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Reconciling Mobile Source Offset Programs with Air Quality Management Plans

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INTRODUCTION:

Industries in many urban areas are faced with stringent new source review requirements, under which all emissions increases must be compensated for by obtaining emission reductions elsewhere in the basin. Yet, these emission reductions (known as offsets) are becoming more difficult and costly to obtain from existing stationary sources. To provide flexibility in siting new stationary sources, many have advocated the implementation of mobile source emission offset programs. These proposed programs would allow stationary sources to develop and implement mobile source control strategies, using the emission reductions achieved from mobile sources to offset stationary source emission increases.

A number of federal and California legislative proposals related to the development of mobile source emission offset programs have been introduced since mid-1990.¹ However, the provisions of mobile source offset programs raise a number of concerns related to air quality attainment planning. The primary concern is that many mobile source emission control strategies are already inherently relied upon (i.e. required by federal and state provisions) to achieve national ambient air quality standards. Furthermore, the majority of potential emission reductions from mobile sources may not be able to qualify under the criteria established by the Federal Emission Trading Policy. Caution must be exercised in developing any mobile source offset programs to ensure that actual emission reductions, above and beyond the reductions already required, are achieved.

BACKGROUND ISSUES:

Three basic strategies can be used to reduce emissions from the motor vehicle fleet: 1) displace new vehicles that would enter the fleet with cleaner vehicles, 2) accelerate vehicle fleet turnover, and 3) change transportation demand or supply characteristics.² Historically, air pollution control regulators have focused upon the first strategy, requiring vehicle manufacturers to meet ever more stringent certification standards. In California, over the past few years, state and local agencies have been paying increased attention to the third strategy, through the implementation of transportation control measures and congestion management plans. However, it can be argued that the current mobile source emission reduction approaches, which require the use of high tech emission controls, raise the cost of new vehicles and actually decelerate vehicle fleet turnover. The use of market incentive approaches to accelerate vehicle fleet turnover and reduce mobile source emissions is currently under investigation. In determining the role that market mechanisms can play in the mobile source arena, it is important to first understand the planning process and existing regulatory mandates.

California Local and State Air Pollution Control Programs: 3,4

County and regional air quality management districts are responsible in California for developing air quality management plans (AQMPs), designed to bring their local area into compliance with federal and State ambient air quality standards. The State adopts the provisions of local plans as key components of the State Implementation Plan (SIP), which consists of those regulations designed to achieve the emission reductions necessary to reach local attainment. The local air districts prepare the SIP components associated with the control of emissions from stationary sources, area sources, and indirect sources (facilities that attract mobile source activity, and are thus indirectly responsible for the mobile source emissions). Also, local districts are responsible for the preparation and implementation of transportation control measures.

The California Air Resources Board, under the authority of the federal Clean Air Act, sets statewide motor vehicle emission standards that are more stringent than existing federal standards. The vehicle standards are adopted for all new California vehicles and are an integral component of local AQMPs.

Local districts submit their plans to the State for review and approval. The state reviews each AQMP (to ensure consistency with the California Clean Air Act), adopts those portions of the plan that address state and federal requirements, and forwards those components that address federal requirements, along with the California motor vehicle control program, to the U.S. Environmental Protection Agency (USEPA). The USEPA reviews and

approves the California submittal (after ensuring consistency with the federal Clean Air Act), and the submittal becomes the "federally approved SIP."

The California Low-Emission Vehicles and Clean Fuels Program: 3

On September 28, 1990, the California Air Resources Board adopted the low-emission vehicles and clean fuels (LEV/CF) program into State law. The LEV/CF program establishes stringent vehicle exhaust emission certification standards to be met by each manufacturer on a weighted sales average. Compliance with the lower emission standards can be achieved through the use of advanced vehicle control technologies, cleaner-burning fuels, or a combination of the two control strategies.^{5,6} Thus, for the first time, the vehicle and fuel is treated as a system that is required to meet emission standards on a gram/mile certification basis.

Under the adopted regulation, four new exhaust emission standards were adopted, defining four new classes of vehicles: transitional low-emission vehicles (TLEVs), low-emission vehicles (LEVs), ultra-low-emission vehicles (ULEVs), and zero-emission vehicles (ZEVs). These vehicle categories range in stringency from 50% lower than current standards (TLEVs) to 100% lower than current standards (ZEVs).

The program provides for an annual phasedown in emission levels for each manufacturer's vehicle fleet, which would be met by the continual introduction of lower emitting vehicle types. Manufacturers are allowed to produce any fraction of each vehicle type, provided that the average emission rate is achieved or surpassed. This type of strategy, known as "bubbling around a production standard," increases compliance flexibility and is designed to reduce emission control cost for each unit of economic output.

Manufacturers are allowed to carry credits forward to a future year if they overcomply with the annual requirements. Plus, the LEV/CF program allows surplus credits earned by one manufacturer to be sold to another manufacturer that cannot comply directly with the regulation, or finds it less costly to purchase credits than to comply directly with the new low emission standards. The flexibility and production-based emission trading designed into the LEV/CF regulations should help to ensure that emission reductions are achieved with a minimum cost to industry, and therefore to the consumer.

