End of Life Vehicles and Air-Conditioning Refrigerant: Can Regulation Be Cost Effective?

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Vehicles that are no longer driven contribute to air pollution. HFC-134a is a common refrigerant in vehicle air-conditioning systems and a greenhouse gas. Increased regulation pertaining to the removal of HFC-134a from End-of-Life Vehicles has been proposed as a means to reduce air pollution. We estimate the amount of HFC-134a that remains in vehicles that are no longer driven in California and find that increased regulation is not warranted.

HFC-134a, the refrigerant used in the air-conditioning systems of vehicles beginning with the 1995 model year, is a toxic greenhouse gas. When released into the atmosphere, HFC-134a reacts with sunlight and creates ground level ozone that is detrimental to the health of humans and ecosystems. As vehicles are driven, small amounts of the refrigerant leak into the atmosphere. When a vehicle reaches the end of its drivable life, an unknown quantity of HFC-134a remains in its air-conditioning system, possibly to leak into the atmosphere, possibly to be recovered.

Vehicles that have reached the end of their drivable lives are commonly known as End-of-Life Vehicles or ELVs. ELVs have been issued either a junk title or salvage certificate by the Department of Motor Vehicles (DMV) and cannot legally be driven. ELVs are often sold to dismantlers or junkyards and used for parts or metal recycling. The removal and recovery of HFC-134a from these End-of-Life Vehicles is regulated under sections 608 and 609 of the Clean Air Act, which prohibits the venting of vehicle refrigerant into the atmosphere. Section 608 and section 609 of the Clean Air Act require vehicle dismantlers to remove and recycle any vehicle refrigerant contained within End-of-Life Vehicles. These regulations, however, are rarely enforced.

The California Air Resources Board (CARB) has identified improving the recovery rate of HFC-134a from End-of-Life Vehicles as part of its greenhouse gas reduction strategy. However, little is known about the quantity of HFC-134a remaining in End-of-Life Vehicles found in licensed junkyards and dismantling yards. Nor is much known about the model years common in junkyards and, hence, about the percentage of ELVs that contain this specific refrigerant.

This report presents the preliminary results from an analysis for CARB that estimates the portion of the ELV population containing HFC-134a and that quantifies the amount of HFC-134a remaining in these vehicles. When combined, these two estimates help determine whether increased enforcement of sections 608 and 609 of the Clean Air Act is warranted.

Vehicle Sampling

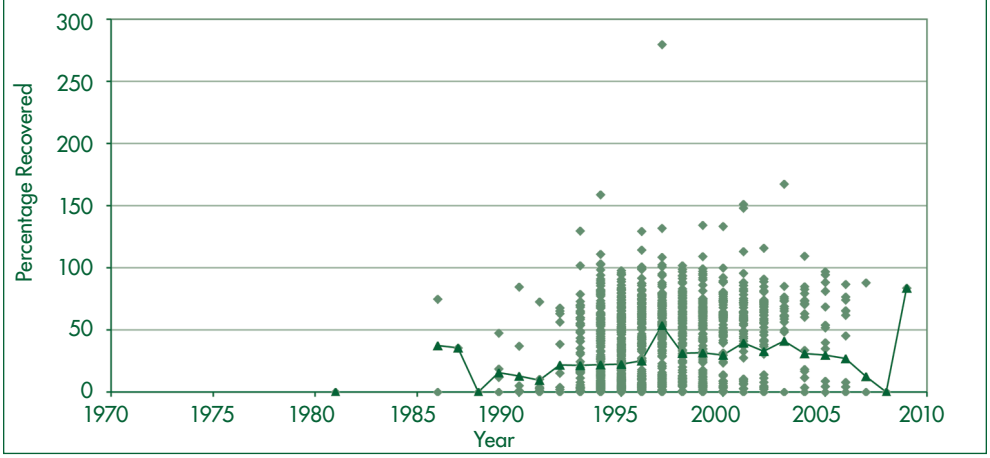
To quantify the amount of HFC-134a remaining in End-of-Life Vehicles, refrigerant samples were taken from 2,002 vehicles on dismantler lots throughout California in two rounds of sampling. An initial sample of 160 vehicles was conducted at one location in Antelope, California in January 2009; later, 1,842 vehicles were sampled at 29 dismantler locations throughout the state. The 30 participating vehicle dismantlers were all licensed by the State of California and were members of the State of California Auto Dismantlers Association.

The sampling was conducted by technicians certified in refrigerant handling and safety procedures from January through August 2009. The technicians entered dismantler lots and identified vehicles with enough spatial clearance to allow for sampling and refrigerant collection. In order to be sampled, a vehicle was required to have an operational front hood and a visible Vehicle Identification Number (VIN).

