Accelerated Retirement of Vehicles

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■ Introduction

The Clean Air Act Amendments of 1990 define "program(s) to encourage the voluntary removal from use and the marketplace of pre-1980 model year light duty vehicles and pre-1980 model light duty trucks" as a transportation control measure. An old car retirement program can be such a measure for helping to attain air quality standards in some states and urban areas. Some basic statistics suggest the potential. Relatively high old-car per-mile emissions and their continuing use means that although pre-1971 model year autos drive only 1.7 percent of national vehicle miles traveled, they produce almost 5 percent of national NO_x, 7 percent of national HC, and 7.5 percent of national CO emissions (11).

This Information Document outlines the theory behind retiring old cars as a pollution control measure, describes a 1990 pilot vehicle retirement program conducted by Unocal Corp. in the Los Angeles area, and considers guidelines for pollution control through vehicle retirement. Although the best cost-effectiveness potential is likely in a few large urban areas with large old-car populations, smaller and less polluted jurisdictions may find retirement programs to be useful additions to their emissions-control toolboxes.

■ Definition

The Theory of Accelerated Retirement of Old Cars

An accelerated retirement program, simply stated, buys old cars and retires them faster than they would have been retired in the absence of the program. The theory behind this approach is straightforward. Controlling previously uncontrolled or minimally-controlled sources might be cheaper than tightening controls on already highly-regulated emitters, whether stationary sources or new cars. In many areas, old cars are one of the few remaining significant sources of criteria emissions that have not yet been controlled.

Old autos are well-known as high emitters, since they were manufactured with no or few mandated emissions controls (Figure 1). From high initial levels relative to today's vehicles, many old-car emissions have gotten worse according to EPA's MOBILE4.0 emissions model. MOBILE4.0, based on extensive auto testing, predicts in-use emissions after accounting for deterioration, evaporative emissions, refueling emissions, and a variety of other factors. (A recently-released version of the MOBILE model, 4.1, changes

