March 21, 2007

Summary of External Review of Disposable Container Heel Testing Study Report

I. Introduction

In 2006, the U.S. Environmental Protection Agency commissioned the Universal Technical Institute (UTI) to conduct tests to determine the amount of refrigerant remaining in disposable 12 ounce cans and 30 pound cylinders used to charge motor vehicle air conditioning (MVAC) systems.

The draft *Disposable Container Heel Testing Study Report* authored by Perrin Quarles Associates, Inc., for the EPA's Stratospheric Protection Division, describes the heel test methodology and results. The report also includes estimates of potential heel emissions based on the heel test results and national sales data, and outlines possible practices to reduce heel emissions.

Independent and stakeholder reviewers commented on the draft *Disposable Container Heel Testing Study Report.* This document provides the reviewer comments, and recommends possible changes to the draft report based on those comments.

II. Reviewers

The individuals that participated in the review, and their affiliation, are identified in the table below. James Baker and Frank Rogers served as the peer reviewers. Rich Henry, Bill Quest, and Gary Murray submitted stakeholder comments. Steve Gentry of Worthington Cylinder Corporation, a manufacturer of 30 pound cylinders, did not provide any comments on the draft report.

MVAC Segment	Name	Affiliation
MVAC System Manufacturer	James A. Baker	Delphi
OEM service engineer	Frank L. Rogers	General Motors
Small Can Manufacturer	Rick Henry	Sexton Can Company
Do-it-yourself (DIY) servicing	Bill Quest	ES Products
Refrigerant Handling Equipment Manufacturer	Gary Murray	SPX Service Solutions
30 Pound Cylinder Manufacturer	Steve Gentry	Worthington Cylinder Corporation

III. Reviewer Comments

Given the brevity of the overall comments, this document provides the comments in full text in the appendix. We have added category headings to organize the comments and have otherwise only edited for obvious spelling and typographical errors and formatting. The following section provides a discussion and response to each category of comments.

IV. Response to Review Comments

The two peer reviewers with affiliation to original equipment manufacturers of vehicles or MVAC systems were positive about the draft study report. James Baker found it to be a credible work, and Frank Rogers commented that it was a good job. Both had questions and comments, which will be addressed later in this section.

Gary Murray, with a refrigerant handling equipment company in the professional servicing sector, also thought the report was fine, that the small can method and study was consistent with what he would expect, and provided some additional comments on aspects of 30 pound cylinder refrigerant transfer.

Rick Henry, with a small can manufacturer, and Bill Quest with a manufacturer of products used by do-it-yourselfers (DIYers) had strong concerns with the report, particularly with the scope of the report compared to the UTI study, and perceived errors related to the observations, emission estimates, and practices.

The comments are categorized below. The report contents and the scope of the study are addressed first.

A. Scope of Study

Bill Quest's review commented that the draft report goes far outside the scope of the study and draws conclusions based on assumptions from an ad hoc survey of students that was not part of the original protocol, an informal study done by Hoffpauir, and additional information supplied by one of the proctors, Ward Atkinson. Further, the other co-proctor, Ken Adams was not consulted in the preparation of this draft report. He goes on to comment that the study was done under the auspices of the MACAPSEP, and should be unbiased and within the original agreed upon scope and protocol for the study.

Rick Henry also points out similar areas outside the scope of the study that should be removed from the report including the Mobile Air Conditioning Society (MACS) 30 pound cylinder testing, charge kit leak observations, charge kit gauge discussions, mention of emissions from charging leaking systems, and the cost information from Elvis Hoffpauir, President of the Mobile Air Conditioning Society.

Response:

The results of the independent 30 pound cylinder testing performed by MACS were removed from the final report. Observations and the discussion of charge kit pressure gauge readings, vent temperatures, and charge kit leaks were retained in the report as the observations were made during the UTI heel testing, and are relevant to the consideration of heel emissions and practices that might reduce heel emissions.

The informal student survey conducted by Ward Atkinson was used in conjunction with charge kit instructions to develop a small can emission estimate, and to help refine public education content efforts. Public education was also part of the study goal. The report has been revised to note the limitations of the survey information in estimating small can practices across the general population.