The success of the LEV/CF program relies upon vehicle fleet turnover, or the retirement of older vehicles coupled with the purchase of new, lower emitting vehicles. By the year 2020, when the vehicle fleet has nearly turned over, the average emission standard will drop to roughly 0.062 grams/mile. This figure represents a 75% reduction in the average California fleet exhaust emission rate, compared to the rate that would exist in 2020 (0.25 grams/mile) if the LEV/CF program was not implemented.⁵

Transportation Control Measures: 3

The California Clean Air Act (CCAA) requires that districts in non-attainment areas implement transportation control measures, to the extent necessary to attain or maintain state and federal standards (California Health and Safety Code Section 40716, 40717, and 40918).⁷ Under the CCAA, moderate, serious, and severe non-attainment areas (as defined by state air quality standards, rather than federal ambient standards) must implement reasonably available transportation control measures, consider provisions to adopt an indirect source control program, and implement public education programs to promote transportation emission reductions (California Health and Safety Code Section 40918, 40919, and 40920), again, to the extent necessary to attain state standards. The CARB has defined reasonably available transportation control measures to include: employer based trip reduction rules (also required by the federal CAA for severe and extreme ozone non-attainment areas), trip reduction rules for indirect sources (e.g. schools, shopping malls, airports, etc.), parking control measures, high-occupancy vehicle system plans, comprehensive transit improvement programs, land use policies, and indirect source review rules that reduce trip generation or provide/improve transit access.⁷

In addition to the requirement that districts implement transportation control measures (TCMs) to the extent necessary to reach attainment, the CCAA also mandates three transportation performance standards be met for

certain areas: 1) serious and severe non-attainment areas must substantially reduce vehicle trips and vehicle miles traveled (growth rates of trips and VMT should not exceed population growth rates, about 2%/year), 2) severe non-attainment areas must achieve an average commute period vehicle occupancy rate of 1.5 persons per vehicle, and 3) severe non-attainment areas must demonstrate that there will be no net increase in vehicle emissions after 1997.⁷

NSR Requirements:

New Source Review (NSR) programs are a major component of the SIP for each local district in California.⁸ NSR regulations for non-attainment areas are designed to mitigate emissions from new facilities (where "new" is relative to the adoption date of the local NSR regulation) and from the modification of existing operations.⁹ Between 1979 and 1982, most districts in California adopted permit regulations containing NSR provisions. California NSR requirements are considered to be as or more stringent than the federal NSR requirements for non-attainment area.¹⁰

Under NSR, when a facility increases emissions beyond the threshold value established by the regulation, the facility is required to apply California Best Available Control Technology (BACT) to their process (California BACT is considered to meet federal Lowest Achievable Emission Rate requirements). Depending upon the magnitude of the emission increase, NSR may also require the facility to provide emission offsets that mitigate the emission increases. Emission offsets are certified reductions of emissions at the same or another facility. Offsets are usually provided at a ratio of greater than 1:1. Thus, when new sources are permitted, offsets requirements will theoretically reduce the net emissions in the basin.

In the past, many facilities were not required to provide emission offsets, either through special exemptions or because their emissions are less than the threshold value for NSR offset applicability that existed at the time of their construction.¹⁰ Thus, emissions growth from sources that avoided NSR offsets was substantial enough to surpass the reductions gained from the NSR permitting offset ratio. In addition, based upon CARB staff evaluations of local air pollution control districts in California,¹¹ significant problems were noted in local district methodologies used to: 1) calculate the emission increases that determine when offset requirements apply, and 2) to calculate the emission reductions that are used under NSR as offsets. The use of offsets that did not represent real emission reductions may have resulted in substantial unmitigated emission growth.

In recent years, due to poor air quality in many regions and in response to California Clean Air Act requirements, NSR regulations in California have been turning to a zero pound per day threshold of applicability. Hence, in many areas, all new sources, regardless of size, are now required to obtain offsets. Offset prices are increasing due to a decline in offset availability and the continuing increase in real emission control costs associated with stationary source reductions.

Given the increasing costs of offsets, industries (and state and local air quality regulators) have been searching for new sources of emission reductions that might be used to offset continued industrial growth. In addition, as the USEPA, under the urging of both the executive and legislative branches, turns toward increasing use of "market mechanisms" to improve the efficiency of pollution control, there is continued focus on providing economic incentives for pollution control. Hence, it is not surprising that the USEPA recently announced their desire to allow state and local air districts to implement programs that would encourage innovative control of mobile sources of pollution for use as offsets by stationary sources.¹²

BASIC REQUIREMENTS FOR CONDUCTING EMISSION TRADES:

The Federal Emission Trading Policy Statement (FETPS) is the applicable federal guidance document that governs emission trading.¹³ In general, an emission trade can be thought of as a transfer of an emission reduction from one operation to another operation within a facility, or from one facility to another facility. Emission trades include alternative compliance plans, source bubbles (a combination of over-polluting and under-polluting within a facility), and offsets.

In general terms, to qualify for trading, emission reductions must be "real." That is, physical reductions in emissions must occur. To ensure that real emissions occur, the EPA outlined the requirements and methods for calculating emission reductions, and defined specific criteria, "surplus, quantifiable, permanent, and enforceable," which must be met before an emission trade is allowed.¹³

APPLICATION OF FETPS CRITERIA TO MOBILE SOURCE OFFSETS:

The general requirement that emission reductions be "real" similarly applies to any mobile source related emission trade. Thus, emission credits, including those that are obtained from the control of mobile sources, must be in conformance with the provisions of the FETPS, and reductions must be surplus, quantifiable, permanent, and enforceable.

