7 FOCUS GROUP AND CASE STUDIES

This chapter presents the results of a focus group and follow-up case studies conducted to gain insight into how different types of trucking operators would respond to more stringent state emission standards for heavy-duty trucks. The results from the focus group and case studies were then used, along with the results of a mail-out survey, to develop information used in a simulation model of how the California trucking industry would respond to projected costs associated with potential regulatory programs.

The focus group was conducted in order to bring together a larger number of trucking firms than could be accommodated in individual case studies. In this way, a more diverse sample of trucking firms could be included in the focus group/case study process and hypotheses about how different types of trucking firms would respond to increased regulatory costs could be tested prior to final design of the mail-out survey instrument. The California Trucking Association (CTA) assisted with organizing the focus group and ensuring that a wide range of different types of trucking firms were represented. In order to broaden participation to include owner-operators who are not typically CTA members, contacts were made with the California Highway Carriers Association. Unfortunately, no members of this association were able to participate in the focus group. The focus group was held on June 28, 1994, at CTA headquarters in West Sacramento. The results of the focus group and a more detailed description of how it was conducted are provided in Section 7.2 of this chapter.

After the focus group was completed, the study team felt it was necessary to explore some of the different types of business responses that were identified in the focus group in more depth prior to the survey phase of the project. There appeared to be a group of small to mid-sized carriers, particularly those who had geographic constraints associated with their operations (e.g., tied to a particular port or intermodal location or a geographical market area) that have a range of options available to them in responding to increased costs different from those available to larger interstate operators. There also were mid-sized companies that seemed very knowledgeable about re-basing options available to them under the IRP. We also felt that it was critical to have some discussions with owner-operators since the consensus of the focus group was that this group of operators would be particularly hard-hit by increased regulatory costs. Lastly, the ARB felt that it was important to talk to operators in southern California to determine if they faced any conditions that were unique from those described by the northern California operators present at the focus group. To address these issues, the study team conducted five follow-up case studies. Two of these case studies were with participants from the original focus group, while the remainder were identified from lists of intrastate and interstate carriers available from the California PUC and the Department of Transportation's Motor Carrier Census File. These case studies are presented in Section 7.4 of this chapter.

It is important to point out that in order to conduct frank discussions with focus group case study participants, it was agreed to keep the names of individual firms confidential. The trucking industry is highly competitive and relationships with the ARB are fragile at the

moment. We believe that confidentiality does not compromise the results of the study and allows us to collect better data.

The next section of this chapter provides a summary of the findings of this phase of the research.

7.1 SUMMARY OF FINDINGS

Most trucking companies will find it extremely difficult to absorb any significant regulatory costs. Profit margins in the industry are very slim. Operating ratios of 96 percent to 97 percent seem typical. Many of the smaller operators appear to be as likely to post small operating losses as marginal profits from year to year. Several of the firms interviewed indicated that current debt obligations are what keep them in business even with such marginal profitability. The consensus was that, for smaller operators and owner-operators, trying to absorb increased regulatory costs by reducing profits might force them out of business. Smaller carriers also stated that it is difficult to cut other costs in order to absorb increased costs of regulation. Driver wages are set competitively with the larger firms, effectively establishing wage floors at around $14 per hour for good drivers. Given the current shortages of drivers reported throughout the industry, cutting driver wages is viewed as a risky strategy.

In general, three options were mentioned most often as a means to deal with increased operating costs: 1) raising rates, 2) delaying vehicle replacements, and 3) re-basing vehicles out-of-state. Raising rates appears to be a feasible option in several distinct market niches including intrastate markets, local delivery, and markets in which location of the carrier is tied to a particular shipping facility or market area. Examples of location driven markets include field-to-processing agricultural hauls, construction, and intermodal activities tied to specific ports and rail facilities. Carriers in these niches reported that they are very unlikely to relocate. This suggests that for analytical purposes, it is important to segment the market properly in order to model business responses accurately. Even within primarily intrastate markets, competition from out-of-state carriers is increasing and putting pressure on rates. This is largely the situation in the general freight market. Recent federal legislation prohibited state and local agencies from regulating "prices, routes or services" in the trucking industry starting January 1, 1995. Thus, it is becoming easier for out-of-state carriers to enter the intrastate market and drive pricing policies. For example, a large interstate carrier taking a load from Chicago to San Francisco can pick up a load in San Francisco, carry it to Los Angeles, and then pick up another load in Los Angeles headed back to Chicago. This is already being done and makes the high traffic corridors in the intrastate market very price competitive. The further deregulation of intrastate markets will increase this competitive pressure. Carriers with vehicles based out-of-state that are not subject to California emissions standards will tend to hold rates down and make it very difficult for California carriers to absorb increased regulatory costs with rate hikes. Even in sub-markets where raising rates appears to be an option, carriers felt that the long run effect may be to reduce the overall size of markets as shippers move out of California to reduce their overall costs. One carrier reported that in his deliveries for

department stores he noticed that, as transportation costs rise and the general business climate in California declines, marginal California stores will be shut down and new stores will be placed in other growth markets. Even in markets where shippers are not prone to relocation pressures, rising costs of transportation can reduce market size in the long run. An example is provided by fresh produce shipments from the Salinas Valley, where shippers report unusually high transportation costs because of the levels of service available. Customers, such as supermarket chains, will try to take transportation rate increases out of the grower's price in order to keep retail costs of the products down. They stated that, if retail prices are forced up, demand for the product will decline.

A second option for absorbing regulatory costs is to delay new vehicle purchases. There were mixed opinions as to the feasibility of this option. Many carriers reported that vehicle replacement rates have been set largely by technology improvements and capital cost vs. operating and maintenance (O&M) cost tradeoffs. Over the past 20 years, fuel economy improvements have dominated purchase decisions. Fuel economy of trucks has increased substantially during this period, allowing trucking operators to reduce operating costs. Carriers reported that under current economic conditions, the optimal replacement period is 5-10 years. However, some carriers argued that the marginal increases in fuel economy appear to be diminishing and the new purchase decision in the future is likely to be driven primarily by the maintenance cost vs. capital cost tradeoff. Some carriers quoted costs of about $4,000 for an engine rebuild (large Class 8 truck) with the ability to achieve a $500 per month reduction in maintenance costs. These numbers would tend to favor continuing to rebuild the engine rather than purchasing a new truck. In the case of smaller carriers and owner-operators, additional regulatory costs would tend to tip the balance towards maintaining older equipment rather than purchasing new equipment. One intermodal carrier estimated that the vehicle replacement cycle could be extended about two years under the regulatory scenarios described in the focus group. This carrier pointed out that a number of costs already decline as the vehicle ages (e.g., registration fees, taxes, insurance fees) and added up-front costs could further discourage new equipment purchases. Given these existing disincentives to capital stock turnover, the low operating margins for trucking in general, and the poor access to capital often experienced by smaller operators, it is likely that increased regulatory costs will create a strong incentive for small firms and owner-operators to hold onto their equipment as long as possible. Some industry sources have stated that these carriers already operate the oldest, most polluting equipment in the industry and more restrictive emission control standards could exacerbate this problem.

In the case of interstate carriers, the re-basing option seems particularly attractive and legally feasible. Many of the larger interstate carriers have already re-based their line-haul fleets to avoid costly California regulations and what they view as a generally unfavorable business climate for trucking in California. For mid-sized interstate operators who already have staff and facilities in another state, the re-basing option is also very likely. This group would include anyone who operates a terminal or office outside of California. There appears to be some disagreement as to what the actual costs of re-basing would be. The firm with the most recent experience with re-basing from within the focus group said that the cost for re-plating

a vehicle is expensive. In his case, there was a period recently (after California joined the IRP) when the California Highway Patrol (CHP) announced that they would not grandfather the old apportioned plates issued by the Department of Motor Vehicles (DMV) and new plates (under the IRP) would need to be issued. Since all of these vehicles were going to need new plates anyway, this carrier took the opportunity to re-base.

In cases in which a smaller carrier operates primarily in California but has some interstate mileage, some carriers were aware that IRP rules would allow them to re-base. A small owner-operator primarily doing agricultural hauls noted a competitor that re-based in Reno. The company operates during the agricultural off season in Nevada and Arizona, hauling whatever commodities they can in order to establish residence for basing purposes. This strategy has reduced taxes and other operating costs. In cases where small carriers that operate primarily in California wish to take advantage of the basing provisions of the IRP, a small office with a part-time person to maintain records and answer the phones would appear to be the minimal cost which would be incurred. While the costs for this type of operation are relatively low, there is probably a threshold number of vehicle replacements annually that would be reached before this is economical. Most carriers interviewed believe that the smaller operators would likely lack the knowledge and sophistication to pursue this option. Most owner-operators interviewed argued against any kind of relocation because they have other compelling reasons which keep them in California.

7.2 FOCUS GROUP RESULTS

On Tuesday June 28, 1994, the study team convened a focus group panel of eight truck operators to discuss the economic impact that future ARB heavy-duty low-emission vehicle regulations might have on the California trucking industry. The focus group session, held at the headquarters of the California Trucking Association in West Sacramento, was attended by individuals representing the following types of trucking firms:

General Characteristics of Participating Trucking Firms

No.	Type of Carrier	For "Hire" or Private	Base Plate State	HDVs Owned by Firm	HDVs Operated in CA	Type of Products Carried	Truck Terminals in CA
1	*	For Hire	California	Unknown	Unknown	Unknown	Unknown
2	*	For Hire	California	48	48	Variety	2
3	*	For Hire	California	95	95	Food	2
4	*	For Hire	California	150	150	Agriculture	5
5	Interstate	Private	Connecticut	7,580	641	Package (LTL)	109
6	Interstate	Private	California	120	100	Dry Freight	13
7	Interstate	For Hire	Oregon	1,400	840	General	20
8	*	For Hire	California	50	50	Rock, sand	2

* Indicates both an intrastate and interstate carrier.

All of the firms operate in California as well as out-of-state; only two of the companies, carriers 5 and 6, characterized themselves as private operators. Again, only two of the firms are base-plated outside of California (carrier 5 in Connecticut and carrier 7 in Oregon). Of the group, carriers 5 and 7 also own and operate the largest number of trucks as well as truck terminals.

The study team began the session by describing the purpose of the ARB study and its two principal goals: to assess the economic impact on the trucking industry of complying with future regulations to reduce emissions from HDVs, and to identify incentives to help maintain a profitable trucking industry while at the same time meeting state and federal clean air requirements. A set of discussion guidelines were prepared for use by the focus group facilitators. These guidelines are reproduced as Exhibit 7-1.

The group was then presented some "preliminary" estimates of incremental vehicle costs associated with incorporating appropriate emission control technologies in order to meet low-emission vehicle standards. These estimates were provided by ARB staff, based on a 1993 report by Acurex Environmental Corporation entitled *Technical Feasibility of Reducing* NO_x

EXHIBIT 7-1

DISCUSSION GUIDELINES FOR FOCUS GROUP ON POTENTIAL LOW EMISSION VEHICLE REGULATIONS FOR HEAVY-DUTY TRUCKS

Brief Scenario Description to be Provided to Each Participant

- what will be regulated
- what will the incremental capital costs per vehicle be
- what will the incremental fuel costs be
- other incremental operating costs (catalysts replacement, filter cleaning)
- incremental maintenance costs

Discussion Guidelines to be Used in the Focus Group (Not to be Distributed)

1. What options would you consider if such a regulation were adopted? Possible responses to be explored:

   - comply with no change in operational practices
   - delay new vehicle purchases
   - register new vehicles in an existing base state other than California
   - establish a new base state and register new vehicles in the new base state
   - establish a new base state and register new and old vehicles there
   - relocate the entire fleet and terminal operations as well

2. How would the costs of the new regulation affect your ability to compete? Do you think that there are others of your competitors who would be able to avoid the costs of the regulations in ways that would not be options for you? Could certain types of tax incentives help level the playing field?

3. If you are a multiple base state operator, explain how you determine where you register new vehicles:

   - What would be involved in registering new vehicles outside of California?
     - changes in workload at existing location
     - would you change actual utilization and terminaling
     - vehicle property or other tax costs in alternative state
     - changes in travel patterns or routes
   - Which of your existing base states would you most likely use as an alternative to California?
   - Why do you base some vehicles in California now? What would you give up if you ceased basing vehicles here?
   - Have you considered relocation of your California based operations before? Why? Why didn't you?

4. If you operate as an interstate carrier and are based only in California:

   - Are you aware of what options there are for you to base in another state?
   - If you established a new base state, where do you think you would go?
   - If you established a new base state, what costs would you incur?
     - costs for employee(s) to conduct business in the new base state
     - telephone hookup
     - other site costs
     - changes in O&M rates
     - changes in property taxes on vehicles and other taxes and fees
     - increased/reduced vehicle inspection costs
   - Would you operate multiple base states or would you consider moving your entire operation to the new base state? What advantages do you see in being able to base your vehicles in the same state in which they are primarily operated?

EXHIBIT 7-1
DISCUSSION GUIDELINES FOR FOCUS GROUP ON POTENTIAL LOW EMISSION VEHICLE REGULATIONS FOR HEAVY-DUTY TRUCKS -- (Cont'd)

- Aside from a straight cost comparison, what other factors would you consider in making a decision to establish a new base state?
- Have you considered establishing a new base state before? Why? Why haven't you?
- What would you give up if you eliminated California as a base state?
- Would you consider having an out of state firm (or service bureau) process your records, maintain your registration, conduct your registration activities etc., in order to establish a new location for basing purposes?

5. If federal regulations included one-stop or two-stop restrictions in non-attainment areas, how would this affect your location decision?

6. If you operate exclusively intrastate, do you believe that there are options available to you which could mitigate the effects of the regulations? Could you operate interstate with a base state outside of California?
   - Could you generate enough new business to justify a new base state?

7. Would you consider leasing your vehicles from an out-of-state source to avoid purchasing the low emission vehicles?

8. What are your current costs of recordkeeping and other administrative functions associated with maintaining vehicle registrations and records and how might these change if you re-based any of your vehicles?

9. What types of incentives could the state offer to you to keep your business but still maintain the regulations?

10. How would your location decisions change if registration fees included a feebate type concept to reward cleaner vehicles and penalize dirtier vehicles and you had to comply with this under the IRP as long as you operate in California?

11. Can you give us a breakdown (particularly for trucks which operate in California) of VMT by state, number and types of trucks you operate, typical commodities hauled, number of terminals operated, and any other information which you feel would help to characterize your fleet relative to the rest of the market?

and Particulate Emissions from Heavy-Duty Engines, and were meant to provide a range of likely costs rather than a precise estimate. These costs would be incurred by individual trucking companies should the regulations be adopted.

For Operators with Trucks Having A Gross Vehicle Weight of 33,000 pounds and over

Baseline vehicle cost	$95,000
Additional capital cost [1]	$9,000 to $15,000
Additional annual operating cost	$700 to $1,100
Average cost per mile (40,000 miles/yr.)	4 cents

[1] Does not assume any additional engine rebuild costs.

For Operators with Trucks Having A Gross Vehicle Weight Between 14,000 and 33,000 pounds

Baseline vehicle cost	$95,000
Additional capital cost	$6,600 to $10,100
Additional annual operating cost	$0 to $500
Average cost per mile (40,000 miles/yr.)	4 cents

As the discussion began, it was suggested that the ARB not refer to trucks by its own weight class designations (e.g., medium-heavy) but rather by the industry's weight classification (e.g., Class IV, V, or VI). There also was some confusion as to whether ARB's proposal was part of or in addition to the Federal Implementation Plans (FIP) for South Coast, Ventura, and Sacramento that were proposed at the time. The study team explained that ARB's proposal is unrelated to the FIP, but if a regulation is ultimately adopted by ARB it may coincide with certain provisions that were contained in the now superseded implementation plan.

7.2.1 Reaction to Compliance Costs

A number of people made the general comment that these additional costs would put California operators at financial risk. It was said that "we cannot eat anymore costs" and, as a consequence, truck operators would need to pass along these additional costs to their customers. This could result in trucking companies losing market share and/or could force shippers to relocate outside California. To remain competitive in the California market, larger carriers could potentially base-plate their operations out-of-state and avoid the compliance costs. Focus group participants believed that line-haul trucking firms including Freymiller, Consolidated Freightway, Yellow, and Roadway have already taken such actions for just these reasons. However, for smaller, independent carriers who operate with little profit margin, it was said that these carriers will go out of business. With fewer carriers, there is potentially less price competition among trucking firms and shipping costs may eventually rise. It was

said that 90 percent of all trucks are owned and operated by small operators, with 10 trucks or less (no source was cited to validate this comment).

There was general agreement that many operators who can rebase their trucks outside California will do so if the action is cost-effective. At least one participant was familiar with provisions under the IRP.

Several people expressed concern that more stringent HDV emission regulations would add to the negative business climate in the state. They felt that additional ARB, Department of Motor Vehicles, and California Highway Patrol requirements would make it increasingly difficult to operate in the state. It was argued that trucking is one of the few entry-level industries, where an individual with a modest investment can purchase a truck and the necessary permits and start a business. However, these regulations would have the effect of substantially increasing capital and operating costs, making it more difficult for operators to financially survive. Several people were adamant that it is unfair to impose more stringent emission requirements on only carriers base plated in California.

One operator said that several years ago, his firm decided to move its operations from California to Nevada since vehicle registration costs were less expensive. The firm chose to do this even though 90 percent of its mileage was in California. When Nevada raised its registration fees to levels comparable with California, the firm relocated again back to California. These registration fee discrepancies may be less apparent under the IRP. However, other operating cost disparities between California and its neighboring states could make it cost-effective for interstate carriers to move. This suggests that trucking firms which are cost sensitive and have the flexibility to move may relocate out-of-state to avoid compliance with various state requirements.

It was also emphasized that existing trucking firms could avoid the additional costs of compliance by deferring replacement of their vehicles, assuming that the ARB would not require the installation of emissions equipment on existing vehicles. Due to the high cost of financing, many truck operators prefer to operate and maintain their existing equipment for as long as possible.