The final report does not include the footnote with the professional servicing cost information provided by Elvis Hoffpauir.

B. Professional Use of Small Cans

Bill Quest noted that the report associates small cans only with DIYers when 30% of the small cans sold are used by professional service shops.

Response:

The final report notes that small cans are also used by professional service shops. The predominate use is by DIYers.

C. 30 Pound Cylinder Test Procedures (Section 2)

Rick Henry commented that the 30 pound cylinders were deemed empty with no discussion as to filling times for different levels of refrigerant in the cylinder, especially as the cylinder is close to empty. He also commented that there was no protocol on the method used to empty the containers. Gary Murray speculated on whether or not there was a spring biased check valve to prevent refilling, and whether the valve might limit the vacuum pulled to empty the cylinder.

Response:

The 30 pound cylinders were taken from cylinders determined to be empty by UTI service personnel in the course of their MVAC servicing activity. This was described in the report, and no changes were made in the final report. The testers did not identify potential issues with spring biased check valves in the data results. They were able to pull cylinder vacuums of 28 in. Hg during the second cylinder recovery runs.

D. Small Can Heel Results (Section 3, Figure 5)

Bill Quest noted that the agreed test protocol called for a 30 minute test. Figure 5 in the draft report stops at 15 minutes.

Response:

Figure 5 was revised in the final report to add columns for the average 30 minute heels for gas phase charging of the two types of MVAC systems. Liquid and gas-liquid mix charging was completed in under 30 minutes.

E. Small Can Test Observations - Kit Gauge (Section 3.1.2)

A number of reviewers commented on the charging kit gauge observations and discussion beyond the issue of whether these observations were beyond the scope of the study. James Baker noted that the gauge can only indicate an undercharged system. Bill Quest commented that the gauge is used in an identical manner as a professional would use the low side gauge of a manifold gauge set. He also noted that it is necessary to close the refrigerants can or flow to take the reading, and from a conversation with Ken Adams, the co-proctor, he understood this was not discussed during the testing procedure.

Response:

The reviewer comments do not contradict the report discussion. Also, the March 16, 2006, small can test protocol has the test personnel record high and low side pressure after the kit valve has been closed. The report text was not revised.

F. Small Can Test Observations - Charge Kit Leaks (Section 3.1.2)

Bill Quest noted that in a conversation with Ken Adams, the co-proctor, charge kit hose leaks were not discussed during the testing procedure, and the report statement that all of the charge kits leaked was not true. One recharge hose leaked, and that kit was rejected and not used.

Response:

The primary staff person from UTI who conducted the tests confirmed that all of the charge kits leaked as described in the draft report. The tester noted that leaks occurred particularly where the hose connected to the can, and thought that it could be due to the cold temperature combined with the can rotation, though he could not be sure. The discussion was not revised in the final report. The observed leakage does not affect the heel results, but as noted under the response under item A. above, the observations provide information related to the development of charging practices that reduce heel emissions.

G. Small Can Test Observations - Vent Outlet Temperatures (Section 3.1.3)

Bill Quest commented that it is established practice in the professional market to charge until the low-side pressure comes within a proper range and there is an acceptable vent temperature in all of the ducts. James Baker and Frank Rogers, on the other hand, both comment that the vent outlet temperature is not an accurate method for determining charge.

Response:

Based on the Baker and Rogers comments, the report discussion on vent temperatures is appropriate as is. No changes were made for the final report.

H. Emission Estimate (Section 4)

Rick Henry and Bill Quest, in addition to stating that an emission estimate is outside the scope of the study, also question the assumption that the heel is eventually released to the atmosphere, and the use of the student survey to develop a typical charging scenario. They both note that the student survey results on charging practice are different than the results of a survey conducted by Frost and Sullivan for the Automotive Refrigerant Products Institute (ARPI), and Bill Quest also provided different small can and 30 pound cylinder sales figures from those used in the study report. They also think the MACS 30 pound cylinder results should not be used as that testing was done independently of the UTI tests.

Response:

The emission estimate discussion in the report has been qualified to note the uncertainty in small can practices used to estimate current emissions. The final report also references the survey results in the draft report prepared by Frost and Sullivan for ARPI.