Surplus:

At a minimum, only emission reductions that are not required by current regulations in the SIP and are not used by the source to meet any other regulatory requirement can be considered surplus. This would include any strategy that is contained in the AQMP and calculated for future implementation. The emission reductions that are claimed as mobile source offsets must come from the implementation of strategies that are more stringent than those already required by the California Clean Air Act and the federal Clean Air Act. Generating credits from measures that were already required yields an emission reduction deficit in the attainment demonstration. However, the definition of surplus really extends beyond the rules and regulations that have been, or are scheduled to be implemented. In order to be considered surplus, the reduction must also be compared to the default assumptions made in preparation of the Air Quality Management Plan (AQMP), as these reductions are inherently relied upon in the attainment demonstration effort. Because the development and implementation of all attainment strategies (emission control requirements) in the basin are based upon the AQMP projected/ modeled need for emission reductions, emission reductions from mobile sources are only surplus when the district has met the emission reductions used in preparing the "baseline future emissions of the AQMP."

Local Planning Assumptions Related to the CARB Program. The CARB uses a two component model known as BURDEN/EMFAC to evaluate planning emissions inventories for motor vehicles. The BURDEN model is an activity accounting package, used to couple the estimated number of trips, hot/cold start splits, VMT, etc., with emission factors supplied by the EMFAC emission rate model.

To evaluate emission reduction effects of the low-emission vehicles and clean fuels program, staff of the CARB used EMFACTE/BURDEN7C modeling procedures.^{6,14,15} The emission factors for future vehicle fleets in EMFAC are based upon the new LEV/CF vehicle certification requirements, fleet penetration estimates, and weighted travel fractions (i.e. percentage of the VMT per year made by each model year of the fleet). Thus, the fleet emission factors are adjusted to account for the phased introduction of TLEVs, LEVs, ULEVs, and ZEVS over the period of twenty years.

The emission reductions that are expected to be achieved by the California low emission vehicle and clean fuels program are already included in the AQMP planning assumptions. The phased emission reduction requirements of the CARB low emission vehicles and clean fuels program are inherent in the emission factors used to prepare the AQMP. The lower future emission standards are also used in air quality models to project the additional emission reductions that will be needed to attain the ambient air quality standards (i.e. reductions above and beyond those that will be achieved by the LEV/CF rule). Thus, if a strategy is to achieve additional (surplus) emission reductions, the reductions must go beyond those reductions inherent in existing mobile source emission control programs.

Emission reductions associated with vehicle fleet turnover (natural replacement of older vehicles with newer, lower polluting, vehicles) are an inherent component of each local AQMP. That is, in preparing plans designed

to attain the ambient air quality standards, local agencies already rely upon the emission reductions that result from vehicle fleet turnover. Therefore, the use of fleet turnover emission reductions as offsets can be problematic. The reductions due to turnover must go beyond those reductions that would have occurred under existing and approved future motor vehicle control programs.

Credits Beyond the CARB Clean Fuel & Clean Vehicles Program. Local agencies and industry in California would like to claim emission reduction credit for the purchase of clean fueled vehicles when these purchases go above and beyond the requirements of the California LEV/Clean program. However, determining what the actual state-wide requirements are at the local level is a bit tricky. For example, the California LEV/CF rule doesn't really specify which vehicles must be sold by a manufacturer in each air basin. A manufacturer fleetwide average doesn't preclude the sale of all standard vehicles in one basin and all clean vehicles in another basin, only that the average of the sales be in compliance with the overall standard. The basic regulatory premise and intent appears to have been that clean vehicle sales would roughly approximate the population distribution, based upon the availability of market niches (i.e. fleets).

Given that manufacturers are required to meet an aggregate California fleet standard, regardless of where in California the vehicles are actually sold or used, and given the fact that manufacturers earn carry-forward or tradeable credits when they exceed their production-based emission requirements, the generation of credits from "excess" clean vehicle sales in one air basin may mean that fewer clean vehicles will be sold in another air basin. That is, once a manufacturer meets their standard, trading will result in no additional emission reductions on a statewide basis (if the profit margin of a clean vehicle is lower than for a standard vehicle).

This means that local air districts could conceivably compete against each other in an attempt to increase the percentage of clean vehicles that are purchased (and operated) in their basin. The potential regulatory solution to this dilemma is to require that: 1) districts meet their population-based penetration of clean vehicles in their basin before credits could be generated, and 2) the state and manufacturers enter into an agreement which stipulates that mobile source offset credits not be double counted (i.e. both transferred to a stationary source within the air basin as well as credited toward the fleet manufacturer average).

Fleet Vehicle Programs. The implementation of low emission vehicles and clean fuels program is expected to begin with stationary source owned vehicle fleets. That is, the compliance plans that will be used by the automotive industry are likely to focus on subsidizing the sale of low emission vehicles to operators of large vehicle fleets. Emission reduction credits for clean fuel vehicle purchases and conversions should be allowed only when the penetration of low emission and clean fuel vehicles into the basinwide vehicle fleet is greater than projected in the AQMP.

Note also that the following question of equity arises: if no credits are to be generated until the fleet penetration reaches planned levels ... should some stationary sources be awarded credits at the margin (and the subsequent financial benefits), when other stationary sources have already voluntarily participated in the implementation of the clean fuel program? Considering the fact that the same financial incentives will exist for companies who wait to convert to clean fuels until after fleet penetration levels are achieved under the CARB program, this type of strategy may actually reward companies for delaying their switch to alternative fueled vehicles.