Panel participants also questioned whether the technology exists to meet the more stringent emission standards, especially at reasonable cost. Contrary to ARB objectives, it was suggested that should engines that comply with the new requirements become too expensive, operators could use smaller vehicles with more limited carrying capacity, thus necessitating more vehicle trips resulting in greater emission levels.

For trucking firms that operate locally and transport construction materials, agricultural, or petroleum products, it was said that these companies have fewer options in avoiding compliance costs, since they must be located relatively close to their customers.

7.2.2 Incentives

The group was unable to identify major incentives to help offset the costs of regulatory compliance. The group did discuss the idea of reducing vehicle registration fees for those firms operating "cleaner" vehicles. It was felt, however, that this idea would be difficult to implement due to the need for legislative action and amending the state constitution related to the payment of in-lieu property taxes.

One individual did suggest, however, that in return for complying with the emissions standard, the state could agree to allow his firm to operate Larger Combination Vehicles (LCVs) on the interstate, thereby allowing his company to transport more commodities at a lower cost per vehicle mile.

7.2.3 Summary of Issues Raised in Focus Groups

In summary, the group expressed concern about the financial impact that the ARB's regulations would have on their industry and on the state's economy. A major unpredictable factor would be the extent to which the market place changes in response to higher costs, since, as one participant said several times, "it is impossible to regulate a dynamic economic model." Large trucking firms will in all likelihood have an easier time in absorbing additional costs than smaller companies. Larger firms, for example, may choose to re-base outside California if it is cost-effective to do so. Both large and small firms could also potentially circumvent the regulations by deferring for as long as possible the replacement of their older vehicles. The group strongly supported a single national HDV emission standard applicable to all carriers, including railroads, airlines, and steamship companies.

7.3 CASE STUDY RESULTS

7.3.1 Case Study 1 - Small to Mid-Sized Intermodal Carrier

The carrier operates 48 trucks for intermodal service connected with port traffic from Oakland and Stockton. Cargo includes a wide range of commodities including computers, paper, auto parts, refrigerated and frozen foods, wood, and other general freight items. All of this firm's trucks are base-plated in California and operate roughly 85 percent of their VMT within California. Occasional runs into Nevada have required interstate operating authority, but from the perspective of the operator, this is primarily an intrastate operation. The firm also operates two truck terminals in California.

While this firm does have a small portion of its operation in interstate hauls, and the provisions of the IRP appear to allow the firm to base-plate in Nevada and still maintain all current operations in California, this option did not attract any interest from the respondent. As far as he was concerned, the firm's operations are tied to their port markets and associated facilities and they operate primarily intrastate. Therefore, he felt re-basing was impractical and

inappropriate to his operation. Several suggestions that it was perfectly legal to set up a small office for basing purposes did not elicit any interest in this option.

The respondent also felt that raising rates to cover increased regulatory costs was not an option. However, his arguments as to why this was the case seemed unconvincing. He maintained that out-of-state operators offering California service are at a disadvantage in trying to serve a local market and this is why he insisted that basing in California is necessary. Yet, he also argued that raising rates would create a competitive disadvantage. It is possible, however, that where intermodal service can be offered by larger companies in joint venture agreements with rail companies, the truck carriers could be based out-of-state and might be able to offer more competitive rates than a local intermodal carrier who did not have access to the re-basing option. If this is the case, then raising rates may be a more limited option. In the short run, any rate changes could affect market share but if all carriers faced the same regulatory costs, in the long run any competitive disruptions should be resolved. The respondent also felt that there was little room to absorb costs through reduced profits. He pointed out that margins were already very low.

The respondent believed that the most likely option would be to forgo purchases of new vehicles as long as possible. He said that their analyses show that the most cost-effective replacement rate for vehicles now is no longer than 8-10 years. Annual mileage on these vehicles is about 80,000 miles. He felt that it might be possible to extend vehicle replacement another 2 years given the likely economics of new engines that would meet more stringent standards. He pointed out that there are a number of incentives already built into the system that encourage holding on to existing equipment as long as possible. Taxes, insurance fees, and licensing fees decline with age of the vehicle and there are no current penalties for older high-emitting vehicles. While increased maintenance costs are associated with older engines, these do not seem to outweigh the reduced costs associated with older vehicles until the trucks are at least 10 years old. Higher costs for new engines (based on new emission standards) would extend this period slightly. He also seemed to believe that at some point there is a disadvantage associated with operating older equipment because of its impact on customer perceptions.

7.3.2 Case Study 2 - Mid-Sized Interstate General Freight Carrier

The carrier is a general freight carrier with interstate operations primarily in California and Nevada. The company owns about 30 power units, 15 of which are double-shifted, and operates another 30 units which are leased. He was selected for this case study because he has re-based his entire fleet twice: first re-basing from California to Nevada and more recently returning basing to California. When the first re-basing decision was made, he was essentially operating a Nevada fleet and a California fleet, although all vehicles were plated in California. At that time, registration fees were substantially lower in Nevada and the overall business environment for trucking was more favorable. The carrier's description of his past experiences in re-basing vehicles seems to pre-date California's joining the IRP since the IRP was designed to eliminate the incentives to this type of jumping from state to state to obtain advantages of

lower registration fees. Sometime after the carrier's initial re-basing decision, Nevada fees rose and the cost advantage disappeared. At that point the carrier decided to re-base in California where the bulk of his operations were. The carrier reported that current registration fees in California cost him in the neighborhood of $1,500 per power unit.

The carrier pointed out that other small to medium-sized interstate carriers would have strong incentives to re-base if California environmental regulations created additional costs which could be avoided by re-basing. He felt that many true interstate general freight carriers who service multiple markets across state lines probably already had some operations in another state besides California. In his case, he maintains terminals in both California and Nevada and has office staff in both states. While more of his customers are in California, he still serves a reasonably-sized market in Nevada. He believed that under these circumstances, he incurred no cost for re-basing and he felt that many carriers in his market would be in a similar position. However, his understanding of provisions of the IRP may be out-dated and he has not taken into account any costs which might be associated with re-plating vehicles in another state (costs associated with re-plating under IRP provisions needs to be better understood to properly assess this issue). He also pointed out that he is in a very competitive segment of the trucking market where he faces heavy competition from larger interstate carriers who are already based outside of California and who would not face the cost impacts of new ARB regulations. Thus, he felt that the decision to re-base could be made easily and at no to minimal cost.

The carrier also felt that this would be a realistic option for any interstate carrier who serviced markets outside of California even if this carrier currently does not maintain physical facilities and office staff in another state. The only costs associated with setting up an operation would be rent for a small office, the costs of a staff person, and other general overhead costs. The costs of re-plating are not considered an added cost because the vehicles must be registered every year and registering in a new state could be easily accommodated. Thus the decision algorithm should compare the annual costs of maintaining a small record-keeping operation in another state with the annualized incremental cost of new vehicles meeting the new standards. This suggests that there is probably a threshold fleet size below which the savings from noncompliance with the regulations do not justify the annual costs of operating a small facility to allow basing outside of California. But, the carrier pointed out that this market is very cost competitive and when the threshold is reached, carriers that are able should be expected to re-plate.

As far as other options are concerned, this carrier felt that delaying vehicle purchases might be a possibility. However, he noted that vehicle replacement rates were primarily fuel economy driven. He said that ideal turnover is 5-7 years. This has been the cycle, over the last 20 years, in which engine manufacturers have introduced new technologies with significant fuel economy benefits. Fuel savings become a primary justification for the new equipment purchases, allowing carriers to remain competitive on a cost-basis. To delay purchases when other carriers are able to invest in more fuel efficient equipment would put you at a cost disadvantage. This carrier said that he is sometimes forced to delay purchases in periods of

poor cash flow and low profitability. He disagreed with another case-study participant on the issue of the impact that older equipment has on customer perceptions. He said that trucks can easily be maintained in good working order and present a good appearance to customers well beyond 5-7 years. He also felt that the maintenance cost/capital cost tradeoff did not drive the decision to purchase new equipment until well beyond his ideal 5-7 year replacement cycle. So here the decision algorithm appears to be related primarily to foregone fuel efficiency savings as compared to incremental annualized capital costs of new, low-emission equipment.

The carrier believed that there were few other opportunities to absorb higher costs within existing operations. He noted that operating margins are extremely low. Last year he lost 2½¢ on the dollar and this year, which he characterized as a very good year, he is making 3½¢ on the dollar. So cutting into profits is not a viable option. He also felt cutting wages was impossible to do. Since his segment of the industry is dominated by larger multi-state operations, these larger companies set the competitive wage rates for drivers (he quoted these as currently around $14-$15/hour). If smaller companies try to reduce their wages they will lose good drivers to the larger companies. Given predicted shortages of long-haul drivers in the up-coming years, this would be a risky strategy. He also believes that the larger companies establish the marketplace rates for service and trying to pass costs on to customers would result in a rapid loss of market share.

7.3.3 Case Study 3 - Small Interstate Freight Carrier

The carrier is located in southern San Bernardino County and transports bulk cement and limestone to destinations in California, Arizona, Nevada and Utah. The company operates on a "for hire" basis and owns 25 power units, all of which are based-plated in California. Sixty percent of the firm's operations occur in-state.

The respondent expressed general concern about the regulatory, anti-business environment in California. He said that it has taken him over two years to obtain the necessary zoning and business permits to expand his office, yard, and shop. He felt that small businesses are being squeezed by more and more burdensome government regulations and higher costs. He said he has already considered relocating his operations outside California.

In reaction to the ARB proposal to impose more stringent vehicle emission standards for HDVs, the respondent said his company would cease to grow and that the firm would need to downsize its operations to reduce costs. The respondent felt strongly that his firm could not absorb higher costs. He said that his firm has not had an increase in tariffs in over 12 years and that it would be difficult for him to pass along the increased costs due to competition. If it were possible for him to avoid repayment of his debt, he would close his operations and pursue another line of work.

If downsizing his operations did not achieve significant cost savings, he would relocate outside California. He stated that serving his existing customers would likely result in incurring higher operating costs, since the cement and limestone he transports is produced near his existing

operations. He believed these higher operational costs could be offset by the lower taxes and registration fees he would pay as an out-of-state truck operator, although it is clear from our conversation that he has not sufficiently researched the costs associated with out-of-state registration, taxes, or fees. He did say, however, that the only reason he has yet to move his company is because of his current debt obligations.

The respondent said that it would be unfair to apply the regulations just to California-based truck operators. These additional costs would place California truckers at a significant disadvantage in competing with out-of-state truckers not required to meet state emissions requirements. With the majority of trucking companies having extremely small operating margins, the respondent said the new emissions standards would force many companies to either relocate or go out of business.

The respondent felt that few trucking companies would delay the replacement of their vehicles, again given the competitive nature of the industry. While capital costs are significant for new equipment, fuel efficiency is an extremely important factor in operating costs. In his case, all the equipment he purchases is used, relatively new equipment that meet current emission standards.

In discussing incentives the state could offer so that he would maintain his business in California, the respondent was not particularly optimistic. He said the best thing the state could do would be to offer tax incentives, such as an investment tax credit, or low interest loans in helping companies purchase equipment. But given the current economic climate, he feels its unlikely the state would adopt this type of program.

7.3.4 Case Study 4 - Small Interstate Freight Carrier (Owner-Operator)

This carrier is located in Butte County and transports lumber to destinations in California, Oregon, and Nevada. While the firm is technically an interstate carrier, 95 percent of its operations occur in California. The company operates on a "for hire" basis. The respondent owns his own truck and trailer and contracts with five owner-operator rigs. All six vehicles are California base-plated.

The respondent was familiar with provisions of the IRP and said that for him and many other operators, it would be cheaper to relocate their operations outside California. He claimed that his customers really are not concerned where he is located, since all his business is done by telephone. And while he is concerned about the rising cost of doing business in this state, he and his family enjoy living in California and he is reluctant to move.

He said that the ARB proposal is another sign of how the California trucking industry is changing. Federal truck deregulation in the early 1980's, new fuel efficiency and safety standards, and air quality requirements have made the industry much more competitive. The decision by the federal government to do away with state regulation of intrastate trucking as of January 1, 1995, will only strengthen this trend towards more competition.

Should the ARB impose its new standards only on California base plated operators, it will make these operators less competitive with out-of-state base plated truckers who would be exempt from the requirements. Since some smaller truckers would probably go out of business due to higher capital and operating costs, the total number of trucking firms would shrink thus reducing competition in the industry. Larger firms can more easily absorb higher costs, thus allowing the larger companies to expand their market share. The respondent felt strongly that the new emission standards should be adopted at the federal level and made applicable to all trucking firms.

He did say that one way trucking firms could avoid complying with the regulations would be to delay the replacement of equipment. However, this would be a temporary measure, since many truckers are interested in achieving lower operating costs through the use of more fuel-efficient equipment.

The respondent was hard-pressed to suggest incentives the state could offer to discourage companies from moving outside the state. He said that he is actually more concerned about the deregulation of the intrastate trucking industry than the ARB emission standards. Deregulation will do away with a lot of paperwork including the publishing of trucking rates, meaning that his costs will go down. On the other hand, it will allow larger trucking firms based outside California to compete in the intrastate market, forcing many small and mid-size companies to reduce costs even more or close their operations.

7.3.5 Case Study 5 - Small Interstate Freight Carrier (Owner-Operator)

This carrier, located in San Benito County, operates primarily in California, and occasionally in Arizona and Nevada. The company specializes in transporting agricultural produce including refrigerated perishables, fruits and vegetables. The firm also carries computer and electronic equipment during the off season. The company, in business for seven years, operates on a "for hire" basis. The company consists of seven owner-operator rigs base-plated in California.

This respondent was the least concerned of the people interviewed concerning future ARB emission requirements. He said that while the additional capital and operating costs associated with the ARB standards would be a financial burden, he would implement every cost-saving measure he could before moving out-of-state. Relocating outside California would be a final "survival" step for the firm before closing up the business.

The respondent did feel that it is important that there be a "level playing field" and that all trucking firms comply with the same emission requirements, not just California-based firms. Everyone should be asked to pay their fair share. And while customers may complain about higher shipping costs, his experience suggests that if the cost increases are well publicized, then most customers are generally willing to pay more to ship their commodities. For example, he cited customers' reactions to the need for truckers to pay higher diesel fuel costs due to recent diesel fuel regulations. He did admit, however, that the willingness of farmers and agricultural

brokers to pay higher shipping costs may be different than other segments of the trucking industry.

He did say that under the IRP, a number of trucking firms have relocated out of California. For example, he knows of one firm that takes delivery of its equipment in Reno, Nevada. The company then operates half the year (the off season) in Nevada and Arizona and the remainder of the year in California hauling agricultural produce. By operating in California only half the year, he saves approximately $35,000 annually in taxes. The firm also pays significantly less in annual operating costs.

The respondent said that he already knows that it would be less expensive for him to operate outside the state. However, he likes living in California and has no intention of moving, even if ARB is to adopt new emission standards. He did say that if competition became too severe, he might consider a joint venture with an Arizona trucking firm or some other arrangement in order to stay in business.

The respondent said that he doesn't think many firms would delay replacement of their equipment to circumvent the ARB regulations. He cited, for example, that in 1986 it cost him $0.20 per mile to operate his truck; now with new fuel economy requirements he has lowered this figure to $0.02 to $0.04 per mile.[38] He also said that the truck manufacturer Freightliner has 85,000 trucks on back order and that many firms are buying new tractors and trailers. Additional capital and operating costs would have to be significantly higher before people would avoid purchasing new equipment.

He believes the state should develop some type of financial incentive to help trucking companies purchase new equipment. One example might be the use of an investment tax credit. He said that "tax credits influence buying decisions" and that the use of credits would help stimulate the state's economy. He also said that companies that help clean up the air should receive some type of benefit for their activities.

[38]These cost figures, however, do not seem reasonable. In particular, looking at costs from strictly a fuel-economy basis and assuming that diesel fuel costs $1.20 per gallon, if it costs $.02 to $0.04 per mile to operate a HDV, then that amounts to about 40 miles per gallon per HDV.

8 SURVEY METHODOLOGY AND RESULTS

The results from this survey complement the findings from the focus group and the case studies. In particular, the survey results indicated that the smaller trucking firms may be economically impacted more than the larger firms by increases in their regulatory costs. In response to more stringent regulations and potentially higher costs, some small firms may respond by moving all or parts of their operations to another state. However, some small firms lack the money and other resources needed to relocate, and some also are tied to their local California customer base. Those firms would be less likely to relocate. Finally, a few firms indicated that they simply may choose to cease their operations and go out of business. The response rate to the survey was low, and the statistical results were based upon small sample sizes. Therefore, any conclusions based upon the survey results should be made with caution.

A survey of trucking companies operators in California was performed as an extension of the focus group and case studies (Chapter 7). The purpose of the survey was twofold:

- to obtain more quantitative data with which to replicate the findings from the focus group and case studies; and

- to perform an exploratory assessment of the economic model of trucking company actions in response to proposed regulations.

Expectations about the survey were fairly minimal. Data from a variety of sources, including the focus group discussions, indicated that the regulatory climate in California was rather unpopular among trucking company owners. In addition, the survey attempted to investigate a fairly abstract issue: the actions that trucking owners anticipated that they would be most likely to take under the condition of a hypothetical and unpopular premise (e.g.., more stringent emission regulations and potentially higher business costs). Voluntary participation for research scenarios such as those often are low. Thoughtful responses to the survey required subjects to envision themselves in unpleasant circumstances, and then to consider their reaction to those circumstances in detail. That task, in itself, may have been difficult and unpleasant for subjects and contributed to the low response rate.

8.1 DESCRIPTION OF THE SURVEY INSTRUMENT

A research questionnaire was developed to measure a variety of variables presented in the economic model of potential trucking operator responses. Among the variables included in the questionnaire were:

- general range of trucking business activities
- number of drivers and vehicles in the fleet
- gross annual revenues from California operations
- attitudinal responses to increases in operating costs

- attitudes about rebasing operations in another state.

The questionnaire contained 16 items on a nominal basis. However, several items had multiple components and a total of 42 responses were possible if respondents answered every item. It was expected that the owner or manager of a trucking company could respond reasonably accurately to all items without the need to consult business files and other sources of information.