Figure 1. Emissions Standards

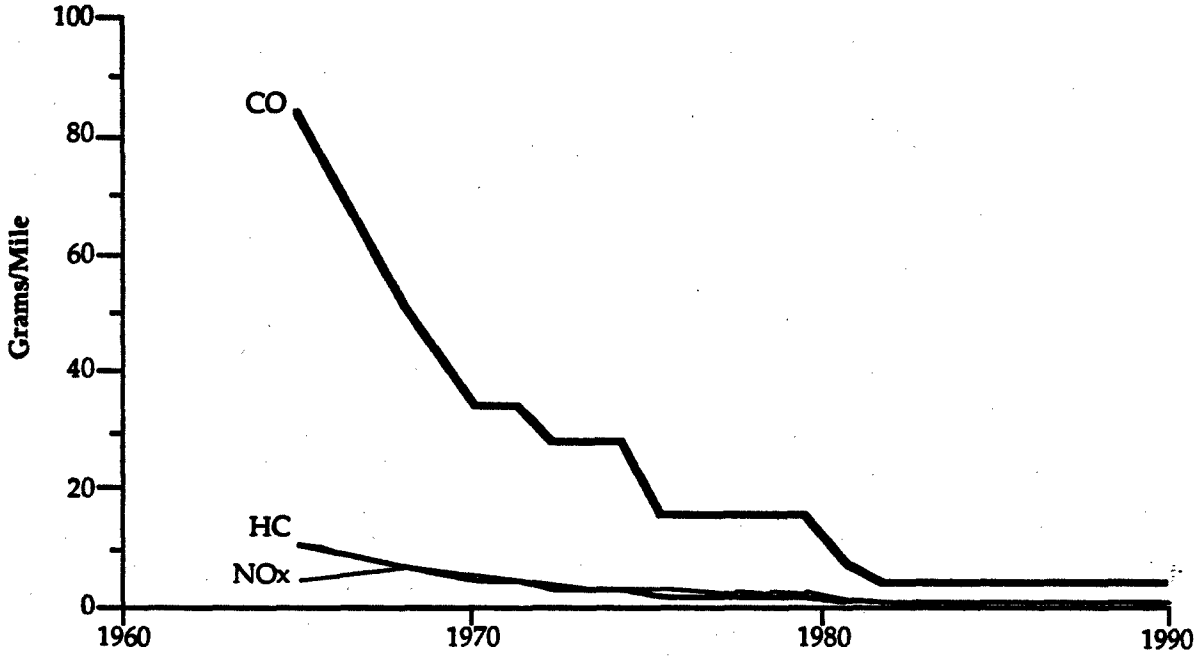
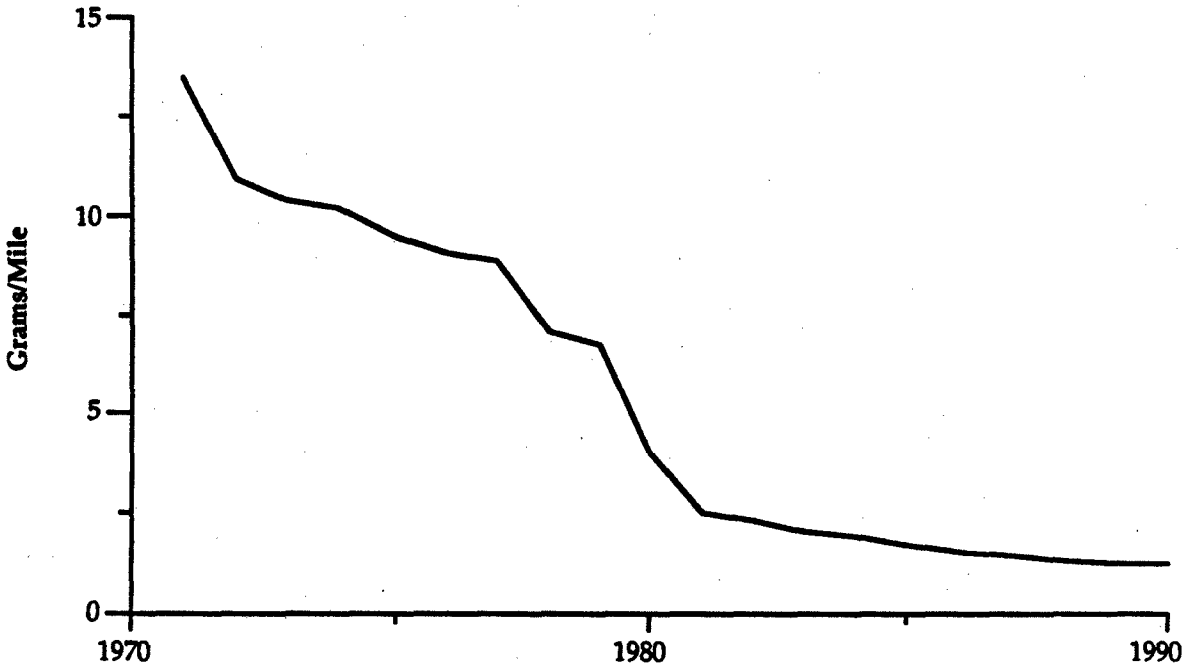


Figure 2. HC Emissions in Grams/Mile



some absolute emissions levels, but the difference between older and newer cars is not significantly different.) The fleet in-use emissions profile, in grams-per-mile, shows the significant difference between cars built in the 1970s and those built under a progressively stricter regulatory regime (Figure 2). The example here is hydrocarbon emissions, but the other pollutants show the same general trend. (All figures are for the 1990 fleet, and only for light-duty autos. Policymakers may wish to consider light-duty truck scrappage, but it is not considered in this document.)

MOBILE4 also can account for people's tendency to drive newer cars further and more often. The difference in HC emissions rates between old and new cars is so great that even after accounting for the fewer miles driven by older cars, the oldest cars still emit the most pollutants per year (Figure 3). However, the picture changes significantly with NO_x (Figure 4) and CO (Figure 5). With these two pollutants, the higher yearly mileages of the late 70s-model cars combine with only slight declines in per-mile emissions to give per-car emissions that rise through 1980 models.

A significant proportion of the old-car emissions problem solves itself through natural retirement. Every year, owners scrap 20 percent or more of all 16-year-old or older cars (9). Nonetheless, the asymptotic shape of the auto survival curve (Figure 6) means that in the absence of policies to encourage their retirement, some old cars will continue to emit at high levels indefinitely.