Credits from TCMs. The California Clean Air Act already requires that districts implement reasonably available transportation control measures. In addition, the CCAA and CAA require that districts implement TCMs in their AQMP as necessary to attain the ambient air quality standards. Recent review of AQMPs for three major air districts in California have indicated that emission reduction claims made for TCMs are a significant part of the attainment effort.³ Because the emission reductions from TCMs are so heavily relied upon in these plans, and because the emission reductions are as yet unproven, it seems inappropriate to allow emission reduction credits from the implementation of TCMs until such time as the districts have identified and implemented all those TCMs that will be required in their effort to attain ambient air quality standards.

Protection of Short-Term Standards. One existing mobile source offset regulation in California requires that excess emissions be "fully offset on a daily basis."¹⁶ Ensuring that daily emission increases do not occur is an integral component of the planning and AQMP process, which is designed to ensure that violations of daily ambient air quality standard are avoided. However, if emission reductions are calculated and consumed on a quarterly basis (as is currently proposed in other draft regulations), it is not clear how local air districts will be able to protect daily (and shorter term) ambient air quality standards. If the generation of quarterly credits from motor vehicles are consumed by stationary sources over shorter timeframes, daily emission increases can occur. Perhaps the credits that would be generated by proposed programs would be small enough to yield minimal air quality effects. But until detailed modeling studies are conducted, protecting short term standards will likely remain an important issue.

Quantifiable:

To be quantifiable, emission reductions have to be qualified and quantified using consistent and repeatable methodologies.¹⁷ The requirement that emission reductions be quantifiable is relatively easy for most stationary sources to meet. Appropriate test procedures and recordkeeping requirements can ensure that emission reductions from industrial sources are quantifiable, and continuous emission monitors can often be applied to have arisen over the past few years.

Emission Reduction Estimates. Sources of mobile source emissions include the following: hot and cold engine starts, engine hot soaks (cool-down evaporation), running exhaust, running evaporation, diurnal evaporation, and fueling losses. The magnitude of the emissions associated with emission-producing vehicle activities are affected by: vehicle age, accumulated mileage, temperature, vehicle speed, congestion delay, operating environment, inspection and maintenance, etc. Quantifying emission reductions resulting from a mobile source control strategy is very difficult. Changes in emission-producing vehicle activity must be estimated, and activity-specific emission rates must be known for these changes. In addition, emission reductions per vehicle are relatively small, resulting in a system that requires the quantification of emissions from numerous mobile sources in order to provide even minor emission reductions for use at a stationary source.

A great deal of uncertainty is inherent in calculating the actual emissions associated with the operation of a motor vehicle. The existing modeling methodologies (i.e. Burden/EMFAC, DTIM/EMFAC, MOBILE4, etc.) were never designed for corridor analysis, let alone the analysis of emissions from single vehicles.¹⁸ The models are the most accurate mobile source emission estimation techniques that currently exist, but there is still a high degree of uncertainty in determining emission reduction effects for the LEV/CF program and TCMs. The current practice of granting emission reduction credits for changes in stationary source operations is significantly more precise and accurate than calculations in the mobile source sector can hope to be in the near term. Data simply do not exist to accurately assess the changes in emissions that will result from the removal of targeted vehicles from the fleet. Air quality planning is based upon general trends that are expected to occur due to changes in the operation of the entire vehicle fleet at the regional level. Demonstrating that actual emission reductions are being achieved by mobile source control measures implemented on a local scale, rather than on a regional scale, will be very difficult.

Further complicating the analyses is the fact that emissions from in-use motor vehicles may differ significantly from the emission results identified by the federal test procedure (FTP). Emission rates from off-cycle operations (i.e. operating conditions that differ significantly from the FTP cycle, such as speeds above 57 mph and acceleration rates above 3.6 mph/sec) appear to be much greater than the emission rates noted under FTP testing.¹⁹ The data are still preliminary in nature and more testing is forthcoming. However, it should be noted that at this time there is no information regarding the off-cycle emission characteristics of alternative fuel vehicles. These emission differences may be greater or smaller than the emission differences noted with conventional vehicles.

The use of the motor vehicle certification standards as a baseline for motor vehicle emission reduction credits is problematic. Certification testing is undertaken under the federal test procedure. The current vehicle emission levels for some vehicles can be significantly lower than the certification standard, because manufacturers often desire to maintain a margin of safety to ensure that their vehicles will pass. It is clearly not possible to test every vehicle on a dynamometer (approximately \$1000.00 per test and limited testing facility resources); hence, building in a safety margin to any emission comparison seems logical.

California vehicle emission models are updated periodically, but reflect on-road fleet emission rates from 2-3 years prior to the revision.²⁰ Hence, when emission trades occur, it will take 2-3 years before we can really be sure that the trades were reasonable. The problems associated with this might be addressed by including a safety margin in any calculation methodologies. However, given the high degrees of uncertainty associated with predicting the actual emission rates of alternative fuel vehicles, and the effects of vehicle aging on emission performance, it is unclear what safety margin is reasonable.