This sampling was not random, as the technician had to get permission from the dismantler owner before sampling and was often told which vehicles were "off-limits." At some dismantler lots, this restricted access meant only a handful of vehicles could be sampled. Once a vehicle's refrigerant was sampled, the refrigerant was returned to the vehicle and the vehicle was marked for refrigerant collection. As the amount of refrigerant was sampled, the technician recorded vehicle-specific information including refrigerant capacity, vehicle make, vehicle model year, license plate information, mileage, vehicle color, and the overall condition of the vehicle. At the end of each day of sampling, the refrigerant was collected from each sampled vehicle and was reclaimed by a licensed disposal service.

Sampled vehicles ranged in model year from 1970 to 2009, with a mean of 1997, and a standard deviation of three years. There were 1,536 vehicles, 77% of the sample, that were 1995 and newer model-year vehicles. Across this sample of 2,002 vehicles, 1,966 vehicles had air-conditioning systems utilizing HFC-134a. Identifying the specific refrigerant used in a vehicle's air-conditioning system prior

Figure 1: Model Year and Percentage of HFC-134a Recovered from Sampled End of Life Vehicles



to sampling was nearly impossible and 36 vehicles containing the precursor to HFC-134a, R-12, were sampled.

Across all sampled vehicles containing HFC-134a, an average of 27% of vehicle-specific refrigerant capacity remained in the air-conditioning system. However, the amount of HFC-134a remaining in the air-conditioning systems of sampled vehicles varied widely. No HFC-134a remained in the air-conditioning systems of 781 sampled vehicles. The other 1,185 sampled vehicles containing HFC-134a contained an average of 45% of vehicle-specific refrigerant capacity.

There was also very little correlation between the percentage of HFC-134a remaining in sampled vehicles and any geographic, dismantler, or vehicle-specific characteristics. Across the sample of vehicles containing HFC-134a, the percentage of refrigerant was correlated with model year and whether the vehicle had a license plate at the time of sampling. Vehicles with license plates tended to have a higher percentage of refrigerant remaining, holding all other variables constant. As the model year of a vehicle increased, or the vehicle decreased in age, the percentage of refrigerant remaining tended to increase, holding all other variables constant. Surprisingly, vehicle mileage, collision status, and a proxy for the number of days the vehicle had been on the dismantler lot were not significant in determining the amount of HFC-134a remaining in the air-conditioning system.

Figure 1 presents the percentage of recovered HFC-134a for each sampled End-of-Life Vehicle with the solid line representing the average. Seventeen of these End-of-Life Vehicle had over 100% of refrigerant capacity at the time of sampling. These abnormally large values could be the result of sampling errors or could be caused by incorrectly charged vehicle air-conditioning systems during the vehicle's lifetime.

California End-of-Life Vehicle Population

The California Department of Motor Vehicles (CA DMV) does not compile statistics pertaining to junk titles and salvage certificates. In fact, the CA DMV purges vehicles from their main database if they have a long lapse in registration activity, whether a vehicle has been junked or moved out of state. As no statistics were directly available regarding the End-of-Life Vehicle population, we had to reconstruct what had happened to vehicles and obtain information about ELVs using a two-step process. We first looked at annual CA DMV registration records from 2000 through 2008, and identified the cross section of vehicles with a registration status that had lapsed from one year to the next. From 2000 through 2008, nearly 40 million vehicles had a change in registration status. These vehicles represented the potential population of ELVs, and their unique Vehicle Identification Numbers (VINs) were submitted to CA DMV to obtain their full registration histories from some supplemental databases.

Among these 40 million VINs, 3,190,040 vehicles were issued a junk title or salvage certificate from January 1, 2005 through December 31, 2007. These vehicles constitute our End-of-Life Vehicle population. Some vehicles may be missing, yet these represent the most recent and most reliable estimate of all vehicles junked within California over a three-year period.

Among these 3,190,040 ELVs, the model year was normally distributed with a mean of 1991 and a standard deviation of seven years. Of the ELVs from 2005 through 2007, 32% were 1995 and newer model years. These statistics are substantially different from the model-year distribution of the vehicles sampled for their refrigerant. The population of End-of-Life Vehicles is much older than the sampled vehicles and a much smaller percentage would have contained HFC-134a.

Of course, the percentage of End-of-Life Vehicles that are 1995 and newer model years increases each year, as seen in Table 1. On average, the percentage of 1995 and newer ELVs reported to the CA DMV has increased 0.25% a month, or 3% a year. Extrapolating ahead, the amount of HFC-134a in ELVs and the potential for significant

Table 1: Portion of End of Life Vehicle Population Containing HFC-134a

Date	1995 and Newer Model Year ELVs
January 2000	9%
January 2005	24%
January 2006	27%
January 2007	29%
January 2015 (Projected)	50%
January 2023 (Projected)	99%

environmental damage will not be fully realized for many years to come.