All of these statistics hide significant regional variation. In warmer areas of the country, with little precipitation and no salt use, auto turnover is slower and emissions tend be even more skewed toward old autos. Conversely, of course, in wetter, salt-using areas, fleets tend to turn over more quickly. This regional variation will make much of the difference in whether a retirement program is cost-effective in a particular area.

What Is an Old Car?

Comparing statistics for emissions per car per year to statistics for emissions per mile suggests that the class of old or target cars – those emitting at a level significantly higher than those being sold today – might extend as far as 1981.

Policymakers, however, cannot choose "old cars" on the basis of emissions alone. Because those who sell their old cars will generally keep driving in a newer car, the prevented old-car emissions are replaced to some extent by those from the new. Thus, in order to select the best class of cars to target and maximize the net emissions benefit, policymakers must estimate how the retired cars will be replaced. The most effective program will maximize the difference between the emissions of the scrapped car and those of the car which replaces it. Thus, although 1980-model-year cars have relatively high emissions per year, society gains little or nothing from scrapping them if they will only be replaced with other 1980 cars. The retired-car age which maximizes the difference between retired-car emissions and replacement-car emissions will vary from place to place, depending on the fleet profile and expected behavior of sellers. The mechanics of calculating net emissions benefits are discussed in more detail below.

Figure 3. HC Emissions by Model Year

Figure 4. NOx Emissions by Model Year

Figure 5. CO Emissions by Model Year

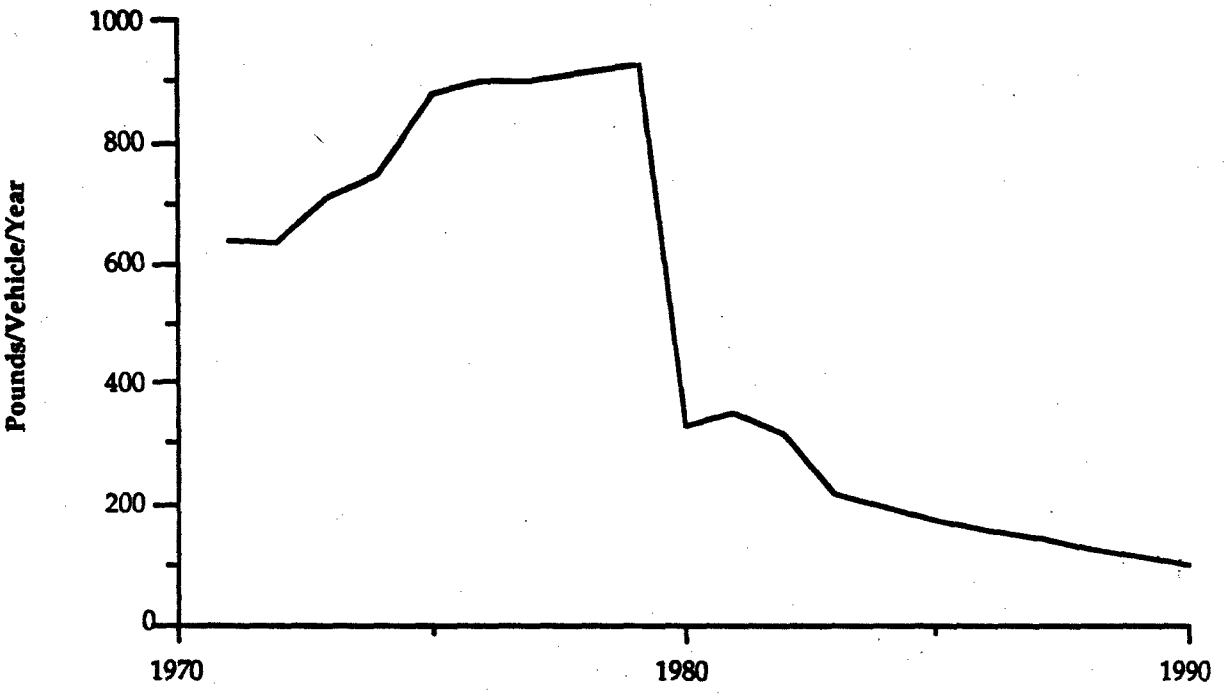
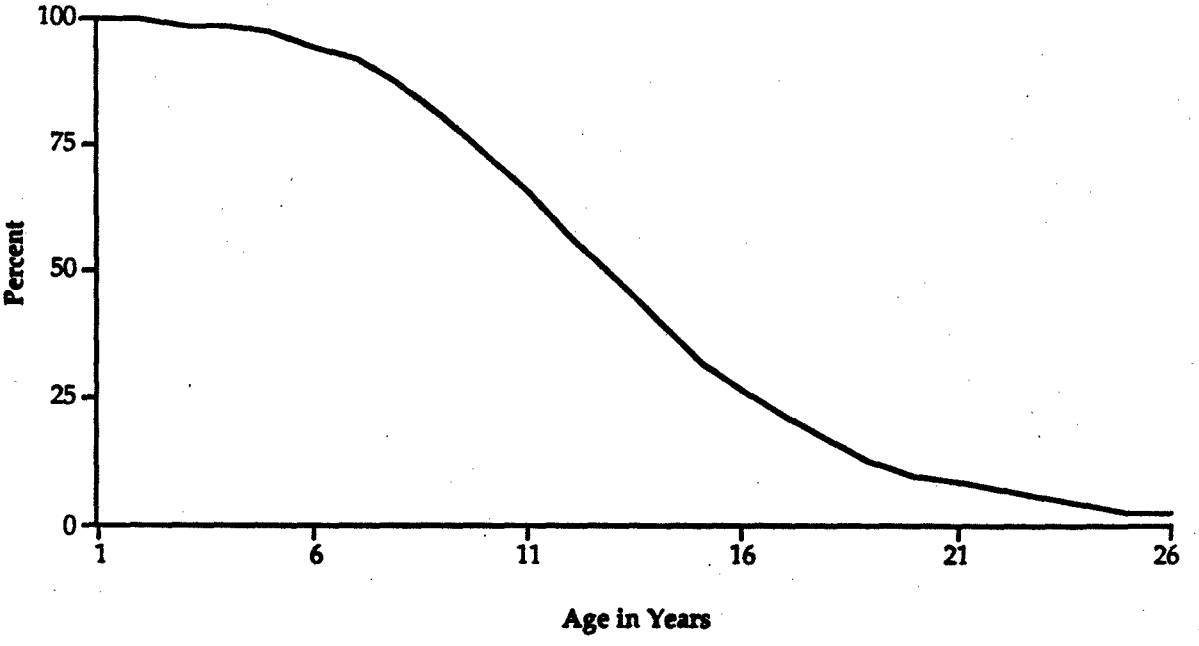