There are further uncertainty problems with respect to specific types of mobile source emissions. Based on discussions at the National Academy of Sciences transportation/air quality research needs conference held in Denver in 1991, the PM₁₀ emission factors for light-duty vehicles are highly uncertain,²¹ and should probably be considered uncertain enough to preclude the generation of PM₁₀ emission reduction credits. In addition, all of the emission factors and methodologies used in developing the emission inventory for heavy-duty trucks and buses²² should probably be considered uncertain enough to preclude the generation of emission reduction credits from these vehicle classes.

With respect to TCMs, in addition to the general problems raised above, a number of additional questions arise: What fraction of the vehicle fleet (clean vehicles versus dirty vehicles) will the TCM affect? Is there a latent demand effect, where a decrease in congestion yields increased transportation demand as traffic flow improves? How does the TCM affect trip purpose, trip destination, and trip-chaining behavior? How will trips not made and vehicle miles not traveled be quantified?

Development of Improved Emission Models. As new and better methods of estimating mobile source impacts are developed (i.e. with the five year CARB plan to develop modal modeling capabilities), emission credit estimates are likely to change significantly over time. Yet, once credits are awarded it may be difficult to adjust them at a later date based upon improved modeling methodologies. A policy question arises: who pays the price when emission reduction credits are found to be inaccurate at a later date? In one scenario, industry would be held responsible for the credits and would be forced to surrender credits if they are later deemed in error. On the other hand, because regulatory agencies have developed the emission models and must approve all trades, it may be just as reasonable to assert that industry should not be held liable for mis-quantification. Hopefully, due to the temporary nature of the credits, this issue will never create a legal dilemma. But the questions that surround this equity issue are still worth asking.

Permanent:

Emission reductions claimed as offsets must be permanent. That is, once the emissions are reduced for a process, the emissions are never allowed to increase without obtaining new offsets. Replacing mobile sources with an alternative transportation mode that will accomplish the same task, on a production basis, with a lower emission rate (e.g. substitution of an electric hoist and conveyor system for forklifts), is an example of a permanent reduction.

Emission reductions from mobile source offset provisions will be temporary at best.^{23,24,25} The remaining lifespan of a vehicle that is displaced by a cleaner vehicle must be included in the analysis. The AQMP process inherently relies upon vehicle fleet turnover as an attainment strategy. As old vehicles are replaced by ZEVs or LEVs, credits should only be generated for the period that the older vehicle would have remained in the fleet. The same assumptions on vehicle lifespan that are used in the AQMP process should be used in the emission reduction analysis.

Vehicle use does not remain constant as vehicles age. Over time, operators are used less frequently and travel fewer miles each year. Hence, average annual vehicle miles of travel (VMT) decrease. If emission reduction credits are generated over a specific period, the question of how much detail should be applied in the estimation of actual emission reductions arises. Vehicles tend to emit more over time, due to engine and control system degradation, yet vehicles are driving fewer miles each year. Should the emission reduction credits be amortized into a constant annual average emission reduction for the life of the credit, or should a more realistic but complex approach be used, where credits associated with the changes in both emission rates and vehicle activity patterns decrease over time?

Further complicating the analysis is the fact that when older vehicles are replaced by newer vehicles, there may be both positive and negative trickle down effects on household vehicle use. An older vehicle, which may accumulate relatively few miles per year, might be replaced by a new clean vehicle. In a single vehicle household, the presence of a more reliable personal vehicle may result in a mode shift (e.g. changes in carpooling or transit behavior), increasing the number and length of trips made by the single household vehicle. On the other hand, a multiple automobile household may retire an older vehicle, relegate a middle aged high use vehicle to the previous low use vehicle pattern, and undertake the high use pattern with the new vehicle; hence, there may be no net change in tripmaking behavior, but a significant double downward shift in vehicle emissions. A third scenario might be the purchase of a niche vehicle, such as a limited range and performance alternative fuel vehicle, which cannot completely replace the high use vehicle activities.

For stationary sources, permanent emission reductions are associated with production and can be limited through operating conditions applied to the operating permit in accordance with EPA policy.^{17,26} It is impractical to place operating conditions upon mobile sources of emissions and their operators in order to guarantee that the emission reductions are permanent. A decrease in a single vehicle's usage may or may not result in an emission decrease. An emission decrease is not permanent if the operator of the vehicle simply switches to another vehicle and continues the same travel patterns. Also, an emission decrease is not permanent if additional drivers begin using vehicles that become available when mobile source control strategies are implemented.

Vehicle migration may be of concern. First, once a clean vehicle is introduced into an area, it also may move to another area where the emission reductions are not needed for attainment. Second, the area where the vehicles are purchased, or registered, may be different from the area in which the vehicle operates. Hence, just as it is difficult to model the changes in the emission inventory that occur due to vehicle migration, it will be equally difficult to allocate mobile source offset credits to specific areas, especially if new source review offset ratio requirements are dependent upon physical location of generated credits.

Political Aspects. When a temporary offset is granted, and the industry relying on that offset fails to take appropriate actions to ensure that future offsets are purchased, it may be politically difficult for a local district to issue an abatement order when the temporary offset expires. Temporary variances from offsets have historically been granted by local air districts. Regulatory agencies will need to stay on top of temporary offsets to ensure that industry obtains necessary future offsets. Plus, oversight of local districts will probably be necessary to ensure that circumvention is avoided and attainment progress continues.