The sales data in the final report is the same as in the draft report. We could not find references for the different small can and 30 pound cylinder sales information noted in the comments.

The MACS 30 pound cylinder heel test results were removed from the final report heel estimate for 30 pound cylinders.

I. Charging Practices - Limit Charging to an Empty System (Section 5)

Bill Quest and Rick Henry both commented that the recommendation/finding that DIYers should only charge to an empty system and discussions pertaining to potential damage from improper charging are outside the scope of the UTI study and should not be included in the report. In addition, Bill Quest commented that the finding to charge only to an empty system is incorrect, and that established practice in the professional market for filling a partially filled system is to charge until the low-side pressure comes within the proper range and there is an acceptable stable temperature in all the vehicle vents. The DIYers have this same ability.

Response:

The final report still recommends that DIYers charge only to an empty system. This is the only way to know the proper refrigerant charge. We added that this recommendation applies to professional facilities as well, and also noted that this recommendation may not be accepted in practice.

J. Charging Practices - James Baker's Suggestion

James Baker suggests that incorporating a flow limiter to control the refrigerant release rate in the liquid phase may offer a solution to flow control instead of the rotation method used in the small can testing. Then a DIYer would only need to always orient the can upside down, open charge valve fully, and allow 10 minutes fill time per can.

Response:

This suggestion with respect to flow control was added to the best practices discussion in the final report

K. Questions/Comments from Frank Rogers

- Was the same recovery/recycling machine used throughout testing? (Hopefully, otherwise add variability.)

Response:

The same recovery/recycling machine was used throughout the testing at UTI for small cans and 30 pound cylinders. This is now noted in the final report.

- What was the charge accuracy of the recovery/recycling equipment used?

Response:

The machine accuracy was not known. It met the SAE standard, but that standard does not have an accuracy requirement. The heel weights were determined by separate balances.

- When charging, did you charge to critical or manufacturers specifications (OE typically has additional refrigerant)?

Response:

The charging was not done to completion. Charging was done to 6 or 12 ounces by the recovery/recycling machine, or not at all, depending on the run conditions, and then a single 12 ounce can was charged to the system.

- What percentage is 6/12 ounces of overall system volume and/or charge?

  Response:

  About 25% for 6 ounces, and 50% for 12 ounces based on 24 ounce system capacity.

- Was heating the 12 ounce cans considered? (Many add heat by setting can in hot water.)

  Response:

  The 12 ounce cans were not heated.

- Compressor on time?

  Response:

Data sheets recorded whether or not the compressor was cycling (yes/no) at 5 minute intervals. "No" means the compressor was on during the interval, while "yes" means it was off for some time during interval. Minutes on or off were not recorded.

- Section 2.1.3 states "charged the system with 6 or 12 ounces of refrigerant using the charging feature of the recovery/recycling machine:" ...data only shows 12 ounce partial charge and empty?

  Response:

Gas phase charging (results in Figure 6) was only done under two initial system states (with a 12 ounce partial charge, and empty system).

- Is 10, 15, and 30 minute data in figure 5 & 6 continuous or disconnected every 5 minutes as outlined? If disconnected how long did the disconnect, wipe, weigh, and reconnect take? Should be a note unless determined to be negligible.

  Response:

The time to disconnect, wipe, weight, and reconnect took approximately 1 to 3 minutes. This information was added to the procedures section of the final report.

- Paragraph after Figure 6: states "Figures 5 and 6 show that the thermal expansion valve (TXV) system tends to charge slightly faster than the orifice tube (OT) system"...the data in Chart "Figure 6" shows TXV systems with partial charge to be the slowest for the 5, 10 and 15 minute data points?

Response:

We agree with the Figure 6 observation. The combined Figures 5 and 6, though, show slightly faster charging of TXV systems. The report was not revised.

- 3.1.3 suggests that outlet temps that are within range and within 10 degrees of one another may indicate full charge? This method can only determine charge for the given condition and not the range of conditions and therefore is not an accurate method of determining charge.

Response:

This comment supports the report discussion.

March 21, 2007

Appendix
Reviewer Comments

I. *James A. Baker (Peer Reviewer)*

I have reviewed the draft study and find it to be a credible work. The permutations of charging employed cover a full range of potential methodologies, albeit long waiting periods and rotating a can while charging are not likely to find favor in the field. Instructions on the small cans pre-suppose enough knowledge of the system to be able to identify an orifice tube system from a TXV system.