Figure 6. Auto Survival



Potential Program Variations

In addition to choosing the age and number of retired cars, policymakers also have to choose whether to scrap old cars, retire them by issuing a non-operating registration and allowing the cars to be used for parts, or remove them from the local fleet through some other means. The latter options risk enforcement problems, but are worth considering if the scrap market is soft, parts value is high, and jurisdictions have confidence in their enforcement capabilities.

Another possibility is to offer owners a choice between a retirement or tune up alternative. Old cars are not always, or even uniformly, high emitters. Rather, their high average emissions generally are due to a small set of extremely high emitters, while other old cars are only moderate emitters, and some are quite clean (4). Recent advances in remote-sensing of in-use emissions, and the development of short-transient dynamometer tests that measure emissions more accurately, raise the possibility of targeting extremely high emitters only. If only the worst cars could be targeted for retirement, and the remaining moderately high emitters targeted for (possibly subsidized) inspection and maintenance programs, cost-effectiveness would likely improve.

■ Example: The Unocal SCRAP Experience

The only major experience with buy-back and scrappage of old cars as a pollution-reduction measure comes from a program carried out by the Unocal Corp. in the South Coast Air Quality Management District around Los Angeles in the summer of 1990. Unocal's program, the South Coast Recycled Auto Project (SCRAP) offered $700 for pre-1971 models that met a set of requirements to ensure that active cars were removed, and had offers for the purchase of more than the 8,350 autos it finally bought and crushed. This program has attracted significant attention and has been the focus of in-depth analyses (6,7,13).