The questionnaire was designed to appear very brief to recipients, and it was printed on the front and back of a single page. The questionnaire also contained the return address of the ARB and first class postage for the convenience of respondents. A copy of the questionnaire is included as Exhibit 8-1.

A cover letter accompanied the survey questionnaire to provide a brief explanation of the purpose for the survey, and to request participation by the recipient. A copy of the letter is included as Exhibit 8-2. The letter was written on the official letterhead of Jack Faucett Associates, and signed by a senior officer of that firm. In the contents of the letter, recipients were:

- offered assurances about the confidentiality of their responses,
- given two names and telephone numbers to call if they had any questions,
- provided with definitions of certain terms in the questionnaire with which they might have been unfamiliar,
- asked to return their completed questionnaires within one week of receipt.

8.2 RESPONSE RATE

A sample of 1,000 survey recipients was selected from an archival computer file of truck registrations maintained by the California Department of Motor Vehicles (DMV). The selection of recipients was performed on a random basis. The list of potential recipients then was screened in an attempt to ensure that only one survey questionnaire would be sent to any company. All duplications of names of owners or operators were eliminated. All sampling procedures were performed entirely by the ARB. The random selection and mailing were performed by the ARB to ensure the confidentiality of the vehicle owners.

Survey materials were mailed by the ARB personnel in mid-May, 1995. By the end of that month, a total of 50 questionnaires were returned for an overall response rate of 5 percent of the survey sample. A significant number of questionnaires were returned by the postal service because they were undeliverable. Presumably, those questionnaires were addressed to businesses that were no longer in operation, or which had changed addresses.

EXHIBIT 8-1: SURVEY OF HDV OPERATORS

1. How would you characterize your business? ( ) for-hire less-than-truckload ( ) for-hire truck-load ( ) private carrier ( ) owner/operator

2. Are you an interstate or intrastate carrier? ( ) interstate ( ) intrastate

3. Please mark all states in which your company bases its vehicles:

( )CO	( )CT	( )DE	( )DC	( )FL	( )GA	( )HI	( )ID	( )IL	( )IN	( )CA	( )AL	( )AK	( )AZ	( )AR
( )ME	( )MA	( )MI	( )MN	( )MO	( )MS	( )MT	( )NC	( )ND	( )NE	( )IA	( )KS	( )KY	( )LA	( )MD
( )OH	( )OK	( )OR	( )PA	( )RI	( )SC	( )SD	( )TN	( )TX	( )UT	( )NH	( )NJ	( )NM	( )NV	( )NY
										( )VT	( )WA	( )WI	( )WV	( )WY

4. Could you tell us the number of California registered HDV's you operate by weight class (GVWR)?
____ under 14,000 ____ 14,001 to 16,000 ____ 16,001 to 19,500 ____ 19,500 to 26,000 ____ 26,001 to 33,000 ____ 33,000 and over

5. How many drivers do you currently employ?_____

6. Could you provide the following information on your estimated California annual revenues and number of employees? Please check those that apply (note: private carriers should only include their trucking operations)

Revenues: ( ) up to $1M ( ) $1M to $9M ( ) $10M to $49M ( ) $50M to $99M ( ) $100M to $249M
( ) $250M to $499M ( ) $500M to $999M ( ) $1,000M or more

Employees: ( ) 1 (owner-operator) ( ) 2 to 49 ( ) 50 to 99 ( ) 100 to 249 ( ) 250 to 499 ( ) 500 to 999 ( ) 1,000 or more

7. Provide the following information on your California base state record keeping operation (include fringes and other allocable costs):
personnel (#)_____ annual cost ($)_____
record storage and other recordkeeping related space rental (sq. ft)_____ annual cost ($)_____
other administrative costs (including computers, office equipment, etc.) ($)_____

8. Where do you store your operational records? ( ) in-state ( ) out of state

9. Please indicate what action you would take if a State low-emission Heavy Duty Vehicle regulation would result in the following increases in your operating costs on a per vehicle basis. For each cost category, please only choose the most likely action.

	Cost Per Vehicle of State Low Emission Vehicle Regulation								
Action	below $1,000	$1,001-$2,000	$2,001-$3,000	$3,001-$4,000	$4,001-$5,000	$5,001-$6,000	$6,001-$7,000	$7,001-$8,000	$8,000-over
(1) comply with no change in operational practices	( )	( )	( )	( )	( )	( )	( )	( )	( )
(2) delay new vehicle purchases	( )	( )	( )	( )	( )	( )	( )	( )	( )
(3) register new vehicles in existing base state other than CA	( )	( )	( )	( )	( )	( )	( )	( )	( )
(4) establish new base state/register new vehicles there	( )	( )	( )	( )	( )	( )	( )	( )	( )
(5) establish new base state/register all vehicles there	( )	( )	( )	( )	( )	( )	( )	( )	( )
(6) relocate the entire fleet and terminal operations	( )	( )	( )	( )	( )	( )	( )	( )	( )
(7) cease operations	( )	( )	( )	( )	( )	( )	( )	( )	( )

10. If California is your sole base state, do you currently have enough business out of state to justify establishing a new base state?
( ) yes ( ) no If not, could you generate enough business out of state to justify establishing a new base state? ( ) yes ( ) no

11. If you established a new base state, which state do you think you would choose? _____

12. If you established a new base state, what costs would you incur, and would these costs be higher, lower, the same, or in addition to the costs you currently incur? (please check all those that apply)

Cost	in addition to	higher	lower	the same
( ) employee(s) to conduct business in new base state	( )	( )	( )	( )
( ) telephone hookup	( )	( )	( )	( )
( ) other site costs	( )	( )	( )	( )
( ) changes in O&M rates	( )	( )	( )	( )
( ) changes in property taxes on vehicles and other taxes & fees	( )	( )	( )	( )
( ) increased/reduced vehicle inspection costs	( )	( )	( )	( )

EXHIBIT 8-1: SURVEY OF HDV OPERATORS

13. If you established a new base state would you:

___ Relocate your entire record keeping operation
___ Set up the minimal operation required by the International Registration Plan (IRP)
___ Set up the minimal operation but consider sharing with other companies

14. If emission regulations were adopted and the costs of compliance would be such that you would consider registering new HDV's outside California, how do you think the following actions might reduce this likelihood?

Action	large impact	small impact	no impact
a. tax incentives	( )	( )	( )
b. clean vehicle purchase subsidy	( )	( )	( )
c. feebate type concept to reward cleaner vehicles & penalize dirtier vehicles	( )	( )	( )
d. emission trading concept	( )	( )	( )
e. other (please specify)_____	( )	( )	( )

15. Have you ever considered relocating outside of California?

( ) no
( ) yes, due to business/regulatory climate
( ) yes, due to route structure/client location
( ) yes, due to _____

16. If you have considered relocating, why have you not relocated? _____

.....(fold along dotted line).....

California Air Resources Board
MSD-North, 5th Floor
Attn: Krista Fregoso
P.O. Box 2815
Sacramento, CA 95812

.....(fold along dotted line).....

EXHIBIT 8-2: COVER LETTER FOR SURVEY OF HDV OPERATORS

May 12, 1995

Dear Heavy-Duty Vehicle Operator,

Jack Faucett Associates, under contract to the California Air Resources Board (ARB), is conducting a study to evaluate the potential economic impacts of more stringent emission standards for new heavy-duty trucks registered in California. The low-emission vehicle regulations under consideration rely on diesel-based technologies. An important part of the study is the enclosed survey of heavy-duty vehicle operators. The purpose of this survey is to collect information to be used in designing effective programs that minimize and mitigate adverse economic impacts. All information provided will be kept confidential and will be used only for the purpose of this study.

The enclosed survey may include some items and concepts which are unfamiliar to you. These include economic incentives that are designed to mitigate the impacts of more stringent emission standards for heavy-duty trucks. Items and concepts which may be unfamiliar that are included in the survey are defined below.

International Registration Plan (IRP) - an agreement between the states that sets forth the procedures for registration of vehicles traveling in two or more states. Vehicles operated in only one state are not eligible for IRP registration. The home or base state collects all fees and issues registration materials for all states in which the fleet operates.

Base State - for the purposes of fleet registration, the state where the registrant has an established place of business, where mileage is accrued by the fleet, and where operational records of the fleet are maintained or made available.

Established Place of Business - a physical structure owned, leased, or rented by the fleet registrant. The physical structure shall be designated by a street number or location, be open during normal business hours, and have located within it: (1) a telephone or telephones publicly listed in the name of the fleet registrant; (2) a person or persons conducting the fleet registrant's business; and (3) the operational records of the fleet (unless such records can be made available).

Operational Records - records which substantiate the reported mileage, costs, and weights of all vehicles registered in two or more states. These include mileage reports from Individual Vehicle Mileage Reports and vehicle and cost records.

Feebate - a program where the California vehicle license, weight, and registration fee for all heavy-duty vehicles (HDV's) is based on the emissions characteristics of HDV's. Through this program, purchasers of low-emission vehicles would have reduced fees for these three fee categories.

Clean Vehicle Purchase - a program in which purchasers of qualifying low emission HDV's receive a cash subsidy for their purchase. Alternatively, the subsidy could be in the form of a rebate.

Emission Trading - a program in which fleets that purchase low emission vehicles would obtain emission "credits" which can then be sold to fleets that do not purchase low emission vehicles.

Tax incentives - a program whereby purchasers of low-emission HDV's receive either a tax credit of a specified amount or a deduction for business income tax. Additionally, these tax incentives could take the form of reduced sales taxes on the purchase of a low-emission HDV.

Thank you for taking the time to answer this survey. We would appreciate your response within one week. If you have any questions concerning the proposed survey, please feel free to contact Jonathan Skolnik at (301) 961-8800, or Michael Fischer at (510) 943-2177.

Sincerely,

Michael F. Lawrence
Vice President, Jack Faucett Associates

Thirteen questionnaires were eliminated from the sample because of the following criteria: received too late to be included in the data analyses (3), provided no data on the questionnaires (2), were not from users of heavy-duty trucks (2), were out of business (1), or were received from governmental agencies (5). Thus, the resulting "effective" sample size was 37, or 3.7 percent of the survey sample.

8.3 SURVEY RESULTS

Overall, the statistical interpretation of the survey results was limited because of the small response rate and also because of the large proportion of missing values in the questionnaires that were returned. Responses to some items also indicated that participants may not have provided accurate data (whether intentionally or through lack of attention). Univariate statistical procedures were the primary method of analysis, although occasional bivariate analyses will be reported as well.

1. How would you characterize your business?

A total of 34 participants responded to this item. Most participants (91 percent) selected one of four response categories for the item that were provided on the questionnaire. Three subjects provided more than one selection among the response alternatives, such as "for-hire truckload" and "private carrier". Responses to the first item are shown in Exhibit 8-3. The column labeled *"N"* in Exhibit 8-3 shows the number of survey participants for each response category.

EXHIBIT 8-3
FREQUENCIES OF RESPONSES TO ITEM 1

N	Response
1	For-hire less-than-truckload
4	For-hire truckload
17	Private carrier
9	Owner/operator
3	More than one response
34	Total

2. Are you an intrastate or interstate carrier?

A total of 29 subjects responded to this item, and most of those subjects (58 percent) indicated that they were intrastate carriers. Some subjects checked both of the two response categories provided on the questionnaire. Responses to this item were crosstabulated with the responses to Item 1, and those results are presented in Exhibit 8-4. Five respondents to Item 1 provided no data to Item 2.

EXHIBIT 8-4
ITEM 2 FREQUENCIES

Response	Interstate	Intrastate	Both	N
For-hire less-than-truckload	1	0	0	1
For-hire truckload	0	3	1	4
Private carriers	4	9	0	13
Owner/operator	2	5	1	8
More than one response	1	9	2	2
Total	**8**	**17**	**4**	**29**

The data in Exhibit 8-4 indicated that nearly one-third (31 percent) of the response sample were private carriers who operated only in California. Overall, intrastate carriers represented 58.6 percent of the response sample while interstate carriers represented 27.6 percent, and "Both" comprised the remainder of about 14 percent.

3. Please mark all states in which your company bases its vehicles.

The initials of the 50 states were listed after this item for subjects to check if applicable. A total of 34 subjects responded to this item, 26 (76 percent) of whom indicated only California as the state in which they base vehicles. Eight subjects checked response categories for states in addition to California, and all but one of those listed 5 or fewer states in total. One subject checked all 50 states. The mean number of states in which subjects based their vehicles was 3.65.

4. Could you tell us the number of California registered HDVs you operate by weight class (GVWR)?

A total of 33 subjects responded to this item by providing one or more responses to the weight range categories provided on the questionnaire. Many subjects actually made responses only to one or two response categories. For purposes of data analysis, however, it was assumed that

subjects omitted responses only to those categories in which they had no vehicles. Therefore, *missing data were converted to zeros* (for this item only) if subjects responded to any of the six categories on the questionnaire. The means (*"M"*), standard deviations (*"S"*), and maximum response values across all subjects for each response category are shown in Exhibit 8-5. Response categories consisted of weight ranges that had unequal sizes, so means across the different response categories were not calculated.

EXHIBIT 8-5
MEANS AND STANDARD DEVIATIONS FOR ITEM 4

Response	M	S	Maximum
Under 14,000	5.64	6.52	80
14,001 to 16,000	0.30	1.27	3
16,001 to 19,500	0.85	1.82	9
19,501 to 26,000	1.70	2.64	30
26,001 to 33,000	10	10.88	240
33,001 and over	29.94	30.42	280

5. How many drivers do you employ?

This was an open-ended item, with a blank line provided for subjects to write in the number of drivers. A total of 35 subjects responded to the item, and the mean number of drivers that they each employed was 38.97 (S = 68.86). Four subjects indicated that they employed no drivers, while one subject employed as many as 325 drivers. (A brief validity check found that the subject who reported 325 drivers also reported owning 280 trucks in the "Over 33,000 lb." category.)

The average numbers of drivers employed within each business category (as measured by Item 1) are shown in Exhibit 8-6. The means and standard deviations, both within and between business categories, indicated rather high variability in the number of drivers employed. In each business category that had more than one response, the value of the standard deviation exceeded the value of the mean. However, a one-way analysis of variance indicated that the mean differences between business categories were statistically significant ($p < .01$). The results from that analysis are summarized in Exhibit 8-7 as a typical ANOVA table. The columns in Exhibit 8-7 indicate the sources of variation in subjects' responses, the sum of the squared deviations (*SS*), degrees of freedom (*df*), the mean of the squared deviations (*MS*), and the F ratio. The statistically significant result indicated that the differences between the means was a true difference, and not simply the result of random variability due to the sampling process.

EXHIBIT 8-6 AVERAGE NUMBER OF DRIVERS PER BUSINESS CATEGORY			
Business Character	M	S	N
For-hire less-than-truckload	16.00	0.00	1
For-hire truckload	40.50	47.23	4
Private carrier	43.53	60.16	17
Owner/operator	12.11	21.50	9
More than one response	112.33	184.22	3

EXHIBIT 8-7 ANOVA RESULTS ON DRIVERS PER BUSINESS CATEGORY				
Source of Variation	SS	df	MS	F
Between Groups	21,988.61	1	21,988.61	914
Within Groups	161,239.60	67	2,406.56	
Total	183,228.21	68		

The number of drivers correlated positively with the total number of trucks operated by the subjects (as measured by Item 4): $r\ (33) = .446, p < .01$. The average number of drivers per truck was 2.19 ($S = 3.16$), and ratios ranged from zero to 40.

The distribution of drivers/truck ratios was considerably nonnormal. It was very peaked (leptokurtic, $g_2 = 31.79$) and the ratio values extended toward the high end of the distribution (positively skewed, $g_1 = 5.59$). Both g_1 and g_2 are approximately zero in normally distributed data, and they each fluctuate in the sampling distribution with a standard deviation of approximately $\sqrt{6/n}$.

Based upon statistical sampling theory, these results differ from the predictions (i.e., of a normal distribution) of the central limit theorem. The cause(s) of such departures from normal could not be precisely determined from the data. However, they probably indicate the effects of nonrandomness in the self-selection of subjects who comprised the response sample. Of the 33 subjects providing data, a total of 20 subjects (61 percent) reported ratios of one or fewer drivers per truck. These findings underscore the need for caution in the interpretation of results from this survey.

6. Could you provide the following information on your estimated California annual revenues and number of employees? Please check those that apply (note: private carriers should only include their trucking operations)

Two sets of response categories were provided for this item, related to revenue and number of employees, respectively. Eight range classifications for each set were provided for subjects to write check marks. Results for this item are reported in Exhibit 8-8.

EXHIBIT 8-8
ITEM 6 FREQUENCIES OF REVENUE RANGE AND EMPLOYEE RANGE CLASSIFICATION

	Revenue in Millions of Dollars									
Number of Employees	Up to 1	1 to 9	10 to 49	50 to 99	100 to 249	250 to 499	500 to 999	1,000 or More	NR	Total
1 (owner-operator)									1	1
2 to 49	8	6				1	1		2	18
50 to 99		1	2							3
100 to 249	3	1	3					1	4	12
250 to 499										0
500 to 999		1								1
1,000 or more										0
No Response			2							2
Total	**11**	**9**	**7**	**0**	**0**	**1**	**1**	**1**	**7**	**37**

While the results in Exhibit 8-8 give the appearance of both distributions being highly skewed, the distributions of the underlying data *may not be* necessarily. That is, the distribution shapes of "exact" annual revenue and "exact" number of employees actually might be normal (as might be predicted from sampling theory) and, thus, the apparent distribution shapes could be artifacts of the response range categories provided in the questionnaire. The bimodal characteristic of the distribution of the Number of Employees would be consistent with this interpretation. The ranges of the response categories for both variables were of unequal sizes, so means and standard deviations were not computed from the responses.

Revenue data also were analyzed in combination with the total number of trucks operated by subjects (as measured by Item 4). A total of 30 subjects provided responses to both variables.

The results of that combination are shown in Exhibit 8-9, showing the means and standard deviations of the Number of Trucks operated by subjects within each Revenue range.