Enforceable:

For an emission trade to be enforceable, it must be possible to monitor the emission change over time and to affect changes when reductions fail to accrue. As discussed earlier, mobile sources of emissions are not as readily controlled and monitored as stationary source emissions. The EPA and local air pollution control districts make stationary source emissions reductions enforceable by tying the reductions directly to facility operations as "specific limiting conditions" (e.g. process throughput and mass emission rate limits), in accordance with EPA guidelines.¹⁷ Stationary source operating limits are enforced through operating records, process monitors, continuous emission monitors, and periodic inspections of the source. In theory, similar procedures could be implemented for each mobile source that provides an offset for a stationary source. But can

enforceable operating conditions be effectively, practicably, or legally placed upon mobile sources and their operators? It is unclear how emission reductions from mobile sources will be made feasibly enforceable. Perhaps due to the limited duration of mobile source offsets, this issue will not be critical, and might be dealt with by ensuring an adequate safety margin in emission reduction estimates.

On the administrative and planning side, each emission trade must be approved by the local agency and made enforceable by submitting the emission trade to the Environmental Protection Agency as a source specific SIP revision.¹⁷ The FETPS specifically states that emission trades involving mobile sources must be implemented as case-by-case revisions to the SIP. Thus, mobile source emission trades must be submitted to EPA for approval. This policy decision appears to have been based upon the premise that it is difficult to determine if the mobile source emission trades fully comply with FETPS criteria.

PAST, PRESENT, AND PROPOSED LOCAL AGENCY PROGRAMS:

In November 1990, the California Air Resources Board prepared a summary document of all mobile source offset provisions that were either adopted or in the legislative process at the time of publication.²⁴ For the purposes of this paper, only three mobile source offset provisions at the local level are discussed: the 1990 SCRAP program conducted in Los Angeles by Unocal, alternative compliance methods in the South Coast AQMD, and the proposed mobile source offset provisions in the Sacramento County AQMD.

South Coast Recycled Auto Program (SCRAP):

South Coast Air Quality Management District Regulation 1309 (Emission Reduction Credits), a component of SCAQMD Regulation XIII (New Source Review), includes general mobile source offset provisions. Rule 1309, Section (f), allows stationary sources to obtain emission reduction credits from controlling mobile source emissions, but limits reduction claims to replacement of conventional vehicles with ULEVs. The magnitude of reduction credits are dependent upon the date claimed (phased down over time). Recognizing the temporary nature of mobile source credits, credits automatically expire on December 31, 2010, and any permit issued on the basis of these credits also expires at that time, unless replacement reductions are obtained. The regulation contains a caveat that prohibits the use of mobile source emission reduction credits by facilities subject to federal new source review (i.e. federally defined major stationary sources).

On June 1, 1990, the Unocal corporation implemented the SCRAP program in the Los Angeles air basin. Over a period of one year, Unocal (with some additional funding from Ford Motor Company and the South Coast Air Quality Management District), purchased, crushed, and recycled nearly 8400 pre-1971 vintage vehicles under the SCRAP program.²⁷ Because the engines and bodies were crushed and recycled, they could never be used to extend the life of other vehicles in the fleet, ensuring permanent retirement.

Emissions reductions resulting from the program were estimated by testing 74 of the 8376 vehicles under the federal test procedure in an effort to determine the relative emission rates of the scrapped vehicles compared to the average fleet vehicle. These estimated emission rates were multiplied by an average 5500 miles traveled per year (based upon multiple surveys of participants and limited Bureau of Automotive Repair data) to estimate the magnitude of emissions removed from the emission inventory.

A number of questions related to the uncertainty in the emission reduction estimates can be raised. Did the program reduce local scrapping rates during the study period (i.e. diverted vehicles that would have been voluntarily removed from service anyway into SCRAP)? Were the vehicle miles of travel estimates reasonable? When replacement vehicles were purchased did tripmaking behavior change (i.e. increasing VMT)? Were the vehicles sampled representative of the scrapped fleet subset? On the other hand, many of the vehicles originally selected for testing had to be rejected, due to serious mechanical defects (e.g. exhaust leaks, etc.) that would have prevented an accurate test;²⁷ it may be that the subset of vehicles tested were cleaner than the average vehicle removed from service.

Nevertheless, laboratory testing clearly indicated that the vehicle emission rates of those vehicles tested were on the order of two to three times the expected ROG and CO emission rates that would be predicted by the applicable mobile source emission model.²⁷ Hence it seems likely that real emission reductions were achieved by the program.

The cost-effectiveness of the program, based upon the Unocal-supplied cost (6 million dollars program cost), Unocal-supplied vehicle emission rates (24.77 g/mi HC, 100.8 g/mi CO, and 2.96 g/mi NOx), 5500 miles per vehicle per year from survey results, and a liberal assumption that all vehicles were replaced with new vehicles with no increase in VMT, is roughly:²⁸

$$\begin{aligned} \text{HC: } & 8400(24.8 - 0.25)/(5500)(1.1\text{E}-6) = 1250 \text{ tons/yr} \\ \text{CO: } & 8400(100.8 - 1.80)/(5500)(1.1\text{E}-6) = 5030 \text{ tons/yr} \\ \text{NOx: } & 8400(3.0 - 0.27)/(5500)(1.1\text{E}-6) = 140 \text{ tons/yr} \\ & \text{veh g/veh*mi mi/yr tons/g annual reduction} \end{aligned}$$