We also analyzed End-of-Life Vehicles by the vehicle age at the time it was issued a junk title or salvage certificate. Each year from 2000 through 2007, the average age of an ELV has increased on average by two months. In 2000, the average age of an ELV was 14 years, 9 months; by 2007 the average age End-of-Life Vehicle was 16 years, 2 months old. Thus, while the percentage of 1995 and newer model-year vehicles is increasing, the population of ELVs is also increasing in age.

The ELV population from 2005 through 2007 was owned by 1,629 vehicle dismantlers within California as well as 210 non-dismantling and out-of-state businesses. Table 2 outlines the breakdown of End-of-Life Vehicle ownership.

CARB and U.S. EPA only have jurisdiction over licensed vehicle dismantlers in California. Thus, the benefits of increased enforcement of section 608 of the Clean Air Act pertaining to the removal and disposal of HFC-134a will be limited to only those ELVs that are on licensed vehicle dismantler lots in California—79% of all ELVs from 2005 through 2007.

Table 2: Last Known Owner of End of Life Vehicles by Category

Category	Percentage of ELVs Owned	Number of Businesses
Licensed California Dismantler	79%	1,518
Non-Licensed California Dismantler	1%	111
Out-of-State and Non-Dismantler Businesses	15%	73
Private Individual and Unidentified Entities	5%	137

Results and Conclusions

In determining the benefit of efforts by CARB to support U.S. EPA's regulations governing the removal of HFC-134a, we estimated the average amount of HFC-134a remaining in End-of-Life Vehicles and extrapolated this finding to all vehicles in the ELV fleet that contained HFC-134a. We have focused on the time frame 2005 through 2007, as this period represents the most recent and most accurate information available from CA DMV. From 2005 through 2007, there were 1,020,938 1995 and newer model-year ELVs—an average of 340,313 a year. Assuming the sample average of 220 grams of recovered refrigerant, an average of 74,869 kg of HFC-134a was left in the air-conditioning systems of vehicles on California dismantler lots each year.

Assuming the conditions from 2005 through 2007 persist, the portion of ELVs containing HFC-134a will continue to increase by approximately 3% a year and the average age of End-of-Life Vehicles will increase approximately two months a year. This translates to an increase of 54,203 ELVs containing HFC-134a from 2008 through 2012. Assuming the mean HFC-134a recovered from each ELV remains at 220 grams through 2012, we project that an additional 10,949 kg of HFC-134a will remain in the ELV population. Thus, while approximately 74,869 kg of HFC-134a remained in vehicles on California dismantler lots each year from 2005 through 2007, by 2012 it will increase to 86,793 kg.

There are large variations in the amount of HFC-134a remaining in ELVs, as well as the portion of the fleet that contains the refrigerant. This variation is due to large differences among vehicles in the rate of dissipation of HFC-134a, as well as the ever-changing profile of the ELV population. The potential benefit to any actions by the California Air Resources Board to enforce sections 608 and 609 of the Clean Air Act will be affected by this variance. In addition, any benefit of increased enforcement will be restricted to the 79% of ELVs that were on licensed dismantler lots in California. Thus, while 74,869 kg of HFC-134a remained on vehicle dismantler lots in California from 2005 through 2007, only 59,146 kg was on licensed vehicle dismantler lots. The presence of unlicensed dismantlers reduces the potential benefit of any efforts by the California Air Resources Board now and into the future to enforce regulations on HFC-134a.

Given the wide range of refrigerant that was recovered from sampled vehicles, along with the inability to identify the specific refrigerant within a vehicle's air-conditioning system, enforcing the removal of HFC-134a from End-of-Life Vehicles would be extremely difficult and expensive. From 2005 through 2007, only one out of every three End-of-Life Vehicles contained HFC-134a and 40% of those vehicles had no HFC-134a remaining in their air-conditioning systems. Only 220 grams of HFC-134a, 26% of capacity, was recovered from sampled End-of-Life Vehicles, which suggests that increased regulation would most likely not be cost effective.

Further research into the leakage of HFC-134a during a vehicle's drivable life, or increased enforcement of vehicle dismantling licensing, may present better options for decreasing the release of such a harmful greenhouse gas into the atmosphere. While sections 608 and 609 of the Clean Air Act were necessary in order to present guidelines to vehicle dismantlers regarding the handling of HFC-134a, their enforcement may be counterproductive at this time. The complexity of the vehicle lifecycle and the factors influencing the dissipation of HFC-134a into the atmosphere may be too complex for the regulations as they currently exist.

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