EXHIBIT 8-9
AVERAGE NUMBER OF TRUCKS PER REVENUE RANGE

Revenue in Millions of Dollars	M	S	N
Up to 1	86	131.68	11
1 to 9	11.56	16.67	9
10 to 49	29.29	57.03	7
50 to 99			0
100 to 249			0
250 to 499	68	0	1
500 to 999	16	0	1
1,000 or More	5	0	1

A one-way analysis of variance was performed on the data, and the results were statistically significant ($p < .02$), indicating "real" differences between the means. Exhibit 8-10 provides a summary of the results from that analysis.

EXHIBIT 8-10
ANOVA SUMMARY FOR NUMBER OF TRUCKS PER REVENUE RANGE

Source of Variation	SS	df	MS	F
Between Groups	30,273.36	1	30,273.36	5.89
Within Groups	32,381.90	63	5,139.98	
Total	354,092.20	64		

7. **Provide the following information on your California base state record keeping operation (include fringes and other allocable costs).**

Blank lines for five open-ended responses were provided following Item 8-11. Results from subjects' responses showed a considerable amount of variability as indicated by the standard

deviations of each variable measured. The means, standard deviations, and number of respondents to each of the open-ended responses are presented in Exhibit 8-11. The Pearson product-moment correlation of each item with subjects' total number of trucks operated is shown in the right column. None of those correlations were statistically significant ($p > .05$). It should be noted that less than half of the subjects in the respondent sample provided data for this item.

EXHIBIT 8-11
MEANS AND STANDARD DEVIATIONS OF RECORD KEEPING OPERATIONS

	M	S	N	r . total trucks
Number of Personnel	17.93	30.79	15	-0.16
Annual Cost	$581,313,846	$207,881,755	13	0.23
Record Storage and Keeping Space Rental (sq. ft.)	1,786.36	1,526.12	11	-0.24
Annual Cost of Space Rental	31,145.45	43,216.97	11	-0.18
Other Administrative Costs	100,216.67	219,463.02	12	-0.26

The accuracy of at least some of the data shown in Exhibit 8-11 may be questionable. A Pearson product-moment correlation was calculated between the responses to the number of people employed and the annual cost of their employment (the first two response locations for Item 7). The value of that correlation coefficient was r (10) = -0.047, $p > .05$, and it essentially reflected no meaningful statistical relationship between those two response classifications. The correlation between the amount of square footage rented for record keeping and the annual cost of that space appeared to be correlated much higher, but it fell just short of reaching statistical significance: r (8) = .627, $p > .05$.

These analyses should be interpreted with the understanding that the small size of the response sample resulted in quite a low level of statistical power for tests for statistical significance. Nonetheless, the consistent lack of correlations between variables that would seem to be closely related might raise questions about the accuracy of the data, at least for Item 7.

8. Where do you store your operational records?

A total of 31 subjects responded that they stored their records in California, and one subject reported that records were stored outside of California. It was interesting that interstate carriers reported storing their records in California as consistently as did the intrastate carriers, despite the state's purported reputation for high business costs.

9. Please indicate what action you would take if a state low-emission heavy-duty vehicle regulation would result in the following increases in your operating costs on a per vehicle basis. For each category, please only choose the most likely action.

This item presented subjects with a response matrix. A list of seven potential response actions were listed down the left side of the page, and across the top of the matrix were nine categories of ranges of cost per vehicle. The frequency of responses to each part of the matrix is shown in Exhibit 8-12. Below each Possible Action/Cost combination in the matrix, the percent is shown for the subjects who answered that item. Across all Possible Actions presented, it was interesting to see that the first and last columns (Below $1,000 and Over $8,000, respectively) were selected the most consistently by subjects.

Item 9 appeared to be difficult for subjects to understand. In order to respond to each of the seven Possible Actions, respondents had to read down the left column. Then, for each action, subjects had to read across the nine cost categories until they found a cost that they associated with the respective action. A total of 11 subjects appeared to follow that procedure, although data for some items were missing from those subjects. The remainder of subjects in the sample appeared to have been confused about the procedure: 13 subjects left the response matrix blank (or wrote in a large question mark), nine subjects wrote multiple responses across cost categories for items, and two subjects provided only a few responses of no discernible pattern in the matrix.

10. If California is your sole base state, do you currently have enough business out-of-state to justify establishing a new base state? If not, could you generate enough business out-of-state to justify establishing a new base state?

A total of 26 subjects responded to both parts of this item. Nearly all of subjects (92 percent) indicated that they currently were unable to justify establishing a new base state. However, a total of eight (31 percent) indicated that they could do so either now or in the future. The frequencies of responses to Item 10 are shown in Exhibit 8-13.

EXHIBIT 8-12
FREQUENCY OF RESPONSES TO ITEM 9 MATRIX

Possible Action	Cost Per Vehicle of State Low-Emission Vehicle Regulation								
	Below $1,000	$1,001 to $2,000	$2,001 to $3,000	$3,001 to $4,000	$4,001 to $5,000	$5,001 to $6,000	$6,001 to $7,000	$7,001 to $8,000	$8,001 to Over
Comply with no change in operations	12	4	1	1				21	2
Row Percent	57	19	5	5				5	10
Delay new vehicle purchases	5	3	4	1	3		1		2
Row Percent	26	16	21	5	16		5		11
Register new vehicles in other existing base state	3	2			2	1			3
Row Percent	27	18			18	9			27
Establish new base state/register new vehicles there	3	1		1		1			2
Row Percent	38	13		13		13			25
Establish new base state/register all vehicles there	3	2		1		1			2
Row Percent	33	22		11		11			22
Relocate the entire fleet and terminal operations	2			1	1	2			2
Row Percent	25			13	13	25			25
Cease operations	2		2	2	1	3		1	1
Row Percent	17		17	17	8	25		8	8
Total	30	12	7	7	7	8	1	2	14
Row Percent	34	14	8	8	8	9	1	28	16

EXHIBIT 8-13
FREQUENCY OF RESPONSES ABOUT ESTABLISHING A NEW BASE STATE

If California is your sole base state:		A. Do you currently have enough business out-of-state to justify establishing a new base state?		
		Yes	No	Total
B. If not, could you generate enough business out-of-state to justify establishing a new base state?	Yes	2	6	8
	No	0	18	18
	Total	2	24	26

11. If you established a new base state, which state do you think you would choose?

A total of 14 subjects provided the names of a valid location outside of California. Four subjects mentioned more than one state as possible choices. The state named the most frequently was Nevada, with 9 responses. Arizona was the second most frequently mentioned state, and it was named 6 times.

12. If you established a new base state, what costs would you incur, and would these costs be higher, lower, the same, or in addition to the costs you currently incur? (please check all those that apply)

This item presented subjects with another matrix for their responses. However, about twice as many subjects responded to this matrix as they did to the one in Item 9. Down the left column of the matrix were six potential sources of business expenses. Subjects were asked to evaluate each potential source of expense according to four categories of comparison to their current expenses. The frequency of subjects' comparison responses are shown in Exhibit 8-14. An overall chi square was performed on the data in Exhibit 8-14. The result was not statistically significant: c^2 (15) = 22.14, $p > .05$, but some cells had expected frequencies of less than 5. Thus, the outcome of the chi square analysis may be somewhat inaccurate. The general pattern of responses in Exhibit 8-14 appear to indicate that most subjects thought that they could lower their costs by establishing a new base in another state.

EXHIBIT 8-14 FREQUENCY OF RESPONSES TO EXPECTED COST COMPARISONS					
Cost	In Addition To	Higher	Lower	The Same	N
Employee(s) to conduct business in new base state	2	0	7	6	15
Telephone hookup	2	0	3	10	15
Other site costs	2	0	8	4	14
Changes in property taxes on vehicles and other taxes & fees	3	1	12	0	16
Increased/reduced vehicle inspection costs	3	0	8	5	16
Total	14	1	42	32	NA

13. If you established a new base state, would you:
Three response categories were provided for subjects to check as appropriate ending to the stem of Item 13.

The results from this item are shown in Exhibit 8-15. Roughly one-half of the subjects indicated that they would relocate their entire record keeping operation if they were to establish a new base state.

EXHIBIT 8-15 FREQUENCY OF RESPONSES TO ITEM 13		
Response	N	Percent
Relocate your entire record keeping operation	9	52.94
Set up the minimal operation required by the International Registration Plan	6	35.29
Set up the minimal operation but consider sharing with other companies	2	11.76
Total	17	100

14. If emission regulations were adopted and the costs of compliance would be such that you would consider registering new HDVs outside California, how do you think the following actions might reduce this likelihood?

This item presented subjects with a third and final matrix. The left column of the matrix contained four hypothetical conditions that might mitigate the impact of new HDV regulations, plus a fourth condition labeled "other (please specify)". Subjects were asked to check one of three response categories to estimate the probably impact of each action. Quantitative results from this item are shown in Exhibit 8-16. In addition, one subject wrote "dollar for dollar incentives" as a write-in for the open-ended fourth condition.

EXHIBIT 8-16
RESPONSES TO POTENTIAL MITIGATION

Action	Impact		
	Large	Small	None
Tax incentives	17	2	2
Clean vehicle purchase subsidy	8	9	1
Feebate type concept to reward cleaner vehicles & penalize dirtier vehicles	4	8	5
Emission trading concept	5	5	7
Other (please specify)	NA	NA	NA

Results from a chi square performed on the data in Exhibit 8-16 were statistically significant: c^2 (6) = 21.93, $p < .01$ (however, some cells had expected frequencies of less than five). Tax incentives clearly were the most popular option to mitigating an increase in the cost of regulatory compliance. Reasons for the popularity of tax incentives among subjects were not solicited. However, it is possible that the results simply indicate the degree to which subjects were familiar with the different types of incentives (i.e., tax incentives may have been more familiar than feebates).

15. Have you ever considered relocating outside of California?

Four response categories were provided for Item 15. The fourth response category was open-ended for subjects to write in a response not covered by the first three categories. No subjects responded to the fourth category, while 27 responded to one of the first three categories. The frequency of responses to this item are shown in Exhibit 8-17. Most of the subjects had never considered relocating outside of the state, although a sizeable minority had done so because of their perception of California's business or regulatory climate.

EXHIBIT 8-17 FREQUENCY OF RESPONSES TO ITEM 15		
Response	N	Percent
No	16	59.26
Yes, due to business/regulatory climate	10	37.04
Yes, due to route structure/client location	1	3.7
Total	**27**	**100**

16. If you have considered relocating, why have you not relocated?

This was the final item on the questionnaire, and it was open-ended. A tabulation of responses to this item are presented in Exhibit 8-18. The most frequently mentioned reason for not relocating was the company's customer base.

EXHIBIT 8-18 REASONS FOR NOT RELOCATING	
Reason	N
Local customer base	6
Money, expenses	3
Plan to leave the business	3
Personal reasons	3
Not practical	1

Supplemental Analyses

The number and types of supplemental analyses were limited because of the small sample size. However, one comparison was selected for further analysis to see whether greater understanding could be gathered on operators' intention to leave California. That analysis focused on responses to the item, "15. Have you ever considered relocating outside of California?"

A 2-way chi square analysis investigated whether the annual revenue range categories of Item 6 differed according to subjects' inclination to leave or remain in California. A total of 25 subjects answered both items on the questionnaire, and their responses are presented in Exhibit 8-19.

EXHIBIT 8-19
ANNUAL REVENUE BY INCLINATION TO RELOCATE

	Revenue in Millions of Dollars						
Ever Consider Relocating?	Up to 1	1 to 9	10 to 49	100 to 249	250 to 499	500 to 999	Total
No	5	5	4	1	1	0	16
Yes - Business Climate	4	2	2	0	0	0	8
Yes - Route Structure	0	0	0	0	0	1	1
Total	**9**	**7**	**6**	**1**	**1**	**1**	**25**

A 3 x 6 chi square was performed on the distribution of frequencies in Exhibit 8-19. The results from that analysis were statistically significant: $c^2 (10) = 26.64, p < .01$. These results tentatively indicate that operators in the lower income ranges are somewhat more inclined to relocate to another state because of business climate than are higher revenue operators.

Like the previous chi square analyses reported, it should be noted that some of the expected values in Exhibit 8-19 were less than five. That violated the statistical assumptions of the analysis and, therefore, the results from the chi square analysis must be interpreted with caution.

9 SIMULATION MODEL DEVELOPMENT AND METHODOLOGY

This chapter provides an overview of the development and methodology used to prepare a simulation model. This model evaluates the impact of the proposed regulations on firm behavior, which in turn has an impact on the California truck inventory. The model provides an illustration of what might reasonably happen based on the results of a focus group, interviews, and other interactions with the trucking firms. In particular, it estimates how trucking firms would react if faced with a state low-emission HDV regulation. How firms react affects the overall state inventory of HDVs and, as a result, the aggregate emission contribution of HDVs.

The models presented in this study necessarily represent an extreme simplification of the HDV purchase and replacement decision process. Each individual HDV owner will make these decisions based on a variety of attributes of their fleet, their competitive market situation, the demand and supply conditions for new and used HDVs, and a variety of other factors. The purpose of the simplified models presented here is to give an overview of how alternative policy formulations might impact HDV owners and the overall introduction of low-emission HDVs. If in order to attain ambient air quality standards the state must adopt emission standards for HDVs that are significantly lower than the national standards, then more sophisticated modeling efforts should be conducted prior to the imposition of any economic incentive plans.

The simulation model is actually a series of two models produced on a series of linked spreadsheets. The first is a microeconomic simulation model that examines the behavior of a typical firm that replaces its HDVs on a regular basis. This model estimates how, under different scenarios, an average sized firm would react with respect to its HDV fleet. The results of this model are used as inputs for a macrosimulation model that measures the truck inventory by type of firm, size of firm, and age of fleet for the entire state. This second model is macroeconomic in nature, considering the behavior of the entire fleet of heavy trucks. Technical details of how both models were created, their parameters, and results are contained in Appendix A. Chapter 10 provides an overview of model results and their policy implications.

9.1 OVERVIEW OF THE MICROSIMULATION FIRM MODEL

A microsimulation model was developed to evaluate how potential changes to emission regulations would impact HDVs in the state of California. As discussed in earlier chapters of this report, the imposition of more stringent HDV regulations will cause a variety of actions to be taken by HDV operators. Some of these reactions will contribute to compliance and the ultimate goal of reduced HDV emissions, while other actions will cause unintended consequences that will in some cases not only involve significant expenditures on the part of HDV operators, but will also result in higher emissions from HDVs.

9.1.1 Model Structure

The microsimulation model measures the behavior of a medium to large (200 HDV fleet) operator that replaces its vehicles on a regular basis. Although trucking firms come in all sizes, from those with one truck to those with 500 or more, a firm with 200 trucks was deemed an appropriate size since it represents an average sized trucking firm. Because many of the reactions to the regulation will take place over an extended period of time as vehicles age and are replaced, the model follows the operations of the firm over a ten year time period.

The purpose of the microsimulation model is to evaluate the magnitude of the impact of low-emission HDV regulations on profitability. The model is based on the assumption that the firm seeks to maximize its profits. The model calculates measures of net income (before and after taxes) and a net present value (NPV) for the ten year time period.

Data from the American Trucking Associations are used to replicate the significant financial factors facing a trucking firm operating in California.[39] Trucking firms face a set of economic conditions regarding revenues, costs and profits. In addition, firms with fleets that are based in California face the possibility of increased costs due to new requirements for vehicle emission controls. Additional costs to comply with emission requirements negatively affect the firm's profitability. The model calculates the financial impacts that alternative strategies of compliance and noncompliance would have on profits.

9.1.2 Firm Behavior

In the microsimulation model, each firm has a choice of a finite number of responses or behaviors. In some cases, certain types of firms will not be able to choose certain types of behaviors. For example, it is assumed that a heavy-duty engine can only be rebuilt once.[40] Each firm chooses from the following seven options based on its profit maximizing behavior:

- Replace old vehicles with new vehicles which meet the higher standards, and absorb the additional costs;
- Replace old vehicles but attempt to pass the additional costs on to the customers;

[39]American Trucking Associations, 1992 Motor Carrier Annual Report, Financial and Operating Statistics, Results of Operation of Class I and II Motor Carriers of Property Regulated by the Interstate Commerce Commission.

[40]This assumption is based on the costs developed in the report entitled *Technical Feasibility of Reducing NO_x and Particulate Emissions From Heavy-Duty Engines*, Acurex Environmental Corporation, April 30, 1993. In this report Acurex assumes that heavy-duty engines are rebuilt only once.

- Replace equipment with used vehicles or rebuilt engines which do not meet the new emission standards;
- Postpone replacement of aging rolling stock as long as possible;
- Replace equipment as usual, but with rolling stock based out-of-state that does not meet the new emission requirements, thus avoiding the additional costs;
- Rebase the entire fleet out-of-state; and
- Downsize the fleet by retiring worn out vehicles but refraining from buying new replacement vehicles.

9.1.3 Microsimulation Firm Model Components

Exhibit 9-1 depicts the operating and investment decision process faced by a trucking firm in the state. The exhibit is intended to provide a general overview or flow chart type map of the model. This section summarizes the relevance of each model component.

1. Total Revenue from Operations

Revenue, in most instances, is produced by the operation of HDVs hauling goods or passengers. In the case of private carriers, who haul their own goods, revenue is produced in a different manner. For these carriers, revenue is produced by the sale of their final product(s).

A fleet of trucks is composed of a variety of different vintages. Operators generally keep HDVs in operation for about 10 years. Trucks come into and go out of the stock on a regular basis. Vehicles are retired, rebuilt, and replaced based on economic considerations.