A. Figure 3: MVAC System Diagrams

Consider indicating the location of the charging ports for reference in the MVAC system diagrams.

B. Charge Kit Observations (Sec. 3.1.2)

A gauge can indicate undercharge only, not sufficient for overcharge, since once liquid is present, refrigerant vapor pressure is constant with temperature and charge independent.

C. Vent Temperature Observations (Sec. 3.1.3)

Measuring vent outlet temperatures is not reliable since the system, when just at critical charge (i.e., just enough charge to satisfy the existing condition with no accumulated liquid -- needed for non-steady state operation), the cooling performance is optimal.

Charging to a vent temperature would lead to undercharged systems. Same for charging by evaporator inlet -- outlet temperatures. The critical point is reached when the outlet temperature is lower than the inlet temperature (called crossover) -- additional charge is needed for transient operation, often called the reserve charge.

D. Charging Practices

There is always the dilemma of what to do with the existing charge of unknown mass in the system to be recharged. The best legal recommendation is to seek professional evacuation as you have done, realizing that such a recommendation will go largely unheeded -- direct venting to the atmosphere is virtually a given as cost is the driving force for doing it yourself! Given this, a better charging approach would lessen the eventual emissions.

I believe the best approach would be to ultimately have a single, consistent set of simple instructions that people can, and will, actually follow. The simplest instructions include can orientation and time to empty the can. If the canning industry would adopt a flow limiter (could simply be the valve outlet diameter) in the can outlet such that, when the valve is opened fully, the rate of liquid release is limited to allow emptying of the can within minutes (rather than

seconds), but not allow sufficient flow to imperil the compressor, the issue would be resolved. Because the pressure difference across the small can valve is relatively constant (can vapor pressure -- AC suction pressure) for liquid charging, the flow limiter could be sized to empty the can of liquid in say 7 minutes, allowing an extra 3 minutes for certainty. Thus, the DIY would only has to do three simple things -- always orient the can upside down, always open the valve fully, and always allow 10 minutes fill time per can.

Perhaps PQA could oversee such testing and MACAPSEP could poll its members to validate the appropriate flow rate.

E. General Comment

All things, considered, I believe the work faithfully and reasonably represents the gamut of professional and DIY service industry behaviors and outcomes, and can provide a sound framework for ongoing emission mitigation activities.

II. *Frank L. Rogers (Peer Reviewer)*

A good job, some comments and questions:

A. Comments/Questions

- Was the same RRR machine used throughout testing? (Hopefully, otherwise add variability.)
- What was the charge accuracy of the RRR equipment used?
- When charging, did you charge to critical or manufacturers specifications (OE typically has additional refrigerant)?
- What percentage is 6/12 oz's of overall system volume and/or charge?
- Was heating the 12 oz cans considered? (Many add heat by setting can in hot water.)
- Compressor on time?
- Section 2.1.3 states "charged the system with 6 or 12 oz of refrigerant using the charging feature of the recovery/recycling machine:" ...data only shows 12 oz partial charge and empty?
- Is 10, 15, and 30 minute data in figure 5 & 6 continuous or disconnected every 5 minutes as outlined? If disconnected how long did the disconnect, wipe, weigh, and reconnect take? Should be a note unless determined to be negligible. Can I see the raw data?

- Paragraph after Figure 6: states "Figures 5 and 6 show that the TXV system tends to charge slightly faster than the OT system"...the data in Chart "Figure 6" shows TXV systems with partial charge to be the slowest for the 5, 10 and 15 minute data points?

- 3.1.3 suggests that outlet temps that are within range and within 10 degrees of one another may indicate full charge? This method can only determine charge for the given condition and not the range of conditions and therefore is not an accurate method of determining charge.

III. *Rick Henry (Stakeholder Comments)*

As a small can manufacturer, ITW Sexton provides the automobile air conditioning market with a container for an affordable method to charge MVAC systems. That being said the following are comments about the Disposable Container Heel Testing Study Report.