Given a total cost of 6 million 1990 dollars to achieve these reductions, and assuming the reductions are viable for 4 years worth of credit (with no phased-down in annual credit magnitude or depreciation of the credits over time), cost of capital at 8% over a 4 year lifespan, the total annualized cost of reductions is about 1.8 million dollars per year. This yields a short term aggregate (HC+CO+NOx)²⁹ offset cost-effectiveness of (\$1.8 million/yr)/(6420 tons/yr) = \$300.00/ton.³⁰ A safety factor of two in this back-of-envelope calculation would yield a \$600.00/ton estimate.³¹

Based on the 25 emission offset transactions undertaken in the South Coast Air Basin during 1990, the cost of CO, ROG, and NOx offsets in the same air basin were roughly equal, approximately \$2000.00 per pound per day, or 4 million dollars per ton per day (ranging from as low as 1.3 million dollars per ton to as high as 8 million dollars per ton per day), for emission offsets that extend into perpetuity.³² Assuming 365 days per year of operation, and an 8% cost of capital into perpetuity, this translates to annualized costs of reductions of somewhere in the range of \$900.00/ton.

At first glance, the cost-effectiveness of SCRAP might appear to compare favorably to the current emission offset market, in that the annualized cost per ton of reduction is somewhat lower than current market prices. However, the emission offsets purchased on the open market are permanent. In the case of mobile source offsets, the credit dies at the end of the four or five year period, and new credits must be obtained. The real cost of obtaining mobile source offsets will continue to increase over time, as the dirtiest vehicles are naturally retired from the fleet. As vehicle fleet turnover continues, and many of the low-purchase-price super-emitters (older, less reliable \$700.00 market price vehicles) are naturally retired, mobile source offsets will become more expensive to generate, and the cost-effectiveness of mobile source offset provisions will decrease dramatically. If emission offsets must be obtained over a 30 year new stationary source lifespan, and the present value costs of obtaining emission offsets on the current market are compared to the present value costs associated with retiring an ever larger set of more expensive motor vehicles every five years, it is clear that the market value for temporary offsets is likely to be lower than permanent offsets, and probably will remain significantly lower than the cost of obtaining those reductions on the open market.³³

It is important to note that SCRAP was not undertaken to make a profit. Unocal needed to provide in-house emission reductions to delay compliance with onsite emission reduction requirements, and Unocal never would have attempted to obtain permanent emission reduction credits for the reductions.³⁴ The program also helped to open the door for innovative emission control strategies, and made an environmental contribution with positive press potential. All in all, the program was a public relations success.

The bottom line with the use of temporary emission reduction credits may actually come down to a company's ability to raise capital to purchase a permanent offset (knowing that the offset will appreciate over time). For a company's that may not be able to raise sufficient capital for an outright purchase of an offset, mobile source offsets may prove a viable method for achieving short term offset needs.

In the short term, it may make sense for regulatory agencies to implement market incentives that encourage the retirement of super emitters. That is, it may be reasonable for states and local agencies to use a SCRAP type program to provide temporary emission reductions to community banks that could be purchased by industry to delay compliance with regulatory mandates and thereby lower net compliance costs (provided the USEPA will allow the delay as a source specific SIP revision). Local agencies need to ensure that facilities using mobile source offsets for delayed compliance achieve the required permanent emission reductions before the offset credits expire. However, in terms of long term cost-effectiveness of emission reductions, this same capital would be better spent to achieve permanent emission reductions in other source categories.

Alternative Compliance Programs in the South Coast AQMD:

The South Coast AQMD will allow aerospace companies to comply with paint and coating solvent limits through the use of mobile source offsets. District Rule 1124(i)(1)(G), specifically allows sources to develop and implement SCRAP-type programs and use emission reductions for rule compliance. To date, there have been no applications for mobile source offset credits under this active rule provision.³⁵

The Sacramento Metropolitan AQMD:

The Sacramento Metropolitan Air Quality Management District (SMAQMD) is currently in the process of adopting Rule 206, which would create a mobile source offset program in that district. The regulation has been shaped with input from the California Air Resources Board (CARB) and California Air Pollution Control Officers Association (CAPCOA) mobile source offset committee and public comment. The SMAQMD is moving to adopt the proposed regulation sometime in the summer of 1992.

The regulation addresses many of the issues raised in this paper and indicates that the reductions are temporary and that quantification and approval are an integral component of the process. The rule does not contain specifics as to the quantification methodologies, but a manual of procedures will be developed in cooperation with CARB staff and members of the CAPCOA committee. The adoption of the rule and the implementation of the rule (i.e. quantification and quantification of emission reductions) are currently being considered separate issues.³⁶ Because each trade has to be approved (in accordance with the manual of procedures that will be developed), the questions as to whether trades are surplus, quantifiable, and enforceable will theoretically be addressed as the program progresses. The adoption of the rule appears very likely, and because there are a number of applications waiting in the wings, the implementation of this pilot program will likely provide valuable study data.

CONCLUSIONS:

Mobile source offset provisions have the potential to provide beneficial emission reductions of a temporary nature. Mobile source offset programs only yield an air quality benefit when the reductions go above and beyond the reductions that would occur in the air basin in the absence of the program. Mobile source offset programs must take into account the regulations included in the AQMP as well as the basic assumptions about fleet turnover that are used in the AQMP to establish future baseline emission inventories and to calculate attainment demonstration emission reductions. Local district engineers need to look beyond the language of specific rules, to the assumptions of the air quality management plan in determining when emission reductions are surplus. Failure to take the planning process into account when issuing mobile source offset credits will yield emission increases and will delay air quality progress.