Major Results and Lessons

The effectiveness of a retirement program will depend almost entirely on a set of statistics whose distribution can only be determined through careful field study. Unocal's experience with SCRAP is encouraging, and the statistics it produced deserve careful study. The results, however, apply only to the Los Angeles area. The Unocal program should be used only as an example of a well-run program that thoroughly documented emissions reductions. It should not be used to suggest that similar reductions can be achieved in areas with different fleet characteristics.

Appropriate Duration of Program

This was not an issue in the Unocal study, but clearly a lengthy program creates an incentive to delay scrapping a car by establishing a minimum price for an old car in the future. All else being equal, a retirement program that sets a public ceiling on the number of cars it intends to buy and then moves rapidly towards that goal will minimize the impact of this effect.

While retirement programs may be usefully repeated in areas with high old car populations, suggesting that a retirement program may be repeated creates an incentive to hold on to old cars.

Vehicle Miles Removed, or Moved to Another Car, Per Year

Unocal calculated removed miles from three sources: information given by the owner at the time of sale, California Bureau of Auto Repair records for the scrapped cars, and a post-sale phone interview. The three sources gave statistically similar answers, and suggested that the average scrapped car had been driven approximately 5,400 miles per year (7).

The other half of this equation asks whether those removed miles were replaced, and if so, how? The data allow for different interpretations, but Unocal concluded that total area fleet mileage stayed constant, and that the 5,400 miles removed per scrapped car were replaced in roughly the same proportion as all miles driven are distributed.[1] That is, since in the current fleet 1989-model-year cars drive 4 percent of total VMT, 4 percent of the VMT from the scrapped cars was added to miles already driven by 1989-model-year cars.

This conclusion is supported by a phone survey of 803 SCRAP sellers who reported the replacements, whether previously owned or bought, for the cars they scrapped. Table 1 summarizes the results (6). The median model year of cars previously owned by a

Table 1. Distribution of Unocal SCRAP Replacement Vehicles

Model Year	Replacement Proportion
1974 or older	15.2%
1975 - 1980	24.9
1981 - 1984	15.7
1985 or newer	32.4
Did not replace car	11.8

1/ See Reference 13 (Tatsutani, p. 41) for a detailed discussion of mileage distribution.

seller, and now driven more because of the program, was 1981. The median year of cars bought to replace scrapped cars was 1983. Twelve percent of sellers said they did not replace the car's miles at all. This group essentially balances out that 12 percent who told the interviewer that the scrapped car had not been driven at all.

Thus, three-quarters of the scrapped pre-'71 cars were replaced with 1975 or newer cars. This is not surprising. Unocal research indicates that in Southern California, prices for 1966-1970 and 1976-1980 model-year cars are essentially the same, meaning that "someone could sell a pre-1971 model for $700 and still have a wide choice among post-1975 models (with all the major anti-pollution equipment) as a next car" (10). A similar price pattern holds nationally, with the market value of pre-1980 autos in "fair" condition always below $700 according to the industry-standard Gold Book. Policymakers could therefore expect to see a similar replacement response, on average, to a $700 scrappage reward in most areas of the country, although care should be taken to tailor any offer to the local market.

Emissions Reduced

Two approaches are possible for estimating emissions reductions associated with the Unocal program. They differ with respect to the assumed miles driven by the replacement vehicle. The following discussion is based on Tatsutani (13).

The Conservative Method

Using this approach, all replacement cars are assumed to be driven the average mileage per year for their model year, and that each mile driven on a scrapped car is replaced by more than one mile driven on the replacement car since, on average, newer cars are driven more than older cars. This increase in miles driven offsets some of the emission reduction, with the magnitude of this offsetting effect depending on the sensitivity of miles traveled to the operating cost per mile. If the demand for driving is fairly sensitive to driving costs, then people with newer and more fuel efficient replacement cars will drive them more than they drove the cars they sold. Assuming that this describes SCRAP participants' behavior yields a total net emissions reduction for SCRAP of 663 tons/yr HC, 3,008 tons/yr CO, 27 tons/yr NO_x, and 52 tons/yr of particulate matter.