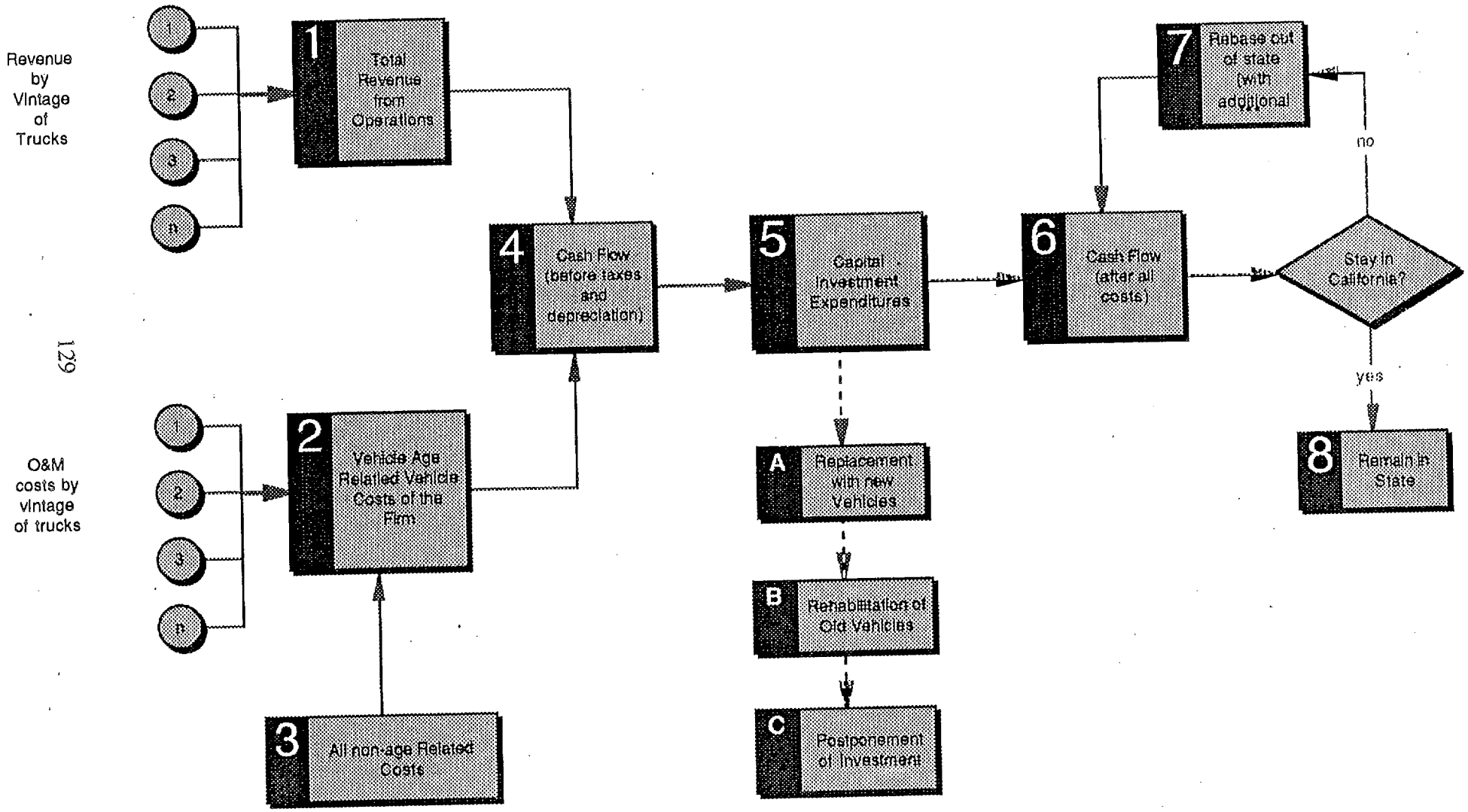
As a truck ages its productivity declines and it is less reliable as its efficiency declines.[41] It will also cost more to maintain as it loses efficiency. The statistics tend to bear out these assertions. Older trucks tend on average to be used for fewer miles. VMT is highest for new vehicles, and steadily declines with age. The use also tends to change, with older vehicles tending to be used for shorter hauls (intra-city travel), or in agriculture, carrying crops locally from the fields, rather than the more rigorous intercity travel.

2. Vehicle Age Related Costs of the Firm

Operating and maintenance (O&M) costs are related to the age of the HDV. As the vehicle ages its maintenance costs increase. These maintenance costs include vehicle servicing, engine

[41]Information on VMT and age is taken from the 1987 Census of Transportation, Truck Inventory and Use Survey.

Exhibit 9-1
Model of Trucking Firm
Replacement/Relocation
Decision



repairs, and other repairs to the vehicle/engine that occur during the life of the HDV. Operating costs, however, tend to decrease as the vehicle ages. Many of these costs (e.g. insurance, registration fees) are related to the value of the HDV, which depreciates over time. In the microsimulation model, it is assumed that the increase in maintenance costs exceeds the decrease in operating costs as the vehicle ages.

3. Nonage Related Costs

Many of the firm's costs are unrelated to vehicle age. Some of these costs are related to office expenses, while others are related to driver costs. For example, the overhead costs for management, administrative, and driver related costs (wages, pensions, payroll taxes, fringe benefits, etc.) are unaffected by vehicle age.

4. Cash Flow (before taxes and depreciation)

Cash flow from operations (before allowances for depreciation and taxes) is the difference between revenue and costs. Depreciation allowances represent an amount of cash potentially available for the purchase of new vehicles. These allowances can be used to finance new purchases rather than using other means of financing, such as a bank loan.

5. Capital Investment Expenditures

Capital costs are accounted for on the basis of annualized economic costs. These costs are the amortization of capital costs for a ten year assumed operating life of an HDV. The firm has four options regarding capital investment expenditures:

- Replace the aging vehicles with new vehicles;
- Replace with used vehicles;
- Rebuild the old engine; and
- Postpone the investment as long as possible.

Vehicle replacement decisions are made based on the relative income earning capacity of vehicles and their associated maintenance costs. The owner has the option to replace the vehicle or engage in major rebuilds which extend the vehicle's useful life. Fleet managers tend to make such decisions on vehicle life cycle costs.

6. Cash Flow (after all costs)

The firm's final cash flow is determined after all expenses and replacement expenditures are made. If the cash flow is low then the firm may postpone capital investments. Alternatively, the firm may elect to rebuild existing trucks rather than purchase more expensive new vehicles.

7. Rebase Out-of-state

The firm has the option of rebasing its fleet out of the state if the cost of replacement with new vehicles under the new emission requirements is too expensive. However, rebasing the fleet has its own start up costs. For example, the operator must establish a new office and incur additional overhead expenses.

In choosing to rebase, a firm would need to decide whether or not to rebase the entire fleet once or incrementally. There may be little cost saving if the latter option is chosen. For example, if the firm decided to rebase only its new acquisitions of HDVs out-of-state, they would be subject to less stringent requirements. But it may take several years for the firm to retire all of its California trucks, and in the meantime it would have to support two different offices.

Trucking firms serving short-haul intrastate markets, including firms hauling agricultural produce or construction debris, may not find it easy to rebase their fleet. These local fleets cannot take advantage of the rebasing option. On the other hand, firms which serve long-haul interstate markets may find rebasing a more feasible option.

8. Remain in the State

The operator has the option to remain in the state rather than rebase. If cash flow is low because of the new emission requirements, then the firm may seek to pass on the increased costs to its customers. In a competitive environment, this action may be difficult, especially where the firm faces competition from out-of-state base plated fleets who do not face, and thus do not need to pass along, higher compliance costs.

If the firm cannot pass the costs on to its customers then it must absorb them and thereby reduce its profitability. However, there is a point at which lack of profitability may force closure of the firm. The firm may, under these circumstances, decide to rebase its fleet rather than risk bankruptcy.

9.2 OVERVIEW OF THE MACROSIMULATION HDV INVENTORY MODEL

Decisions by firms as to whether or not to rebuild older vehicles or rebuild their engines, buy new vehicles, rebase vehicles out of the state and/or downsize operations have an impact on the inventory of HDVs in the state. In particular, these decisions affect the ultimate composition of the fleet and determine the proportion of the fleet (and vehicles operating in the state) that meet the new environmental regulations. The macroeconomic simulation model can be used to determine how different regulatory scenarios affect the overall HDV inventory. It also allows calculation of the types of costs that will be incurred assuming alternative regulatory scenarios. These costs include expenditures by HDV operators on rebasing,

rebuilding of old HDVs, the incremental cost of the lower-emission HDVs and any fees placed on non-complying HDVs. In addition, the state may expend funds on rebates to purchasers of low-emission HDVs. As is the case with the microsimulation model described in Section 9.1, the macrosimulation model is based on a ten year time frame.

9.2.1 Model Structure

Exhibit 9-2 is a flow chart which depicts how the HDV inventory changes over time. An arithmetic accounting model was developed based on this inventory process flow which calculates the ending vehicle inventory and components of inventory change. The model examines alternative scenarios with respect to compliance costs and the likelihood of non-compliance, which have implications for the ultimate fleet composition. Each scenario has a set of regulatory costs, along with a set of benefits.

Finally, conclusions are made as to the expected number of vehicles operating in California which will meet the new standards. Under the status quo it can be anticipated that a certain number of old trucks will be replaced during a period of time. The state's goal is to upgrade the fleet by replacing the old nonconforming trucks with vintages of newer trucks which comply with stricter environmental standards.

The inventory model (which is depicted graphically in Exhibit 9-2) is in three parts:

1. Beginning inventory accounting
2. Components of change over time accounting
3. Ending inventory accounting

1. Beginning Inventory Accounting

The model begins with an accounting of the vehicles which currently use California's roads by the type of owner: vehicles owned by governmental units, vehicles owned by out-of-state companies, and vehicles owned by California companies (both intra- and interstate).

For the microsimulation model, 12 strata were developed by type of carrier and firm size. These 12 strata, which were used to estimate impacts of potential low-emission impacts by size and type of firm, are shown in Exhibit 9-3. As shown in this exhibit, for example, strata 3 applies to interstate California-based trucking firms with 1 HDV (owner-operator), strata 4 applies to those firms with 5 HDVs, etc. Note that HDV size classes do not apply for government and non-California-based interstate trucking firms because these two groups would not rebase or downsize due to a state only low-emission HDV regulation. The methodology and sources used for the data shown in Exhibit 9-3 are discussed in the following section.

Exhibit -- 9-2:

California Trucking Fleet Inventory & Components of Inventory Change

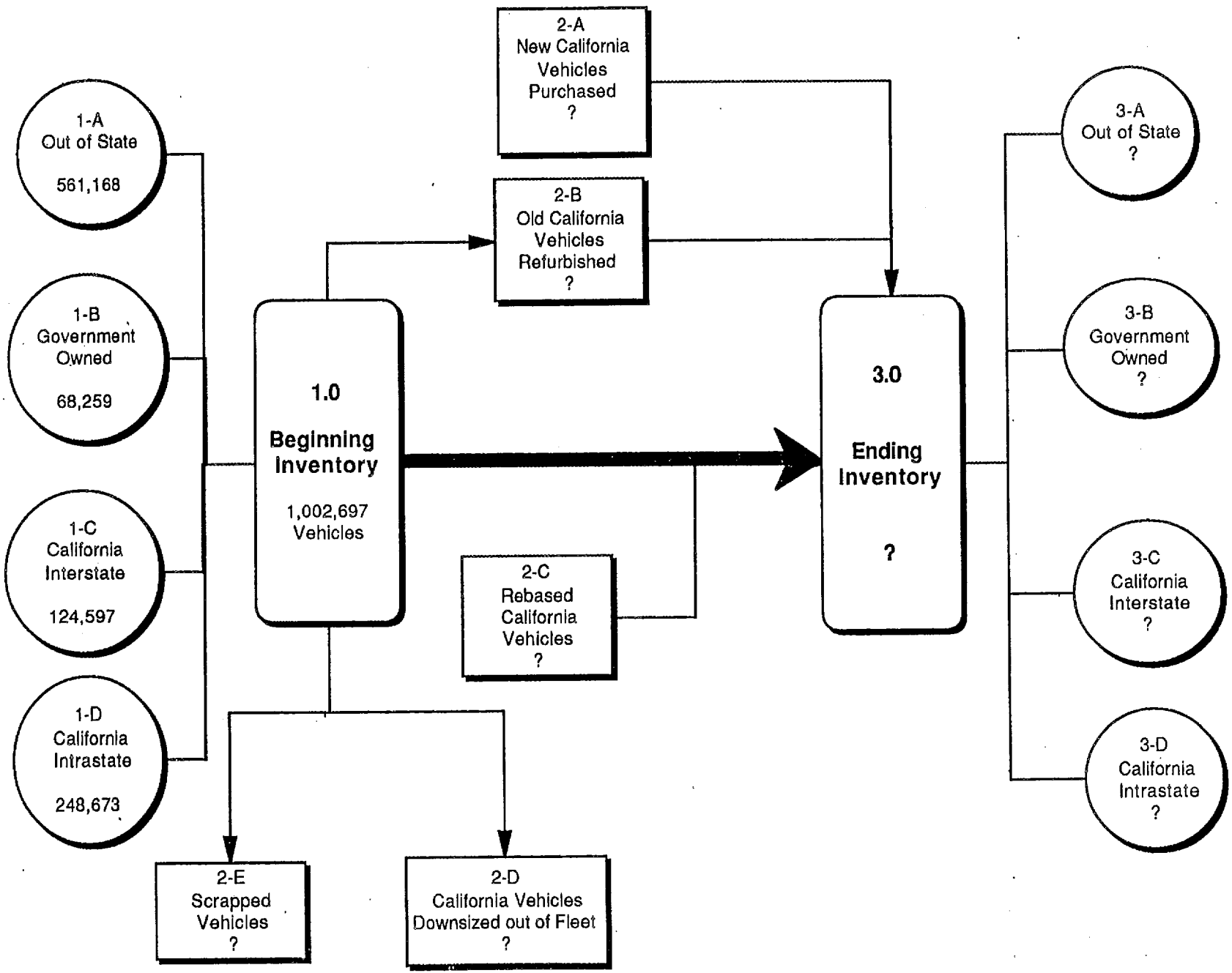


Exhibit 9-3 Number of HDVs in Simulation Model by Strata			
Strata	Owner	HDVs Operator Size Class (number of HDVs operated)	Total Number of HDVs
1	Interstate non-California-based	N.A.	561,168
2	Government	N.A.	68,529
3	Interstate California-based	1	4,361
4		5	8,722
5		50	21,804
6		200	38,625
7		400	51,085
	Total - Interstate California-based		**124,597**
8	Intrastate California-based	1	8,704
9		5	17,407
10		50	43,518
11		200	77,089
12		400	101,956
	Total - Intrastate California-based		**248,673**
	Total for Strata 1-12		**1,002,697**

N.A. Not Applicable

1A - Interstate Non-California-based HDVs (Strata 1)

The number of HDVs operated in state by non-California-based carriers was estimated from the DMV Gross Report data previously discussed in Section 1.4. According to an analysis of laden vs. unladen weight, an unladen weight of 6,000 pounds corresponds, on average, to a laden weight of approximately 14,000 pounds. This latter figure is the lower limit for inclusion in the HDV category. According to this data, 561,168 IRP/Prorate vehicles were based in other states and paying fees to operate in California in 1993.

1B Government Owned HDVs (Strata 2)

The DMV Gross Report estimated that there were 68,259 fee-exempt vehicles registered in the state that had unladen weight of over 6,000 pounds in 1993. For purposes of this study it was assumed that these HDVs were government (federal, state and local) owned and operated.

1C California Interstate HDVs (Strata 3-7)

The total number of HDVs based in California was estimated by using the CEC estimate of 441,529 HDVs (Exhibit 1-6) and subtracting the number of government vehicles (68,259) from this total. Thus, the model assumed that California-based carriers operate 373,270 HDVs. Furthermore, the total number of California-based interstate HDVs was estimated by comparing the percentage of trucks shown in the 1992 TIUS that were operated by California-based interstate carriers. The 1992 TIUS estimated that approximately 33 percent of the HDVs were operated by interstate carriers in California. Using this percentage allocation, the total number of interstate, California-based HDVs was estimated at 124,597. Presumably, interstate carriers would seem more likely to establish a new base state outside of California, due to the provisions of the IRP, as discussed in Chapter 2.

1D California Intrastate HDVs (Strata 8-12)

The number of California intrastate HDVs was estimated using a similar procedure to that described for California interstate HDVs. In the case of intrastate HDVs, the 1992 TIUS estimated that approximately 67 percent of the HDVs that were operated in California were intrastate HDVs. The number of intrastate HDVs was estimated by multiplying 67 percent by the total number of HDVs operating in California of 373,270 (after subtracting out government vehicles) for a figure of 248,673. Intrastate carriers do not belong to the IRP and would need to add new routes outside of the state in order to justify establishing a new base state.

9.2.2 Firm Size

The number of HDVs operated by each firm is an important determinant of the firm's reaction to alternative regulatory strategies. Therefore, the number of firms and HDVs in different firm size categories were estimated. The number of firms in each strata was estimated by using data from the Federal Highway Administration's Motor Carrier Management Information System. This database contains data on carriers that, during the period from 1988 to 1990 had three or more roadside inspections and had a safety or carrier review from 1987 to 1990. For different trucks per company classification, the database shows the number of firms within each group. One drawback with this data is that it may over-represent larger carriers, which tend to be inspected more frequently than smaller carriers.

This relationship was then formalized into an equation relating the number of HDVs per company with the number of companies. Once the equation was developed, estimates were made for the number of firms in each strata. Then the total number of HDVs in each group

was estimated. The number of HDVs was weighted down for strata 3 through 7 based on the total number of interstate HDVs for California. A similar procedure was applied for strata 8 through 12 based on the number of intrastate trucks. Finally, the number of firms was then obtained by multiplying the ratio of the scaled number of trucks to the original estimated number of trucks by the number of companies originally estimated.

An example will help illustrate this procedure. Based on the equation developed relating the number of trucks per company with the number of companies, it was first estimated that in strata 5 there were 3,643 companies each with 50 trucks, for a total of 182,128 trucks. The total number of estimated interstate California-based HDVs for strata 3 through 7 was 1,036,833. The estimate of 124,597 interstate HDVs was 12 percent of this total. Figures on the number of estimated HDVs and firms from the equation developed were each multiplied by 12 percent to obtain estimates of the total numbers of firms and HDVs.

9.2.3 Components of Change Over Time Accounting

Over the ten year relevant time period of the model, the fleet inventory changes as old vehicles are retired and/or rebuilt and new vehicles are purchased. A certain number of vehicles will be based in the state and the remainder will be based in other states. How the regulation is structured affects the fleet inventory over time.