A. Report Summary

The first paragraph, which states: "Any refrigerant remaining in these disposable containers after charging a MVAC system is eventually released to the atmosphere" is incorrect. Typically, the can uses a threaded tapping device with a closing valve or a side tapping device with a check valve on the hose to contain the refrigerant for another installation. This is important to recognize while viewing Table 5 -- Scenario 1.

1. Table 5 - Scenario 1

A 52.8% heel with a 12 oz net weight container would be a noticeable amount and the closing valve would allow use at a later time. The report seems to imply that the 52.8% heel would be allowed to vent into the atmosphere.

B. Report Summary Key Findings - First Bullet

This is an important factor. The tests performed at the Universal Technical Institute (UTI) in Avondale, AZ substantiate the fact that the remaining heel in the small container, if properly installed, may be minimized to the levels of a 30-pound cylinder by educating the general public in the use of the small can.

C. Report Summary Key Findings - Second Bullet

The second bullet is not accurate. If needed, DIYers may purchase professional high side/low side multiple hose and gauge system for under $80, which is much less then the cost of a professional automotive service installation. ARPI contracted the Frost & Sullivan Study and the results showed that the average cost of professional service was $147. The DIYer industry provides inexpensive kits containing a hose, tapping and closing device and a gauge for easy economical installation for DIYers.

D. Report Summary Emissions

The first paragraph after the "key findings" bullets should reflect the results of the best case scenario for DIYers. That is, if the can is rotated during the filling operation for 15 minutes, the expected heel of the can would be 1.63%. To base the total annual emissions on DIY practices of discarding 52.8% of a container is inaccurate.

E. Report Summary Charging Practices

I am in agreement with the first (1) and third (3) recommended best practices. I disagree with the second (2) item; it defeats the purpose of DIYers installing refrigerant if they have to rely on a professional automotive service to evacuate their system. Equipment is available (thermometers and gauges) to determine when a system is charged. Closure valves or check valves allow the DIYers to save the remaining amounts for future use.

F. Background and Report Contents

Last sentence of the second paragraph should include "professionals" in addition to Do-It Yourselfers. Professionals also use and appreciate the convenience of the small can.

G. 30-Pound Cylinder Test Procedures (Sec. 2.2)

The 30-pound cylinders provided for the heel test were deemed empty with no discussion as to filling times for different levels of refrigerant in the cylinder especially as the cylinder is close to empty. No protocol was discussed as to the method used to empty the containers.

H. Heel Emissions Estimates for Small Cans (Sec. 4.1)

Annual Emission Estimate: The 25/75% split used to calculate the 52.8% heel is based on 37 students from page 18 (second to the last paragraph). Because nine students said they would hold the can upside down and 28 said upright the 25/75% split was used for Scenarios #1 and #2.

ARPI contracted Frost & Sullivan to perform an extensive survey and the results were that 88% of DIYers either agitate or hold the can upside down. To use the 25/75% split based on 37 students is flawed and does not truly reflect the results of the general public.

I. Outside the Scope of Study

In reviewing the UTI study, it is my opinion that all MACS test results should be eliminated from the independent study and the UTI Heel recovery should be used as a basis for the 30-pound cylinder. Adding the MACS information skews the results to benefit the 30-pound cylinder market. The September 2006 Study by Frost & Sullivan and the Automotive Refrigerant Products Institute determined that the professional automotive service industry, which MACS is a part of, would stand to profit immensely (in excess of $2 billion nationally) by

the elimination of all "Do It Yourself" charging of air conditioning systems. The Frost & Sullivan Study results do not agree with and are higher than the professional cost footnoted on Page 22, Elvis Hoffpauir information. This would place a tremendous financial burden on the general public and a great windfall to the automotive service industry.

With respect to hose and gauge leaks (Sec. 3.1.2) on small can installations, it is my understanding that the test was to focus on container heel amounts. Mentioning this information deviates from the focus.

In Section 5.1, the third sentence of the last paragraph is not relative to the focus of the Heel Study and should be omitted. In my opinion, "emissions from charging a leaking system without fixing the underlying leaks" is not relative to the Disposable Container Heel Testing Study Report.

