAC Training Center

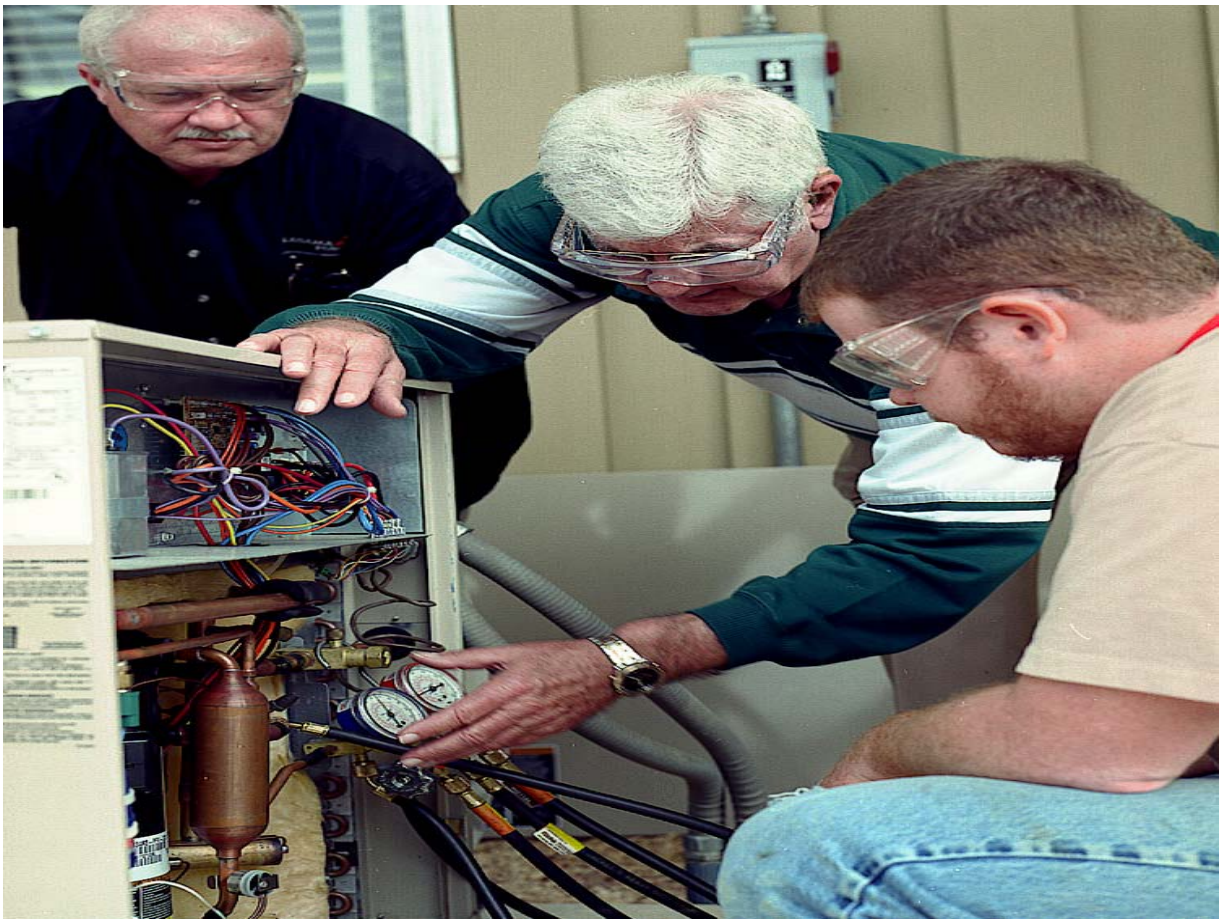
“One of a kind" is a phrase often used to describe Alabama Power's HVAC Training Center. Centrally located in the state and overlooking picturesque Mitchell Dam, the state-of-the-art facility has provided training, professional development and continuing education to over 20,000 participants from 40 states and three countries since 1986

The 15,000-square-foot main building houses three classrooms, three laboratories, an auditorium, dining area, computer laboratory, library, offices and administrative area. The three classrooms can easily be expanded to five.

The building is equipped with 29 fully operational trainer units from 26 manufacturers; types include air source, geothermal, and dual-fuel heat pumps and commercial heat pump water heaters. The Center's staff has modified the units so participants can address virtually any technical, electrical, refrigerant or air-related questions.

The facility features 14 heat pumps mounted on casters and used for tasks such as rewiring electrical systems and re-piping refrigerant systems. Simulators with internally metered devices to reflect time and proper trouble-shooting procedures measure the participant's ability to repair potential problems.

In addition to the main building, the Center includes a 1,536-square-foot house with a full basement for duct board fabrication training. One half of the house is of Good Cents energy-efficient construction; the other half is of conventional construction. Cutaways allow the participant to see the advantages and disadvantages of both types of construction. Together, the facilities offer the most current equipment supplemented by hands-on, performance-based classroom training.



CONCLUSIONS

1. Total heat pump system median service life in the 2001 EPRI report was found to be 20.5 years – similar to results of the 1985 study. Median service lives of various brands ranged from 18 to approximately 25 years.

2. Average age at replacement for that subset of the population that had been replaced in the 2001 report was 18.2 years, up from 13.5 years in the 1985 study. This increase was anticipated because more heat pumps have now been replaced and the average age of the survey population has increased.

3. Approximately 63% of the heat pumps that were replaced were still operational when replaced, up from slightly less than 50% in the 1985 study.

4. The most frequently cited reason for heat pump replacement was that the unit was simply getting old. This indicates that owner perception of how long their unit will last is a major factor in determining when units get replaced, and many units are apparently replaced prematurely. Failure was the second most often cited replacement reason, with around 38% of units replaced due to failure.

5. Over 20,000 persons from 40 states and 3 foreign countries have participated in training at the HVAC Training Center.

6. Heat pumps sales are up in Alabama. In 2004, the electric utility represented here had approximately 1.3 million residential customers with approximately 13,000 new customers (single family residences). Over 60% of these new homes installed heat pumps and over 10,000 heat pumps were installed in the retrofit market.

7. Incentives for builders and customers, along with customer financing, initiated in the eighties have been refined and enhanced but continued to have a dramatic, positive impact on market growth through 2004.

8. Dealer competency levels have increased through outstanding training classes offered at the HVAC Training Center. When coupled with reliable products, a win-win situation for the customer is maintained.

Epilog

Has consumer confidence in heat pumps changed? Yes! And in a very positive way. What part did the Assured Service Program, the Certified Dealer Program or the HVAC Training Center play in this successful sales effort? The initiatives to address reliability concerns from 25-30 years ago were significant and the HVAC Training Center continues to serve the industry well. Heat pumps have proven to be viable and marketable when installed and serviced properly.

I am proud to have been a small part of an electric utility whose management had the vision to embark on a course that would lead to a positive outcome and ”stay the course" even when the road got “rocky”. I’m also proud that this utility has continued to see the value in training dealers at its HVAC Training Center. This Training center could have been closed on more than one occasion with “economy” moves that are addressed regularly. I commend the vision of management to stay the course when other companies did not. Heat pump sales and Market share statistics indicate it was a good decision. However, the true winners are the satisfied customers who enjoy comfort in their homes provided by quality heat pump installations.

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