2-A New California HDVs Purchased

As vehicles are retired they tend to be replaced by the purchase of new vehicles. When older vehicles are retired from the fleet new vehicles will be purchased in order for firms to maintain their fleet size or expand their operations. In the model the number of new vehicles purchased is a residual after their other options are considered and taken into account.

2-B Old California HDVs With Rebuilt Engines

A certain number of older vehicles will have engine rebuilds rather than be retired from the fleet. This has the practical effect of extending the life of the vehicle. We assume that the life extension is three years (based on information furnished by ARB provided by Acurex Corporation that the life of a rebuilt engine is between two and four years).

2-C Rebased California HDVs

Rebasing is a option for some firms, depending on the size of their fleet and the costs of rebasing. The microsimulation model provided the thresholds for firms size and rebasing costs. In the inventory model it is assumed that firms under the threshold sizes will not rebase but that some number of firms above the threshold size will engage in rebasing.

2-D California Vehicles Downsized Out of the Fleet

Downsizing is an option for avoiding the costs of compliance. Rather than purchase the new more expensive vehicles the fleet owner can retire vehicles without purchasing replacements. The owner loses the revenue for those retired vehicles, but avoids their O&M costs and the costs of replacement. For marginally profitable firms this may be a rational action.

2-E Scrapped Vehicles

Vehicles are regularly retired from service when they reach the end of their useful lives. In our microsimulation model we assumed that vehicles are retired after ten years of service unless they have their lives extended by rebuilding. This assumption is used for the macrosimulation inventory model as well.

3. Ending Inventory

The ending inventory accounting is the beginning inventory with allowances made for the various components of change. For each type of HDV operator (out-of-state, government, California interstate, and California intrastate) the ending inventory is a result of different factors. An overview of these factors is provided in the following paragraphs.

3-A Out-of-state Vehicles

As shown in Exhibit 9-3, 56 percent of the heavy duty vehicles servicing the state are based out-of-state in the model. These firms are not likely to switch their registrations to California, especially if this makes them subject to potential new regulations. It is assumed that the number of trucks registered out-of-state will remain constant or grow as the economy grows. The results of the microsimulation model demonstrate that unless a firm is doing almost all of its business in California they are better off economically by not basing in California. Even though the out-of-state firms will purchase new vehicles during the interval, it is assumed that national HDV emission standards are less stringent and therefore they will not be vehicles that will meet the more stringent California-only standards. Out-of-state firms have no incentive to voluntarily upgrade.

The ending number of trucks in the out-of-state inventory will be equal to the beginning inventory plus:

1. changes caused by overall growth of the fleet of trucks servicing California, plus
2. the number of California vehicles rebased out-of-state during the period, plus
3. some number of vehicles induced to service the state caused by the reductions of California trucks through downsizing.

3-B Government Owned Trucks

A significant number of trucks are owned by units of government (cities, counties and sate agencies as well as federal and military units). While these owners are not profit maximizing, they are prudent owners that will engage in replacement decisions that suit their needs. It is assumed that a modest amount of rebuilding and refurbishing will occur in this sector (ten percent) The remainder will consist of new vehicle purchases on a regular basis. It is assumed that government vehicles will be unable to avoid the costs of compliance through other strategies, including rebasing.

There will be no appreciable change in the number of government owned vehicles except for a modest growth to account for the increase in the state's population.

3-C California Interstate Trucks

The number of California-based trucks that service the interstate market will be affected by the proposed regulations. These firms are subject to any regulations imposed by the state. In order to avoid the cost of compliance they would have to rebase out-of-state or postpone new vehicle purchase. This group of firms is the prime candidate for the rebasing option.

The ending inventory of California interstate trucks is the beginning number:

- plus -- new trucks purchased (which meet new standards)
- plus -- Old trucks refurbished
- minus -- vehicles taken out of service or downsized
- minus -- vehicles rebased out-of-state

3-D California Intrastate Trucks

As shown in Exhibit 9-3, approximately 25 percent of HDVs operate exclusively in the state in the simulation model. These firms vary in size from very small to very large. Since their markets are localized they have less incentive to rebase their operations. However, rebasing is still a viable option for the intrastate firm in some instances. For example, large intrastate carriers may want to establish an interstate route in order to set up a base state outside of California. Smaller intrastate carriers could also set up partnerships with large, interstate carriers and purchase their new HDVs out-of-state. The IRP has no minimum mileage requirement to become apportioned through the IRP as noted in Chapter 2.

The number of California-based trucks serving the intrastate market is derived in the same manner as for the interstate trucks described in 3-C above.

9.2.4 Operating the Inventory Accounting Model

The microsimulation model provides measurements of the impacts of alternative investment decisions of the firms by size of firm. Based on the strength of these incentives, one can infer what the investment decisions would be for the profit maximizing firms. The inventory model assumes that different size firms will behave differently because there are investment thresholds for actions, such as rebasing.

A base case scenario was constructed on the assumption that potential regulations are not in force during the time period. This is used as a standard to evaluate the likely changes in the inventory assuming the implementation of the proposed regulations. The ending fleet inventory is equal to the beginning inventory plus or minus any changes which have occurred during the interval. The inventory model is based on a ten year time period. During this period the fleet of heavy duty vehicles will change as new vehicles are purchased and existing vehicles are retired, rebuilt or rebased out-of-state and as out-of-state vehicles continue to do business in the state.

9.2.5 Behavior of Firms by Size

Size of firm is an important factor in seeking to minimize the costs of compliance. The following discussion describes how the inventory model measures how the size of firms affects the location and investment decisions.

The Single Operator firm

The very small single operator firm has limited options in avoiding the costs of compliance with new regulation as its vehicle ages. It can downsize; however, that implies going out of business altogether. It cannot economically rebase. Its only recourses are to extend the life of its vehicle (rebuild or refurbish) or buy a new or used vehicle. Therefore, in constructing the inventory model it is assumed that the single vehicle owner will engage in one cycle of rebuilding and then purchase a new vehicle (which meets the new standards).

The Small Operator with 2 to 5 Trucks

The small operator with less than five vehicles cannot afford to rebase. However, it can downsize its operations by not replacing its oldest trucks. Its profit maximizing behavior is to engage in some rebuilding and then either to downsize or purchase new vehicles. In constructing the inventory model it is assumed that the small firm will first engage in rebuilding, and some downsizing (ten percent of the operations). Based on the results of the focus group (Chapter 7), it was assumed that some downsizing would occur. Several focus group participants had stated that fleet downsizing may be a response to more stringent emission standards. A 10 percent downsizing estimate was used to reflect this focus group result.

Downsizing is a serious option. In the focus group and in response to the questionnaire some operators did say that they would seriously consider downsizing rather than purchasing new HDVs that meet the regulation. Therefore, this likelihood is taken into account in the inventory composition.

The Medium Size Operator (6 to 50 Trucks)

The medium size operator has limited options. The firm is not large enough to afford the costs of rebasing. Like the small operators it is faced with refurbishing its older trucks, downsizing or purchasing new vehicles. It is assumed that the medium size operator will engage in one round of refurbishing its oldest trucks and downsizing by ten percent.

The Moderately Large Operator (51 to 200 trucks)

The large trucking firm has more options. Based on the results of the microsimulation model the large firm can afford to rebase to avoid the costs of compliance. It can also engage in refurbishing its old trucks or downsizing its fleet. It can purchase new vehicles if it seeks to maintain or expand its fleet size. It is assumed that the large firm will engage in one cycle of rebuilding to extend the life of its vehicles.

The Very Large Operator (over 400 trucks)

Very large firms, over 400 trucks, have the full range of options available to them. These firms have larger assets than smaller firms and are better equipped to respond to these regulations.

The Rebasing Option

Although theoretically the best course of action for the large California trucking firm may be to rebase its operations, whether it would actually do so is somewhat more complicated. The decision would depend on the exact cost of compliance with the new regulations (whether the cost per vehicle was high or low), the cost of rebasing, the geographic areas of its operations in the sate, their receptivity of a neighboring state, and the firm's allegiances and ties to California. For example, a firm that does work for the state or that is identified with some aspect of the state or the state's economy may not see rebasing as in its best interest regardless of the immediate financial relief.

Therefore, the inventory model includes a set of alternative scenarios depending on how the large firms would react to the proposed regulations. The first scenario assumes that 25 percent of the large and very large firms would rebase their operations out-of-state. The second and third scenarios assume that 50 percent and 75 percent respectively take advantage of the rebasing option.

Based on the number of trucks in the beginning inventory, and based on the assumptions enumerated in the previous explanations, the ending inventory of trucks servicing California and the components of change in the inventory are estimated.

9.2.6 Calculation of Costs of Various Options

The microsimulation model is also used to determine the costs of the various options for the trucking firms and the state. For example, the costs of refurbishing the old trucks, the costs of new vehicles, the costs of the environmental improvements, and the costs of rebasing are determined for various size firms. The state would face the cost of any rebates or tax credits offered in order to mitigate negative impacts of the regulations.

The costs of these options was used in the macrosimulation model to determine total compliance costs. In particular, the amounts of expenditures for the firms is multiplied by the number of firms in the particular class to arrive at the total costs for the entire fleet of California trucks.

9.3 SIMULATION MODEL INFERENCES

The simulation model was developed to evaluate the impact of the potential regulations. This model, as discussed in this chapter, was devised in two parts: a microsimulation firm model and a macrosimulation inventory model. The microsimulation model measures how firms would react while the macrosimulation model illustrates the impact on the overall inventory of HDVs. The results of these models are discussed in the following chapter.

10 MODEL RESULTS

This chapter presents a summary of the findings derived from the simulation models developed for this study and discussed in Chapter 9 and Appendix A. These two models include a microsimulation model of a medium to large size HDV operator and a macrosimulation inventory model. They are intended to demonstrate the relative attractiveness of alternative responses to HDV operators faced with more stringent emission regulations and the cumulative impact of these decisions on the emission characteristics of the fleet of HDVs operating in California. The first section of this chapter discusses the analytical results obtained from the microsimulation model, while the second section discusses the findings of the macrosimulation model. The third and final section provides inferences and conclusions that can be drawn from these results.

10.1 MICROSIMULATION MODEL RESULTS

The microsimulation model was run under different assumptions which affected the firm's profitability, using the Net Present Value (NPV) of the stream of net profits of the firm over a ten year period as the indicator. The variations included a base case and alternative scenarios for (1) replacing old vehicles with new vehicles meeting a more stringent emission standard and absorbing the costs, (2) extending vehicle lives by rebuilding and (3) rebasing vehicles out-of-state. In addition, various incentive schemes were analyzed including: (1) a scrappage fee incentive; (2) tax incentives; and (3) fees for noncompliance and rebates for compliance (Feebate). As stated earlier in Chapter 9, the model was used to simulate the decisions facing a medium to large size (200 HDV) firm, except in the case of the rebasing decision which was determined to be sensitive to firm size.

Base Case

A base case assumed the status quo (*i.e.*, without implementation of a more stringent emission standard). This provided a benchmark against which to evaluate and rank the results of alternative scenarios and assumptions.

The base case new vehicle cost was assumed to be $90,000 without the extra costs for an engine meeting a more stringent emission standard. The incremental cost for such an engine, as cited earlier in this report in Chapter 1, is estimated to be between $9,000 and $17,000. A midpoint of $13,000 was selected as the most likely cost and was used in the model runs.

Extending Vehicle Life Options

Compliance costs can be avoided by rebuilding existing heavy-duty engines. Alternative scenarios were constructed extending vehicle life by rebuilding rather than purchasing new vehicles.

The costs of rebuilding an engine and thus extending the life of the vehicle is estimated at $10,000.[42] This data assumed a rebuilt engine life ranging from two to four years. The midpoint of three years was used in the model for the life of a rebuilt vehicle. While engines can theoretically be rebuilt many times, this analysis examines the impact of one additional rebuild as a method of avoiding purchase of a new vehicle that has risen in cost by $13,000.

Rebasing Vehicles Out-of-state

Rebasing was considered as an option using varying rebasing costs of $50,000 to $150,000 per year as the costs of rebasing operations out-of-state. The estimate of $50,000 appeared to be a reasonable minimum cost to add an office with a telephone, street address and person capable of conducting the business of the fleet. The estimate of $150,000 was used as an upperbound cost, while $100,000 was used as a midpoint.

The lower bound cost of $50,000 for rebasing was developed as follows. A cost of $35,000 for an individual conducting the fleet registrant's business was assumed. With a fringe rate of 15 percent, labor costs would be $40,250. The firm is assumed, at a minimum, to require two rooms with dimensions of 15' by 15', for total square footage of 450 feet. Assuming annual rental costs of $15 per square foot, which is a representative rate for B quality office space, these rental costs amount to $6,750. Phone service, including installation, monthly service, and long distance phone charges, are assumed to be $1,500 annually. Other equipment, including office furniture, supplies, and computer equipment, is assumed to cost $10,000 which, amortized over five years, would be $2,000 per year. The total rebasing cost was rounded to $50,000. For the upper bound, it was assumed that the firm would add two additional employees with an office three times as large, which would require additional equipment.

10.1.1 Explanation of Model Results

Exhibit 10-1 contains a recap of model results for the base case and three options (absorb costs, refurbish vehicles or rebase out-of-state). The Net Present Value of the cash flows from the operations over a ten year period is used to measure the impact of the options.

[42]The source for the engine rebuild cost is *Technical Feasibility of Reducing NO_x and Particulate Emissions from Heavy-Duty Engines*, Acurex Environmental Corporation, April 30, 1993.

EXHIBIT 10-1 SUMMARY OF MICRO MODEL RESULTS	
Scenario	NPV (in thousands)
Base Case	$4,994
Replace Vehicle/Absorb Cost Option	4,503
Extend Vehicle Life Option	4,702
Rebase Out-of-State Option ($50,000)	4,395
Rebase Out-of-State Option ($150,000)	4,794

The base case is essentially the status quo without the requirements to comply with new emission standards. It assumes that the firm regularly replaces its vehicles as they age over the ten year period, but not with vehicles meeting a more stringent emission standard. This option, as is to be expected, has the highest net present value of the options, just under $5 million for the ten year period.

The Replace Vehicle/Absorb Cost Option assumes that the fleet owner retires the old vehicles with no change in schedule and replaces them with new, lower-emitting vehicles meeting a more stringent emission standard. The incremental cost of each lower-emitting vehicle is $13,000 plus increases in fuel and maintenance charges. This option reduces the NPV by approximately ten percent from the base case scenario.

The Extend Vehicle Life Option assumes that the first response of the fleet owner is to rebuild the engines of the older vehicles rather than retire them and purchase new vehicles. Extending the life of a vehicle for three years is estimated to cost $10,000 plus increased maintenance costs. This option has a NPV of $4,702, which is roughly six percent less than the base case.

The Rebase Option assumes that the owner rebases the fleet and by doing so incurs the cost of rebasing but avoids the cost of complying with a more stringent emission standard. It is assumed that the owner continues to replace old vehicles but with new, cheaper out-of-state vehicles that do not conform to the more stringent emission standard. A range of $50,000 to $150,000 for the annual cost of rebasing is assumed. The rebasing cost is a continuing cost for staff, office space and administrative support for an out-of-state office in accordance with the requirements of the IRP. At the low cost of rebasing ($50,000 per year) the NPV is $4,794 and at the high end ($150,000 per year) the NPV is $4,395. These are both lower than the status quo option.

Evaluation of the Alternatives

According to the results shown in Exhibit 10-1, the most profitable alternative is to rebuild the heavy-duty engine, thereby postponing the purchase of new vehicles. This course produces the highest NPV among the options. In this case, the model has assumed one additional cycle of

rebuilding the vehicles before they are retired. One would expect raising the price of new vehicles to change the relative economic costs of vehicle replacement favoring keeping older vehicles on the road longer. Exactly how much longer would be economical is unknown.

An important point to make concerning rebuilding heavy-duty engines is that it is a temporary expedient allowing the postponement of new vehicle purchase. The useful life of a vehicle with a rebuilt engine is much shorter than the life of a new vehicle. Therefore, in order to keep the fleet size constant over time, new vehicles eventually must be purchased even though the fleet owner is rebuilding engines.

Rebuilding the engines of the vehicles postpones the new vehicle replacement decision for the duration of the life of the vehicle. For example, if the life of the vehicle with a rebuilt engine is three years, it eliminates the need to purchase a new vehicle for three years. However, in order for the firm to keep the fleet constant, after three years it would have to start purchasing new vehicles, and these new vehicles would have to meet the new standards or be based out-of-state.

Absorbing New Vehicle Costs

The firm could absorb the costs of new vehicles while retiring the older vehicles systematically. This will lead to lower profits under the assumption that the firm cannot unilaterally raise its fees due to the competitive nature of the market. Absorbing the costs is the least attractive option in terms of profitability. One would not expect HDV operators to absorb the increased costs unless they could not pursue any other options.

Rebase Operations Out-of-state

The firm could rebase its operations to a neighboring state. We assume that the rebase costs would be a minimum of $50,000 per year up to $150,000 per year. The rebasing cost (which is a fixed cost each year) must be compared with the cost of amortizing the cost of new vehicles. Amortization of the incremental vehicle costs ($13,000 per new vehicle) on an annualized basis is equal to $1,300 per vehicle per year. Rebasing is sensitive to costs and firm size. For example, the cost of rebasing could be as low as $50,000 per year. If it costs $50,000 per year, then over a ten year period the firm will have spent $500,000 to avoid the cost of compliance.

For a 100 truck firm the cost of compliance (at an average cost of $13,000 per vehicle, and an annual equivalent cost of $1,300 per year per vehicle) over the ten year period is $715,000. Therefore it makes sense for the 100 truck firm to rebase. The breakeven point for a trucking firm to rebase, if the annual cost is $50,000, is approximately 75 vehicles. If the rebasing cost is $100,000 per year, then the additional cost over the period is $1,000,000. The cost of compliance is $1,072,500. So the breakeven point for a trucking firm to rebase is approximately 150 trucks if the rebasing cost is $100,000 per year. For a cost of $150,000 per year as an annual rebasing expense the breakeven point is a fleet size of 200 trucks.