Mobile source emission reductions are difficult to accurately quantify at this time. Changes in tripmaking behavior are difficult to predict, and the emission rates associated with these tripmaking changes are highly uncertain. The issue of permanence is also in question, because the demand response associated with reduced congestion is difficult to model. That is, as congestion is reduced there is an incentive to increase travel demand and reintroduce congestion. Furthermore, because reasonably available TCMs are already required by state law,

it will be very difficult for air districts to demonstrate that enhanced TCM programs provide surplus emission reductions, above and beyond the reductions required by the California Clean Air Act. Hence, emission reductions associated with transportation demand management and transportation supply improvement strategies will not likely conform with the FETPS. However, TCMs are an area in which research should continue, so that cause-effect relationships will become better understood and so that potential emission reductions can be quantified.

The EPA established the 1986 Federal Emission Trading Policy to safeguard emission trading practices, and ensure that emission reductions actually occur. It is important to emphasize that policymakers are not blindly following this policy just because the policy is on the books. The emission trading policy is designed to ensure that only real emissions are traded, avoiding a paper shuffle of false credits. The criteria outlined in the FETPS ensure that the emission reductions are real. Thus, it also makes sense to ensure that mobile source offsets programs yield emission reductions that are permanent, surplus, quantifiable, and enforceable.

From the perspective of the private sector, the economic viability of mobile source offset credits is questionable. Companies would probably be better advised to seek permanent emission reduction credits from other source categories, rather than purchasing mobile source offset credits every four to five years. The present value of the long term offset cost (for the life of a stationary source) is likely to be significantly higher using mobile source offsets.³⁷ Yet, there are a number of temporary stationary source categories that might be able to use mobile source offset credits directly (such as temporary construction operations). In addition, industries that desire to delay compliance with rule-required emission reductions might substitute mobile source offset credits during the period of time necessary to plan the most cost-effective emission control approach for their specific operation.

From the perspective of the public sector, a comprehensive least-cost path toward air quality attainment would probably preclude the use of public funds to operate a mobile source offset program. That is, public funds would probably be better spent to obtain permanent emission reductions from other source categories at a lower present value cost. However, other externalities associated with the use of those older vehicles that would be retired under a mobile source offset program should be included in a social cost/benefit analysis (e.g. social impacts of higher fuel consumption, increased safety and liability concerns, and the impacts of vehicle reliability on congestion). These other externalities may indicate that mobile source offset provisions are worth a second look. If total public benefits do exceed program costs, programs might be implemented under agency cost sharing arrangements (e.g. air pollution, energy, safety, traffic, and other agencies all providing a share of the public funds). Remember also, the final analysis of mobile source offset provisions must include detailed social analysis of equity impacts, to ensure that the cost of adequate mobility and access to services does not rise beyond the means of the public affected by the programs.

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26. Permanence of emission reductions must also be assured by requiring that each emission trade be submitted as a source specific SIP revision (see reference 17).
27. Unocal Corporation; SCRAP, A Clean Air Initiative from Unocal (10M 0791); Los Angeles, CA; July 1991.
28. In actuality, 46% of the participants purchased a new vehicle after scrapping their pre-1971 vehicle (see reference 27). No information was available as to the number of individuals who purchased a replacement vehicle at some time prior to scrapping. Only 8% of the participants changed modes to transit or carpool. Also, 20% of the replacement vehicles purchased were pre-1975 vehicles, significantly reducing the cost-effectiveness estimates that follow.
29. The mass of the various air pollutants have varying effects, and should never be considered equal in impact. For the purposes of this simple analysis, the mass emission reductions for the pollutants were added solely because the costs of offsets for each of these pollutants on the open market have historically been roughly equal (see reference 32).
30. The allocation of the costs by pollutant could be varied; for example, with 1/3 of the cost is allocated to each pollutant:
 HC: $(\$1.9E6)(0.33)/(1250 \text{ tons/yr}) = \$ 500.00/\text{ton/yr}$
 CO: $(\$1.9E6)(0.33)/(5030 \text{ tons/yr}) = \$ 130.00/\text{ton/yr}$
 NOx: $(\$1.9E6)(0.33)/(140 \text{ tons/yr}) = \$4500.00/\text{ton/yr}$
31. The USEPA staff report emission reduction estimates for the SCRAP program (Reference 12) are roughly equivalent to the safety factor of two used in this back-of-envelope calculation (663 t/yr ROG, 3,008 t/yr CO, and 52 t/yr NOx).
32. J. Margolis; AERX; personal communication; San Francisco, CA; February 28, 1992.
33. Another way to look at the same analysis is to include a salvage value for the permanent emission reduction credit. This salvage value would need to include appropriate adjustments for any locally required offset ratio, reasonably available control technology compensation, and the cost of emission controls to achieve the reductions (if the reduction is to be sold to an offsite source). However, the salvage value is positive and potentially significant (especially if reductions are going to be used onsite) as the marginal cost of emission reductions from other sources continues to increase.
34. M. Riechle; speech delivered at the Innovative Regulatory Strategies Workshop; Unocal Corporation, Los Angeles, CA; Conference Sponsored by the USEPA, Office of Policy, Planning and Research; Washington D.C.; January 1992.
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37. Perhaps the higher present value costs of obtaining these offsets, however, will be partially offset by the positive press that such programs can generate ... this is a decision that must be made at the corporate level.

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