J. General Comments

It is my opinion that the documentation of the Disposable Container Heel Testing Study Report is flawed and very biased toward 30-pound cylinder use and the professional automotive service industry. On the Summary page, assumptions are made that DIYers are discarding over half of a container (which is a net weight 6 ounces) based on a small survey. Then it states that if DIYers instead used a rotation method for 5-10 minutes the heel would be 10 to 12%. It should also include in the summary that rotating the container for 15 minutes would yield a heel of 1.63%. This result is similar to the heel of the 30-pound cylinder in the UTI tested cylinders.

IV. *Bill Quest (Stakeholder Comments)*

The "Disposable Container Heel Testing" was to be a "best practices can heel study" with the agreed scope that was revised on March 16, 2006 as follows:

A. Scope

1) To determine the amount of refrigerant remaining in a 12 ounce container (heal) after a vehicle A/C system has been directly charged from the small container of refrigerant.

2) To determine the amount of refrigerant remaining in a 30 pound container (heal) after it has been determined to be empty and removed from refrigerant charging equipment.

Refrigerant charge study will be done on a production orifice (OT) and expansion valve (TXV) system representative of current system designs and having a nominal refrigerant charge in the range of 24 ounces.

B. Outside the Scope of Study

The draft report goes far outside the scope of the study and draws conclusions based on assumptions from an ad hoc survey of students that was not part of the original protocol, an informal study done by Hoffpauir, and additional information supplied by one of the proctors, Ward Atkinson. Further, the other co-proctor, Ken Adams was not consulted in the preparation of this draft report.

In order to bring the report back within the agreed scope of the study, I have enclosed a revision that deletes information outside of the agreed scope. In addition, it eliminates the reference in small cans to DIYer since 30 percent of all sales of small cans of R-134a are installed by a professional mechanic.

If outside studies are to be included in this report, I would like to offer a September 2006 study conducted by a reputable research firm, Frost & Sullivan, and a report submitted to EPA by ARPI in Sacramento, California on December 13, 2006. Karen Thundiyil has the report. If you need an additional copy, I will be glad to supply it.

Section 4 draws conclusions based on assumptions outside the scope of the study and there is no reference to the fact that two ounce or more of refrigerant in a 12 ounce can is in a liquid state and can easily be felt. Therefore, it is highly unlikely that someone would think a can is empty when they can feel the liquid moving inside the can and discard it. They would store the refrigerant until further use. This was demonstrated to Karen Thundiyil and CARB in Sacramento last December. As we discussed on the conference call, while the demonstration is in a non-working environment, clearly, if someone could feel two ounces in a non-working environment, they would not consider a half-full (six ounces) can empty.

Section 3.2 - the MACS testing referred to in this section was not an independent study and should be eliminated from this report.

C. Conclusion Omitted

In addition, an important conclusion was omitted. That conclusion is:

If a 12 ounce can is fully discharged, either by rotating the can, turning the can upside down, or charging in the upright position for a long period of time (up to 90 minutes), the heel will be vapor only and approximately the same percentage as the heel left in a typically empty cylinder.

D. Incorrect Findings

While all conclusions outside of the agreed scope of the study should be deleted, here are some incorrect findings.

E. Incorrect Findings - Summary

1. "…typical DIY practices could involve up to 75% of small cans being held upright (with 25% held upside down)…"

This is based on an ad hoc survey and assumptions that are incorrect, according to the Frost and Sullivan survey that shows that only 12% of the DIY hold the can upright.

2. "…Under this scenario, the estimated average discarded can heel could be as high as 52%, with total national annual emissions of 12 million pounds."

This draws assumptions that are not in evidence. 75% of DIYer do not holds the can upright according to the Frost and Sullivan study. The amount of refrigerant sold to the DIYer annually is incorrect and does not include those small cans installed by the professional mechanic. The fact that a DIYer could feel the liquid refrigerant inside the can and not discard a half-full can is not calculated in the assumption.

3. "...(2) DIYers limiting small can use to charging already empty systems or professionally evacuated systems, so that they know how much refrigerant they should use..."