The rebasing cost of $50,000 will amortize from 30 to 60 vehicle years, which is substantial, especially for a small to medium sized firm. It would appear that the rebase option is really not feasible until the firm has at least 100 trucks.

10.1.2 Evaluation of Incentive Schemes

The competitive advantage that a firm with a substantial portion of its vehicles based out-of-state would derive presents a significant problem to the state. Even California medium size firms would be encouraged to purchase and base new vehicles outside the state, frustrating attempts to reduce emissions. As a result, the state would prefer to "level the playing field" such that emission reduction gains would be maximized and trucking companies and their operations would not be encouraged to flee the state. From the state's perspective, a more stringent federal standard would be the best solution to this problem. It is up to the federal government, however, to decide whether the cost of tightening these standards justifies the benefits on a national level. In consideration of this, the U.S. Environmental Protection Agency, the ARB, and the heavy-duty engine manufacturers have recently signed a Statement of Principles agreeing to set a national new, on-road heavy-duty engine standard comparable to what is called for in California's own State Implementation Plan. However, in the absence of a federal standard, several economic incentive programs to level the playing field have been suggested by this report. The following paragraphs analyze the impact of these incentives on the hypothetical firm.

Fee Program on Noncomplying Vehicles

The state could impose fees on noncomplying vehicles entering the state through the IRP. For example, if fees were levied on all noncomplying vehicles (in-state and out-of-state), then the "playing field" could theoretically be leveled. Since the cost of compliance on an annualized cost basis is from $900 to $1,700 per vehicle as shown in Exhibit 1-9, then comparable charges could be levied.

The model was run using a set of three fees ($1,000, $1,500 and $2,000 per noncomplying vehicle). The model further stipulated four situations regarding the amount of mileage for a particular firm on California roads (25 percent, 50 percent, 75 percent and 100 percent). The latter two conditions represent firms that have already rebased out-of-state but do most of their business in the state.

The simulation results show that a firm that does a small amount of business in the state (the 25 percent situation) would be better off to pay the fee for noncompliance rather than convert its fleet to new vehicles meeting a more stringent emission standard. Even if the fee for noncompliance were as high as $2,000 per vehicle, the firms that do only 25 percent of their business in the state would still be better off paying the fee rather than buying new, lower-emitting vehicles.

At 50 percent business in the state, the fees raise the cost of doing business enough so that the option of buying new, lower-emitting vehicles becomes more attractive. At 75 percent business in the state, the fees make the investment in new, lower-emitting vehicles a positive alternative. At 100 percent business in California, it is more economical to comply with the regulations and invest in new vehicles, rather than follow the course of noncompliance. With the imposition of a fee on all noncomplying vehicles entering the state, then rebasing ceases to be a viable option. The fee need not be at a high level to obviate the rebasing decision.

Tax Credits

Tax credits exert powerful incentives. The tax credit, unlike the deduction, is a dollar for dollar after tax transaction. Even at relatively low rates for the credit, the results are substantial. For example, a five percent tax credit on profits would cover the incremental costs of the new vehicles; more than five percent produces substantial profits for the firm. In other words, a five percent tax credit would equal the additional cost for the upgrade on an after tax basis.

California has a substantial sales tax (8.25 percent in some urban areas). If the sales tax were lifted for purchase of conforming vehicles it would substantially lower the capital cost and positively impact the profit and NPV of the firm. The model was run under the assumption of no sales taxes, which had the effect of lowering the annualized economic costs for the amortization of the new vehicles purchased.

Waiving the sales tax on new vehicles had the practical effect of neutralizing the higher costs of the new vehicles. The NPV of the status quo (which assumes no incremental costs for new vehicles) is approximately equal to the NPV of the sales tax exemption for the low range of the incremental vehicle cost. Even at the high end of the vehicle incremental cost ($17,000 per vehicle) the NPV is not very much lower than the base case. Although the sales tax exemption lowers the firm's capital costs, it does not offer a very large incentive.

Scrappage Programs

The scrappage rebate option was examined by running the model and including as income various scrappage fee schedules. A scrappage program would pay owners a fee for every older vehicle retired from their fleet, presumably encouraging the purchase of new vehicles meeting the lower emission standards. The fee was varied incrementally from $1,000 to $10,000 per vehicle scrapped. The model assumed a retirement of 20 vehicles per year and the purchase of 20 new vehicles meeting the lower emission standards.

At $9,000 per vehicle (tax exempt), the NPV of a scrappage fee program approaches the base case value. The model results tend to show that for a scrappage fee to be effective it would appear that it would have to be substantial, at about $9,000 per vehicle after tax to be an effective incentive. If the scrappage fee is taxable income, the fee would have to be as high as the incremental cost of the improvements ($13,000).

The Feebate System

Theoretically, it is possible to levy fees on all HDVs that do not meet the new emission standards and that are using the state's roads, and concomitantly award a rebate to firms that purchase new trucks which meet the standards. The fees could be set at a level to provide the funding for the rebates.

Setting the rebate and fees at levels which would provide the truck owner with an incentive to purchase a new, lower-emitting vehicle could be accomplished as follows. Assume the incremental cost for purchasing a new vehicle is $13,000, which is the pre-tax cost. Since this is depreciable for both federal and state taxes, the after tax cost to the firm is approximately $9,100. From the net after tax cost subtract the fee of $500 to $1,000, making the net cost $8,100 to $8,600. Therefore, the rebate could be set at approximately $8,000 if it is non taxable to the firm. Coincidentally, this is about the same amount as a rebate of the sales tax if the vehicle is bought in the state. The microsimulation model was used to test the hypothesis that a fee and rebate scheme could provide incentives for purchasing new vehicles. Fees of $500 or $1,000 for each vehicle that does not meet the low-emission standard and rebates of $5,000 to $10,000 for each reduced-emitting vehicle were tested. The results are shown in Exhibit 10-2.

EXHIBIT 10-2 NET PRESENT VALUES OF FIRM PROFITS UNDER A FEEBATE PROGRAM		
Fee	Rebate	NPV (000)
500	5,000	4,625
500	6,000	4,730
500	7,000	4,835
500	8,000	4,939
500	9,000	5,044
500	10,000	5,149
1,000	5,000	4,375
1,000	6,000	4,479
1,000	7,000	4,584
1,000	8,000	4,689
1,000	9,000	4,794
1,000	10,000	4,898
1,000	11,000	5,003

A rebate of $8,000 combined with a fee of $500 compares favorably with the base case in terms of NPV of the options. As the NPVs are equivalent, the trucking firms should be indifferent to the imposition of the feebate program and purchase of the new HDVs.

An arithmetic calculation was made based on the number of vehicles on the road, their miles traveled in the state and the fee charged. This generated revenue streams that could be compared with the amount of money needed to generate the rebates.

The results are as follows:

Fee @ $500 generates $1.87 billion or 233,800 vehicle rebates of $8,000

Fee @ $750 generates $2.80 billion or 350,000 vehicle rebates of $8,000

Fee @ $1,000 generates $3.74 billion or 467,600 vehicle rebates of $8,000

In the beginning of a feebate program, the number of vehicles that do not meet the lower emission standards will be much higher than the number of vehicles that do. Therefore, a small fee on the higher-emitting vehicles can generate a large amount of money to pay the rebates on the lower-emitting vehicles. As more lower-emitting vehicles are purchased, the level of fees generated will decline. Careful consideration would need to be taken to design a fee system that would be neutral in terms of revenue to the state in the long run.

The model suggests that the fee and rebate scheme is a viable option to encourage firms to purchase new lower-emitting HDVs. If the fee is levied on all HDVs operating in the state, then it would reduce but not eliminate the option of rebasing. For example, if the fee is set at $500 for each high-emitting vehicle, then a 100 HDV fleet would be faced with the cost of $50,000 per year that it could not escape by rebasing. Rebasing would cost an additional $50,000 making the total cost of avoiding the regulations $100,000 per year. Thus for the 100 HDV firm rebasing is not a viable option, since it is cheaper to remain in the state and pay the fee. If rebasing costs are $100,000 per year, then the threshold size of the firm increases to 200 HDVs at a fee of $500 per vehicle.

10.2 INVENTORY ACCOUNTING MODEL RESULTS

An Inventory/Replacement Accounting Model was constructed for the purpose of accounting for the changes in the truck fleet inventory over time. The purpose of the model is to determine the composition of HDVs in the fleet at the end of the ten year period. Of particular interest is the degree to which HDVs that meet the more stringent emission standards are introduced.

At present, no HDVs have been certified to a lower-emission standard comparable to what is called for in California's State Implementation Plan. It is expected that new vehicles meeting more stringent standards will gradually replace the older vehicles in the inventory. However, the vehicle owners may react to avoid compliance with the new regulations, since implementation will be expensive.

The Inventory Accounting Model was used to determine the impacts of potential regulations and alternatives on the inventory of HDVs in the state. The purpose was to demonstrate the components of change and the ending fleet inventory after a ten year time period. The results show arithmetically the number of California base-plated and out-of-state HDVs which will comprise the inventory, and the likely number of HDVs which will meet the potential new emission standards under certain assumptions.

The results from the microsimulation model were used as a starting point. It was assumed that the decisions to purchase or postpone purchase of vehicles are based on the economics of the firm as calculated by that model. The Inventory Accounting Model, however, considers the behavior of firms in a variety of strata as defined by size of the firm in terms of HDVs

operated, whether they are based in the state or out of the state, whether they are privately or government owned, and whether they are interstate or intrastate.

Assumptions Used in the Inventory Model

As discussed in Chapter 1, there are approximately one million heavy-duty trucks using California's highways. The distribution of this inventory is contained in Exhibit 10-3.

EXHIBIT 10-3
INVENTORY OF HDVs OPERATING IN CALIFORNIA BY TYPE OF OPERATOR

Type of Operator	Percent
Government	6.8
Non-California-based Interstate	56.0
California-based Interstate	12.4
California Intrastate	24.8
TOTAL	100

It is important to note that a large portion of the HDVs operating in California are interstate vehicles that are base-plated in states other than California. Attempting to reduce emissions appreciably without involving these vehicles will be difficult.

In the simulation model runs, all of the alternatives explored in the microsimulation model (extending the life of existing vehicles, postponing purchases of new vehicles, and rebasing out-of-state) were reasonable options that a profit maximizing firm would likely follow. Out-of-state firms would not voluntarily purchase new reduced-emitting vehicles since they are not required to do so, and since it would add substantially to their costs. Based on the economic impacts identified in the first phase of modeling, the California firms would in all likelihood:

- postpone purchase of new vehicles,
- extend the lives of their existing fleet through rebuilding and refurbishing,
- rebase their fleets out-of-state or
- downsize their operations.

Respondents in the focus group indicated that they considered downsizing to be a viable option. Rather than buy the new vehicles, they would gradually retire their fleet. They could still stay in business a long time by rebuilding and refurbishing the existing trucks. They could also purchase used trucks to delay or avoid downsizing. Out-of-state firms will take up some

of the slack in the market caused by California firms downsizing, since they are not prohibited from operating additional out-of-sate based vehicles in California and they would not be subject to the additional cost of meeting stricter emission standards.

The intrastate carriers, usually those with specialized market niches, have fewer options. They can extend the lives of their existing fleet and purchase used vehicles for a time. However, the rebasing option is not as viable an option for them. Rebasing involves a sizable expenditure each year to fund an out-of-state office. This rebasing expenditure must be compared with the amortization of the marginal costs of the new regulations. The microsimulation model simulations indicate that the rebasing option is probably not viable for firms with less than 100 HDVs.

There are many small truckers that operate locally, such as hauling construction debris, agricultural products and miscellaneous products. They are not usually significant purchasers of new vehicles, so would be largely unaffected by the new regulations. Trucking is characterized by its relative ease of entry, with many persons obtaining a single truck and hauling goods for hire. Their options are to remain in the used and rebuilt engine market. The fact that they operate in small short-haul local markets may also shield them somewhat from interstate carriers who do not have to comply with the new standards and can therefore offer lower prices based on lower costs.

Base Case Scenario

For the base case, we have assumed the current regulations and distribution of HDVs for the beginning inventory. Over a ten year period, new trucks would be gradually introduced into the fleet inventory. Used vehicles and vehicles with rebuilt engines would also normally be a part of the inventory. In the base case there would be no increased incentives to rebase out-of-state or to downsize fleets.

The base case shown in Exhibit 10-4 is that of a status quo in which the introduction of new vehicles changes the fleet composition to 31 percent new vehicles at the end of the period. This is the most optimistic case for getting older vehicles off the road through normal market forces.

Scenarios with Implementation of New Requirements

A base case and three scenarios measuring the impact of potential regulations on the trucking industry and the composition of the fleet over time were created using the Inventory Model. The basic assumption of the scenarios is that the affected firms will take defensive action available to them which maximize profits, such as prolonging the lives of their existing fleet and rebasing to some extent. The scenarios further assume that 25 percent or 50 percent or 75 percent of the large firms rebase their operations out-of-state.

EXHIBIT 10-4
ENDING INVENTORY OF HEAVY-DUTY VEHICLES SERVING CALIFORNIA UNDER ALTERNATIVE SCENARIOS

	Base Case	25% Rebase	50% Rebase	75% Rebase
California Vehicles				
Government owned	75,400	75,400	75,400	75,400
	6.8%	6.8%	6.8%	6.8%
Interstate -- Unadjusted	137,633	137,633	137,633	137,633
less rebased vehicles	0	22,427	44,855	67,282
less downsized vehicles	0	12,024	12,024	12,024
Total Interstate Vehicles	137,633	109,184	86,766	64,339
	12.4%	9.9%	7.8%	5.8%
Intrastate Vehicles				
Interstate -- Unadjusted	274,690	274,690	274,690	274,690
less rebased vehicles	0	44,761	89,522	134,283
less downsized vehicles	0	23,997	23,997	23,997
Total Intrastate Vehicles	274,690	217,931	173,170	128,409
	24.8%	19.7%	15.6%	11.6%
Out of State Vehicles				
Total Unadjusted	619,879	619,879	619,879	619,879
plus Rebasing	0	67,188	134,377	201,565
plus Downsizing	0	18,011	18,011	18,011
Total Out of State	619,879	705,078	772,267	839,455
	56.0%	63.7%	69.7%	75.8%
Grand Total	1,107,602	1,107,602	1,107,602	1,107,602

The government sector will be relatively less affected than the private sector by the imposition of the regulations and will not make a major change in behavior. The interstate trucking firms not based in California would see no change in capital investment behavior. They would not invest in the more expensive, lower-emitting trucks since they would not be required to do so. Therefore, these out-of-state trucks would remain in the inventory and on California's roads.

The California-based trucking firms would, on the other hand, be faced with difficult investment decisions. In all cases there would be some rebasing out-of-state by the large firms. There would be an increase in rebuilding existing heavy-duty engines in order to preserve the fleet. Some firms would downsize rather than buy the new vehicles. Out-of-state trucking firms would pick up some of the business that occurs as a result of downsizing, with the remainder spread among the California firms. Very small operators would not significantly be affected since they are not normally part of the new truck purchasing market.

Scenario Impact Results

The HDV fleet inventory would change significantly as a result of the implementation of potential new standards. The summary of the results of the inventory accounting simulation are shown in Exhibit 10-4. All of the scenarios show a heavy impact on the California-based truckers. Out-of-state operators would take a larger share of the market. Under the base case, out-of-state operators account for 56 percent of heavy-duty trucks on the road (which is the approximate current share). A rebasing rate of 25 percent of large firms would increase that share to 63.7 percent. If 75 percent of large firms based new vehicles out-of-state, then the out-of-state share would grow to more than 75 percent. There would be a sharp drop in the purchase of new lower-emitting vehicles. At the end of the ten year period, new vehicles would account for less than 10 percent of the inventory of trucks on the road in California.

10.3 INFERENCES AND CONCLUSIONS

The composition of the state's HDV inventory would be substantially different with the implementation of new heavy-duty emission standards. Under the base case scenario, the number of new vehicles entering the fleet inventory from California firms was estimated at approximately 37,000 per year for a total of 370,000 for the ten year period. At the end of the ten year period, new vintage vehicles would comprise approximately 35 percent of all HDVs.

According to the simulation model, the implementation of possible regulations would cause the number of new trucks purchased and registered in California to decline as a percentage of the fleet inventory. As a result, the reduced-emitting vehicles would account for less than 10 percent of the vehicles on the road. This is compared with the 35 percent which would have happened under normal market conditions, assuming there was no cost penalty for purchasing the new, reduced-emission vehicles.

11 CONCLUSIONS AND RECOMMENDATIONS

Successful regulatory design requires that a regulation be economically efficient, equitable, legally viable, and reasonable from an administrative cost standpoint. Economic efficiency for environmental problems is often measured in terms of the dollars spent per unit of pollution eliminated. The equity issue involves considerations as to what type of regulations will treat each interested party in a fair manner. For example, a solution that places the entire burden on intrastate firms may not be politically acceptable. The legal aspect concerns whether or not the regulatory design can be legally instituted by the ARB or the state and what type of legislative or executive approvals will be required. The administrative cost issue considers the level of the administrative and transaction costs to government and business. If the regulations are too confusing or involve high transaction costs, they may not be as successful in practice as they are in theory.

This section covers each of these issues for a California performance standard, rebate, tax credit, an emission fee based registration system, and an emission trading system. A summary of the efficiency, equity, legal issues, and administrative costs for each alternative are provided in Exhibit 11-1. These regulatory strategies are discussed only in the context of the possible implementation of a California-only emission standard that is more stringent than a national standard. These strategies are not applicable if a more stringent emission standard for heavy-duty vehicles is implemented concurrently by both the ARB and the U.S. EPA.

11.1 ECONOMIC ISSUES

In our society the marketplace determines how many particular goods and services to produce, and how to distribute them to individual consumers. Frequently, however, a market economy will fail to achieve an efficient or equitable distribution of a particular product. These market failures provide an important rationale for public intervention into private market situations. Externalities are an example of a market failure that occurs when the actions of producers or consumers impose costs or confer benefits on others. HDV emissions are an example of a negative externality in that they deprive consumers of clean air at no cost to HDV operators. Economists note that such pollution results in inefficient use of resources as well. By failing to include the full costs of production (that is, the costs to those who consume the polluted air), HDV operators will tend to underestimate costs and produce more transportation than is justified in terms of the benefits and costs to society.