The Data-Supported Method

The evaluation results of the Unocal program indicate that the conservative method overestimates the number of new miles driven, and so underestimates net emissions reductions. "While 41 percent of those who were driving a replacement car did report that they were driving it more than they had their SCRAP car, ... 59 percent reported driving the same amount or less. ...it seems unlikely – especially in cases where an additional vehicle was not purchased because the SCRAP car was one of two or several vehicles to begin with – that the driver would begin to travel substantially more as a consequence of participating in SCRAP...."

Assuming the number of miles driven remains constant and therefore that replacement cars are driven the same number of miles as scrapped cars results in total net emission reductions from SCRAP of 717 tons/yr HC, 3481 tons/yr CO, 75 tons/yr NO_x, and 63 tons/yr of particulate matter.

But even this method might be too conservative. Almost any buy-back payment will be insignificant relative to the price of a new car and therefore may be too small to stimulate much replacement. Total net emissions reductions could be calculated by assuming that the miles driven by retired cars are absorbed into the overall vehicle fleet. Since the average car on the road is newer than the average replacement car under SCRAP, this measurement yields higher total net benefits. This method is further supported by the argument that the previous owners of replacement cars must replace those cars, too, and this ripple effect implies that many retired cars are ultimately replaced by new cars.[2] Using this method, SCRAP yields total net emission reductions of 750 tons/yr HC, 3674 tons/yr CO, 93 tons/yr NO_x, and 63 tons/yr PM.

Each jurisdiction considering a scrappage program will have to decide which assumptions it believes most closely reflect reality.

Value of Removed Emissions

The dollar value of removed emissions is simply the cost of the next-most-expensive alternative emission control measure. This value will obviously vary greatly from place to place. California's South Coast Air Quality Management District, for example, uses cost cutoffs of over $25,000 per ton for NO_x, SO_x, a variation on HC known as reactive organic gases, and PM_{10} (12).

At the other end of the spectrum, an analysis of a national retirement program, not targeted to the worst areas, found that pre-'71 autos were such high emitters that a national program would be cost-effective even if emissions had the following low avoided cost values: HC, $3,050/ton; NOx, $2,750/ton, and CO, $300/ton (11).

Average Remaining Life of Removed Vehicles

This is the last step in determining a retirement program's benefits. Because scrapped cars would have been retired eventually even in the absence of a retirement program, net yearly emissions reductions can only be credited to the retirement program for a

2/ Finally, Steve Plotkin of the Congressional Office of Technology Assessment argues that while removed miles are likely distributed to the existing fleet, the additional miles must wear that fleet out more quickly, accelerating the move to new cars overall. While this line of reasoning is valid, resulting new car sales must be limited by the reality that a $700 bounty cannot by itself motivate the sale of a new car costing at least 10 times as much. Readers of DRI's report on this subject should keep this limit in mind (5).

finite period. When calculating the value of second and third year dollar benefits, policymakers should discount at the current cost of the capital used to fund the buyback.

A remaining life of three years for '71 and earlier models is supported by Unocal's experience. It is also supported by an estimate from Phil Patterson of the Department of Energy's Office of Transportation Systems, and by data collected and analyzed by Shaw-Pin Miaou at Oak Ridge National Laboratory (9). All three sources indicate that the average removed car could be expected to be on the road for longer than three years. These estimates are for older cars; if a locality chooses to scrap younger cars, the remaining life will be longer. The three year average figure accounts for the likelihood that a proportion of cars scrapped as part of the program would have been scrapped anyway.[3]

■ Expected Capital and Operating Costs

Price Required to Attract Cars

Unocal's $700 incentive resulted in excess offers to sell. A survey of the Gold Book of used car values suggests that nationally, even a $700 bounty will exceed the value of the majority of older cars. Of 65 domestic non-sports-car 1973 models, the average Gold Book price of 37 (57 percent) was below $600, and of 59 (91 percent) below $1,000. 1973 was the earliest year in the book; one can expect 1971-model-year prices to be still lower. Further, these are prices for cars in average condition, while the many cars in below-average condition – precisely the ones a program wants to attract – will be worth less. Finally, in the Unocal Program, many owners accepted far below both market price and personal valuation of their car in return for the convenience offered by the program, and in some cases, the desire to "help the environment" (13).