Established practice in the professional market for filling a partially filled system is to charge until the low-side pressure comes within the proper range and there is an acceptable stable temperature in all the vehicle a/c ducts. The DIYer has this same ability. Certainly, this report is not suggesting that all professional recharging be done only after the system is evacuated. Also, there is nothing within the scope of this study to address any problems created by over or under charging an air conditioner. An additional study may be required to determine refrigerant loss, however, the fact that millions of DIYers, as well as professional mechanics, continue to recharge partially filled air conditioners indicates that they are receiving the benefits of air conditioning without damage to the air conditioner.

F. Comparison of Can Heels (Sec. 3.1.1)

Figure 5. The agreed test protocol called for a 30 minute test. This report stops at 15 minutes.

G. Emission Estimate

Table 5. I have updated information based on the ARPI report of December 2006 that shows a total of 19,335,000 pounds of R-134a sold annually to the DIY automotive aftermarket. In addition, the ARPI report estimate is that the DIY small can heel is less than 1,000,000 pounds annually.

Table 5. Hoffpauir, 2005 estimates that the annual sales of R-134a in 30-pound cylinders are 23.3 million pounds annually. A more accurate figure is 35 million pounds annually. If you

are to use this figure, I suggest you research further with the cylinder manufacturers. (One of which is reviewing this report.)

H. Charge Kit Observations (Sec. 3.1.2)

Section 3.1.2 and in summary: "...Records of the kit gauge readings during the charging demonstrate this limitation…. For example during the empty system scenario for upright can testing, the gauge readings showed that the MVAC system was fully charged for all 30 readings…" The gauge on the recharge kit is used in an identical manner as a professional would use the low side gauge of a manifold gauge set. It is necessary to close the refrigerant can (or stop the refrigerant flow from the cylinder) before taking a pressure reading. In a conversation with co-proctor, Ken Adams, this was not discussed during the testing procedure.

"The UTI technicians also observed leaks from the hose and coupling of all charge kits used during the tests."

In a conversation with co-proctor, Ken Adams, this was not discussed during the testing procedure and is untrue. One recharge hose leaked, was rejected, and not used. If this is to be included in the report, then it should be substantiated. If all recharge kits leaked then the results of this study are suspect.

I. General Comments

This study was done under the auspices of the Mobile Air Conditioning Aftermarket Parts and Service Equipment Partnership and should be unbiased and within the original agreed upon scope and protocol of the study.

The September 2006 study by Frost & Sullivan and ARPI presentation to CARB and EPA concluded that, if all the sales of small cans of R-134a to do-it-yourselfers were to go to the professional market there will be a $2,774,000,000 windfall profit to the automotive service industry.

As a result, representatives of the service industry are highly motivated to "ban the sales of small cans" and, in my opinion, have given biased and unsubstantiated information to the writer of this report.

I believe EPA is interested in protecting the environment and not in promoting a business agenda.

It is the desire of all those involved in the sale of small cans of R-134a to the automotive aftermarket to learn and implement the best practices of charging refrigerant into an auto air conditioner. However, I believe that expanding this report based on assumptions, ad hoc surveys and information supplied by individuals who have publicly requested that EPA ban the sale of small cans would be inappropriate.

As a result of information already received from this study, refrigerant packagers of small cans have started to change the installation instructions to minimize can heel. This was shown to Karen at the December 2006 Sacramento meeting

I hope you take these suggestions and comments in the text to which they are written. If you disagree with me on limiting the scope of the report to what was agreed on before the study, I hope that you will consider both the September 2006, Frost & Sullivan Study, and the ARPI December 13, 2006 presentation to CARB.

In my opinion, the report in its present form is not acceptable.

V. *Gary Murray (Stakeholder Comments)*

The report is fine. The following are just some comments for consideration.

A. 1 lb cans

The method and study is consistent with what I would expect.

B. 30 lb can heel study

All equipment should be capable of reaching efficiency levels. I would recommend transferring liquid to minimize tank cool down and the false impression that the tank is empty.

Repeated recovery cycles when empty with time for tank temperature rise helps to assure recovery efficiency.

The only unknown is the tank backflow valve method. If the tank has a spring biased check valve it will eliminate the capability of the recovery machine to efficiently clear the tank. (This is speculation on my part, I only know the tanks have check valves to prevent refill, if they are spring biased it could reduce efficiency by limiting vacuum level, but I have not personally observed this.)