Administration Costs

If a program uses an established commercial auto crushing facility, there should be no capital costs. Unocal found that administration costs were $50 per car after taking into account all costs other than the actual purchase outlays. The value of scrap will vary by local market across the country.

3/ It is also possible to do this analysis in terms of removed miles driven in older cars, rather than removed years. The removed miles are an integral part of this analysis, but it then assumes that each model year car is driven a certain number of its remaining lifetime miles per year. While this has the weakness of ignoring some of the variation in driving habits, it has the advantage of suggesting when benefits will appear.

■ Other Benefits and Costs

Congestion Benefit

If older cars break down more often than average, removing them may have a congestion-reduction benefit if local roads regularly operate at or above capacity. No one has attempted to quantify how often older cars break down. However, the second half of this benefit has been examined. It is generally accepted that broken-down cars slow traffic flow, increasing emissions. Responding to this phenomenon, Unocal began a companion program to SCRAP, a breakdown patrol on Los Angeles-area freeways, and it claims significant emissions reductions as a result of clearing these freeway incidents. (Reference the chapter on Traffic Flow Improvements for a discussion of Incident Management Techniques.) In highly congested areas, a vehicle retirement program could also have some congestion-reduction benefit, although that benefit will be difficult to quantify.

The benefits of criteria emissions reductions and any congestion relief would accrue directly to the area which implements a retirement program. To the extent that cost-savings result, there may be some national economic benefit. Other benefits will likely accrue more directly to the nation as a whole: gasoline savings and carbon dioxide reductions. A local jurisdiction will likely not implement a costly local program for these dispersed benefits, but they are worth recognition and brief discussion.

Fuel Consumption Reduction Benefit

In addition to being high emitters, older cars also tend to be fuel inefficient. MOBILE4 predicts fuel economy from in-use cars to fall steadily in older model cars. Unocal data essentially confirmed the MOBILE4-predicted fuel use profile when it found that its scrapped cars had an average fuel economy of 12.5 mpg.

If local programs scrapped 2 million average 1971-and-earlier model-year cars, national gasoline savings would be 996 million gallons of gasoline over three years (11).

Carbon Dioxide Emission Reduction Benefit

CO_2 reductions follow directly from gasoline use reductions. Projected national reductions from a two-million car total, as above, would be 9,810,000 tons of CO_2 over three years.

■ Guidelines for Achieving Effective Implementation

Given the number of variables involved, any accelerated retirement program must be carefully run to produce satisfactory results. The California Air Resources Board (CARB) has proposed a set of principles for retirement programs which represent a good starting point for local policymakers considering a retirement program (2). This section identifies CARB's proposed principles, and in some cases suggests changes where Unocal's experience or other considerations indicate them. However, this discussion is not meant to endorse the CARB principles, nor to offer the guidelines with changes as EPA-endorsed. This document is meant for information purposes only, and does not represent EPA policy.

The CARB proposed guidelines offer a good outline of how to approach an accelerated vehicle retirement program. However, they are not the only reasonable way to approach some questions. In the absence of a perfect analytic method, policymakers will have to accept some uncertainty.

Vehicle Eligibility

To be eligible for buy-back, CARB suggests that vehicles should:

a. Have been registered in the nonattainment area for a minimum of one year.

b. Be operable, and judged mechanically sound enough to continue in operation without immediate major repair.

c. Satisfy the age, and if applicable, the emissions-related requirements of the program.

Retirement operations may be of high enough volume that subpoint (b) could be a bottleneck at the buyback location, and it is arbitrary enough to produce disagreements which may alienate some and slow the process. Another approach would use the driver's judgment of further operability as indicated by continuous registration. Any vehicle whose registration had recently lapsed and not immediately renewed would be excluded. Immediate re-registration is an indication that the driver thinks the vehicle will be driven, even if it would be judged in poor mechanical condition. Conversely, a car in seemingly good mechanical condition whose driver does not think it will be driven a lot in the future, as indicated by failure to immediately re-register, is not the desired target of a retirement program. Proof of insurance is another yes/no quickly checked condition which tests for a driver's belief that a car will be driven. While insurance is easy to obtain at short notice, it is also a disincentive to someone who wants to sell an otherwise "dead" car.

Benefits Estimation

Emissions reductions claimed for the program prior to adoption should be estimated as follows, according to CARB:

a. Be based on the average mileage accumulation of the model year of the vehicles targeted for buyback.

b. Be based on the difference between the expected emission rate of the vehicles bought back, and the emission rate of the average replacement vehicle.

c. Be depreciated each year from the retirement of the vehicle.

Subpoint (b) makes general intuitive sense, but local policymakers will have to decide whether grams per mile or pounds per year constitutes the appropriate emission rate. If pounds per year is used, which makes the most sense from a policy perspective, then an assumption must be made about the annual mileage of the replacement cars.[4] The importance of these decisions in the benefits calculation is illustrated in the discussion of the Unocal experience.

In addition, the analytic basis for subpoint (c) is not clear; the decline in average mileages per year may already be embedded in the average mileage figures.

Use of Reductions Credits

Opportunities for cost-effectively controlling pollution through vehicle retirement could be defined so that the program is open to all participants, both governments and industry. Governments might use retirement programs to meet CAA SIP standards, and both government and industry might use them for a broader range of control goals. For example, emissions reductions from vehicle retirement could be used for for the following situations:

a. To provide for more rapid interim improvements in air quality, or for earlier attainment.

b. To expand the universe of sources that are available to provide, consistent with new source review rule requirements, offsets for increased emissions from new sources.

c. To create alternative means to comply with certain stationary source emission reduction requirements, where permissible by law.

4/ It is important to note that the language in this area can become unclear: The Unocal experience suggests that "replacement" cars are likely to come almost entirely from the current fleet, and that there is essentially no "replacement" in the sense of new cars, or cars coming from outside the immediate urban area.

d. To mitigate emission increases associated with variances or, as part of an enforcement action, to make up for excess emissions due to violations of rules.

Some observers, including CARB, argue that buyback programs should not be used to provide ongoing offsets for permitted sources subject to NSR offset requirements. The analytic basis for this objection to the use of retirement for "ongoing" offsets is not clear. From a purely analytic perspective, accelerated retirement reductions could be applicable provided that the retirement program documentation demonstrates that the reductions are quantifiable, enforceable, and permanent. While retirement benefits last only as long as the cars would have been on the road, if a large pool of old cars exists sequential retirement programs could be used in theory to achieve the emission reductions of any other offset.[5] A retirement program could provide an emissions reduction that is actually less temporary than many other possible mobile source reductions in that the cars are permanently off the road. There also may be a concern that a retirement program may not be able to sustain the emissions reductions. As one progressively moves from older to newer cars, one must scrap more and more cars to achieve equivalent reductions. This is a very significant concern in the context of NSR offsets, and should be addressed by policy-makers as they develop specific guidance or regulations governing the creditability of accelerated vehicle retirement programs for offset purposes.

Verification

As the program is implemented, the original emission reduction estimates should be verified. To calculate and verify the emissions reduction benefit granted the program, CARB suggests that the following minimum data should be obtained:

a. At the time of buyback,

   1. An estimate of the mileage driven by the vehicle over the last one to three years.

   2. The seller's expectations regarding how the travel provided will be replaced.

b. Six months subsequent to the buyback, determine how sellers actually replaced the sold vehicles, and determine mileage driven with the replacement vehicle.

c. Emissions benefits should be recalculated annually so that the benefit is consistent with the actual number and age of the vehicles purchased and the documented mileage and replacement choices of participants.

5/ One objection to this is that the public should not expect that the programs be sequential, lest it begin holding old cars.

These suggestions go beyond what Unocal did; specifically, annual recalculation may not be necessary. For emissions tracking purposes, however, the use of actual registration age distribution and reliable data such as readings taken as part of inspection and maintenance programs could provide more accurate estimates.

The CARB guidelines do not address the probability of replacement through in-migration, one of the most significant questions concerning the attributes that make an urban area appropriate for a retirement program and the appropriate level of credits. In Unocal's case, the program was so small in relation to the size of the urban fleet that in-migration was not a concern. The relative sizes of the retired and active fleets will become important as the former grows relative to the latter. Policymakers should be sensitive to the possibility of in-migration when designing programs for smaller areas and for areas surrounded by other populations of old cars.

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