Economists would argue that to maximize society's net well-being, a negative externality should be reduced to where the marginal cost of further reducing the externality equals the marginal benefit resulting from that reduction. While this concept is simple, in practice construction of a marginal social cost curve and a marginal social benefit curve are quite difficult. No such attempt is made in this study. It is assumed that California is faced with meeting the requirements of the Clean Air Act Amendments of 1990. The economic question, however, is how these air quality goals can be efficiently achieved.

Exhibit 11-1
Summary of California Regulatory Strategies

California	Efficiency	Equity	Legal Issues	Administrative Costs
Performance Standard Only	Encourages extending vehicle life, purchasing and registering new HDVs out of state and does not reflect differing marginal costs of pollution reduction.	Strong negative impact on intrastate operators.	ARB has authorization for CA trucks. Application to out of state trucks would be difficult under commerce clause of U.S. Constitution.	Some startup costs but low operating costs.
Rebate	At less than the incremental cost of new vehicles, encourages extending vehicle life, purchasing and registering new HDVs out of state and does not reflect differing marginal costs of pollution reduction.	At less than incremental cost of new vehicles, strong negative impact on intrastate operators. Public would be forced to pay for air pollution they did not cause directly.	ARB likely has authority although the source of funding is unclear.	Low startup and operating costs.
Tax Credit	Same as Rebate.	Same as Rebate.	ARB does not have the ability to change the tax code. Would require legislation.	Same as Rebate.
Emission-Based Registration Fee	Requires operator to pay social cost of emissions, eliminates incentive to extend vehicle life and purchase and register new HDVs out of state. Poorly set or frequently changed fees can lead to inefficiency.	Substantially levels playing field by requiring both intra- and interstate operators to share cost.	IRP does not prohibit emission based fee. DMV, and not ARB, has authority to set fees under the IRP. Application to out of state trucks may be difficult under commerce clause of U.S. Constitution.	Low to medium startup cost and operating costs. Level of fees difficult to set.
Emission Trading System	Most efficiently sets cost of emissions. Incentives to extend vehicle life and purchase and register new HDVs out of state are eliminated. Poor initial distribution of pollution rights can cause inequity. Can be difficult to determine the emission reductions that are actually achieved.	Substantially levels playing field by requiring both intra- and interstate operators to share cost. Poor initial distribution of pollution rights can cause inequity.	ARB has authorization for CA trucks. Application to out of state trucks may be difficult under commerce clause of U.S. Constitution.	Medium to high government startup and operating costs since trading systems can be difficult to administer. High total transaction costs for participants.

As discussed above, economic theory maintains that economic efficiency requires that the last dollar spent by each polluter on pollution reduction be equally effective. One way to achieve this goal is make each HDV pay the full cost of their emission contribution. This might be approximated based on the product of the per mile emission characteristics of the individual HDV and the number of miles traveled.

In terms of this efficiency criterion, emission-based registration fees and emission trading schemes are more efficient than performance standards (with or without rebates or tax credits) because they make each polluter pay for the negative externality (emissions) they cause. A performance standard, on the other hand, does not allow polluters to utilize less expensive means of achieving pollution results. A regulation that sets fleet average emission levels, for example, would allow an operator with multiple HDVs to achieve the same level of emissions at lower cost by using the low-emission vehicles whenever possible and using the higher emitting vehicles only when necessary. The cost of meeting emission standards varies widely across a number of characteristics including weight, fuel type, vehicle miles of travel, and other factors. Rebates and tax credits may increase the penetration of low-emission HDVs but will not make the program more efficient. The performance standards may in fact cause HDV operators to adopt a series of inefficient noncompliance strategies such as extending vehicle life, purchasing and registering vehicles outside the state, and buying used vehicles. As seen in the preceding chapter, it is not at all clear that performance standards with or without rebates or tax credits will significantly affect emissions, especially in the short run, unless the rebate is almost high enough to subsidize the entire incremental cost of the emission controls.

Emission-based registration fees and emission trading schemes are more efficient because they allow for more flexibility. Under emission-based registration fees, the cost of the regulation is spread out over the higher polluting older and out-of-state registered vehicles. Operators can use a mix of vehicles to minimize their cost. The incentives to minimize cost by extending vehicle life and purchasing and registering vehicles outside the state are eliminated. In order to efficiently implement such a system, regulators would need accurate information on the cost of the emission systems and numbers of vehicles involved in order to set charges and rebates at the proper levels. Often the argument is made that government does not have to set fees accurately because adjustments are possible. However, once companies make decisions and capital investments, changing the level of the fees could lead to inefficiencies and as well as unpopularity. Setting the fees too low or high and rebates too high or low could result in not enough or too many low-emission vehicles sold and not enough or too many fees collected. The fee and rebate system should set rates so that they closely approximate the cost of the externality to society. Otherwise, the fee and rebate system can send the wrong signals to operators and actually cause inefficiencies.

Emission trading schemes can be even more efficient then emission-based registration fees because the level of the fees and rebates are determined in a marketplace rather then having government attempt to enforce them. Problems with such a system include how to initially distribute pollution rights, how to set up a market for trading of pollution rights, and the high

transaction costs for firms (especially small firms) to participate in trading. Moreover, it can be difficult to determine if reductions are real and how to quantify them.

11.2 EQUITY ISSUES

Equity concerns work against taxes and rebates because of their large costs. Given the high initial investment required to purchase the low-emission vehicles, it is unlikely that they will have much effect, except on firms that would not take advantage of tax breaks or rebates until their monetary value approaches the incremental cost of the low-emission vehicles. The state government would be forced to subsidize not only those who would avoid the regulation but those that would comply without the rebate or tax measure. Public opinion would be clearly against such an option. While the general public will share in the benefit of clean air, it is not clear that it is fair for the public to cover the pollution avoidance costs of HDV operators.

California-only performance standards cause substantial inequities between the treatment of interstate and intrastate firms. In proposing performance standards as part of the FIP, EPA admitted this problem was significant:

> "If new emission standards are adopted for California trucks, the interstate trucks would likely remain certified only to the less stringent federal standards, and their use in California could increase, preventing the new California standards from achieving their full potential for emission reduction. Tighter emission standards only on California registered trucks could impose a cost burden on California shipping firms that would not exist for shippers based outside the state. EPA wants to avoid such a competitive disadvantage for trucking firms based in California since it could result in even more operation by out-of-state trucks."

Clearly, California-only performance standards will cause an inequitable situation where California base plated fleets are placed at a competitive disadvantage. Rebates and tax credits can reduce the degree of inequity but will not eliminate them until they approach the incremental cost of the low-emission vehicles. EPA's solution was to create a totally separate intrastate market by using so-called one-stop, two-stop regulations. The one-stop, two-stop regulations restricted interstate truck travel, limiting these trucks to one stop in the FIP area, and not more than two total stops in the state per trip. This solution was quite radical in nature. What it envisioned was the creation of a totally separate intrastate trucking business that used low-emission HDVs while the interstate business would register trucks outside the state. This proposal was unusual because it would have allowed vehicles in interstate commerce to pollute more. It would have also resulted in interstate operators moving their registrations and some of their administrative functions outside the state and certainly would have encouraged these operators to move their headquarters functions as well. It could have had profound negative productivity impacts through reduced flexibility and less than optimal route structures, actually separating some fleets apart to reflect out-of-state routes. It would

not have prevented intrastate market participants from extending vehicle life and perhaps buying used trucks from firms purchasing their new vehicles out-of-state.

In order to remove this inequity, the more stringent standards must apply to vehicles traveling in California no matter where they are base plated. One option is the adoption of a more stringent national standard. Another is the use of a registration fee and rebate system that requires out-of-state base plated vehicles to pay apportioned registration fees that are based on the emission characteristics of their vehicles. The former solution depends on action at the Federal level and is therefore beyond control of the ARB. Moreover, the Federal government would need to determine that the benefits of these more stringent standards outweigh the costs at the national level. On the other hand, emission-based registration fees and emission trading schemes have the potential to cause inequitable solutions. Fees can be poorly set such that the wrong incentives are provided, or HDV operators pay too much or too little. In addition, operators of larger fleets might, in some instances, be in a better position to take advantage of the incentives provided by the fees or trading programs.

11.3 LEGAL ISSUES

Although the ARB has the authority to develop performance standards for California-based HDVs under Sections 43013 and 43701 of the California Health and Safety Code, the dormant commerce clause of the U.S. Constitution would seem to prevent the state from setting such a standard on non-California-based HDVs. Based on a preliminary review of those cases in which state regulations have been challenged based on the commerce clause, it would appear that the Supreme Court has overturned those regulations which hamper interstate commerce. Prohibiting certain HDVs from operating in the state based on their emission characteristics would seem to be a clear violation of the commerce clause. However, it must be stressed that constitutionality issues are ultimately determined by the Supreme Court itself and the statements made here are based on a preliminary review of cases in which the commerce clause has been invoked.

The legality of economic incentive measures was reviewed as part of this study. In the case of tax credits, the ARB does not have sufficient legal authority to rewrite the tax code. The difficulties in changing the tax code are inherent in Article XIIIA (Proposition 13) of the California Constitution, which states that increases in state taxes must be approved by two-thirds of each house of the legislature. However, any new tax imposed for a specific purpose adopted by a city, county, or special district, requires the approval of two-thirds of the registered voters within the affected jurisdiction. Under Proposition 62, taxes imposed for general purposes must be approved by a majority vote. Finally, Article XIIIB (the Gann Initiative) also places limits on the growth in government spending.

Any tax credit measure would need to be approved by the state legislature. Even if such a measure was adopted, it would undergo considerable public scrutiny due to potential lost tax revenue. In addition, provisions would need to be made for this lost revenue in terms of

budget cuts. From a legal perspective, then, although a tax credit may be preferred by the trucking industry over a feebate system, such a measure would lead to cuts elsewhere and could put a drain on the state's economy.

Rebate measures appear to be within the ARB's authority. A significant problem with a rebate measure, however, is securing the necessary funding. In addition, Chapter 6 noted that a rebate measure would need to cover the full incremental cost of a regulation. Based on incremental regulatory costs discussed in Chapter 1, the resulting rebate measure, then, may be on the order of $5,000 to $15,000, which could be prohibitively high. In addition, raising this revenue would present a significant challenge to the ARB which must compete for revenue along with other state agencies. As noted above, any tax raise can be defeated by a minority in the state legislature due to Proposition XIII, and would be difficult to implement.

The ARB has sufficient legal authority to develop an emission trading system that affects California-based HDV operators only. Under provisions of the Health and Safety (H&S) Code, the ARB is authorized to issue guidelines on mobile source emission trading programs for local air quality districts. In February 1994, the ARB issued a document, entitled "Guidelines for the Generation and Use of Mobile Source Emission Reduction Credits" that provides guidance to air quality districts in developing an emission credit trading system, including one for HDVs. This document states that, with respect to HDVs, "programs designed to generate emission reduction credits must comply with current Federal Emission Trading Policy which requires that credits only be allowed for emission reductions that are surplus to federal, state, and local regulation."

Although setting up an emission trading system within the state, or through the air quality districts, is permissible under California state law, the state may not have sufficient authority to develop such a system that includes non-California HDV operators. Because no state has as of yet implemented an emission trading system that includes in-state and out-of-state participants, the constitutionality of such a measure is not clear. It seems likely that the constitutionality of such a trading system would be determined on the basis of whether or not it is seen by the courts as placing an undue burden on interstate commerce.

Three issues are important to consider here related to a fee-based registration system: 1) the IRP, 2) ARB's relationship with the DMV and 3) the commerce clause. The IRP does not prohibit states from imposing fees based on the emission characteristics of a HDV. As noted earlier, the IRP is a "loosely formed coalition" and each state's rules take precedence over the IRP. Each state, under the IRP, can set its own registration, weight, and vehicle licensing fees. If California were to adopt a fee-based system under the IRP, the state would need to send a new fee schedule to each IRP state, which will include all 48 contiguous states by September 1, 1996. A fee-based system could lead to higher administrative costs for other states as personnel would need to be trained on how emission fees would be calculated. If a registration fee required each state to dramatically change their fee calculation systems, then the system could be met with resistance from other states unwilling to increase their administrative costs.

The DMV, and not the ARB, sets vehicle licensing, weight, and registration fees. Based on discussions with California DMV staff, the state's IRP program would probably not be affected by the imposition of market-based pricing measures. Nevertheless, ARB may not have sufficient authority to change these fees without the DMV's consent. Developing an effective fee-based registration system can only be done with full cooperation between the ARB and the DMV.

The constitutionality of the fee-bate system depends in large part on how such a law is interpreted by the courts. Based on our legal research, the federal courts have attempted to analyze commerce clause objections to state regulations by weighing the strength of state interests against the burdens on interstate commerce. However, achieving this balance can sometimes be difficult. Consequently, it is fair to say that should the state adopt a fee-based registration measure that is perceived to infringe on the movement of goods in interstate commerce, it is likely to be challenged in the courts. Such a challenge would determine the system's constitutionality.

11.4 ADMINISTRATIVE COSTS

Administrative costs would almost certainly be lower under a performance standard with or without rebates or tax credits than they would under the other market-based economic incentive programs. A performance standard normally involves fairly high initial costs to develop testing requirements, procedures and other administrative systems. However, market incentives, such as credit programs, also have testing requirements to quantify emission reductions. Since California already certifies mobile source emission levels, the additional burden would likely be relatively low. Moreover, recurring costs should be low because most of the actual testing costs are borne by the manufacturers. Rebate or tax-credit measures have slightly higher costs to increase awareness and to process claims, but in relation to the cost of the rebates or tax-credits, these costs would be fairly minor.

An emission-based registration fee would involve slightly higher administrative costs. Since it would be a new program, careful study would need to be made of the appropriate level of the fees. This is especially true if the fees would vary based on emission levels and other factors. Administering the program through the IRP might also be cumbersome, especially since each state in the IRP would have to calculate fees for their apportioned vehicles. In addition, the program would need to be publicized and operators would need to be educated. Fee collection could use the existing registration fee network but a system for distributing rebates would probably be necessary.

Emission trading systems would have the highest transaction costs. The state government would have high initial and operating costs in order to set up the market and oversee its operation. As a whole, operators would face high transaction costs because each of the many operators would need to analyze the costs of their alternatives and spend small but significant effort to first learn how to participate in the system and then to buy and sell credits.

11.5 CONCLUSION

The IRP was designed to allow for maximum flexibility for HDV registration. Through the apportionment system HDV operators can cheaply locate vehicles in any state in which they accrue any mileage. If California is to make serious reductions in HDV emissions then a program must be designed that keeps registrations from fleeing the state. Accomplishing this task can only be done with a level playing field. This requires that either a federal-level standard be enacted, a rebate program be implemented that pays for most of the costs of the emission controls, or a scheme be designed that makes every HDV that travels in California pay for the social cost of low-emission HDVs through an emission-based registration fee. The latter more equitably charges the polluter rather than the general public and reflects the IRP's goal of deferring to state interests while allowing operators to register vehicles in the state of their choice. Any of these solutions will also have the benefit of eliminating the incentive to extend vehicle life, which costs money while increasing emissions by keeping older vehicles on the road. Under these programs no incentive would exist for HDV operators to purchase and register their vehicles out-of-state, which would otherwise send certain HDV operator administrative functions out of the state.

Trading systems are too untried for mobile sources and suffer from high transaction costs and difficulties in determining if reductions are real and significant. In addition, a mobile source trading system has not yet been developed by a state agency that includes both in-state and out-of-state participants. Attempting to create a separate intrastate market would be neither effective nor equitable.

In addition, it should be noted that local fleets which do not compete with the interstate market may not be at a competitive disadvantage as a result of a state low-emission HDV regulation. In most cases, local fleets are strictly intrastate and would each be fared with the same regulatory costs. However, it is possible for a local intrastate operator to add an out-of-state route and to set up a non-California base state as the IRP only requires that some portion of the fleet mileage be accrued in the base state. Note that if one competitor or a new entrant in a local market were to follow this strategy, the remaining firms would then be at a competitive disadvantage.

In summary, it appears evident that the imposition of stricter California emission standards, together with the registration freedom allowed by the IRP, would have serious economic repercussions on firms attempting to operate the low-emission HDVs. As a result, operators would base plate outside California, refurbish and rebuild old HDVs, downsize, and purchase used vehicles. The result would be minimal introduction of low-emission vehicles. A system of rebates or tax credits could be used to help level the playing field, but the level would need to approach the additional costs of the low-emission vehicles costing the state a large amount of funding. An alternative registration fee system, based on emission characteristics of HDVs, could be applied to both in-state and out-of-state vehicles through the IRP, effectively leveling

the playing field while providing economically efficient incentives by charging polluters based on their emission contributions.

A. TECHNICAL APPENDIX

This technical appendix supplements the discussion from chapter 9, providing an overview of the methodologies used in the two simulation models. In particular, this appendix describes the data sources and methods used to estimate the impacts of alternative regulatory scenarios. Examples of model runs are also provided. The details of the microsimulation model are provided in section A.1, while section A.2 discusses the macrosimulation inventory model.

A.1 DETAILS OF THE MICROSIMULATION MODEL

In order to more fully illustrate how the microsimulation model is formulated this subsection provides a series of four spreadsheets which illustrate different portions of the model for the base case. The base case represents the status quo. The first spreadsheet is the fleet inventory which tracks the number of vehicles by vintage and type of vehicle (normal or low-emission) over the ten year period considered by the model. The second sample spreadsheet tracks revenue from the operations of the fleet. The third spreadsheet calculates operating expenses, while the fourth provides an accounting of the firm's operations over the ten year period. Following the discussion of these basic modules, further subsections discuss how these base case spreadsheets are manipulated to model five groups of alternative scenarios. These scenarios include the impact of variations in the costs of the addition of low-emission vehicles, varying the fleet mix, and varying the number of vehicles with rebuilt engines in the fleet. In addition, examples are provided of how fees, rebates, and tax incentives impact the firm's operating statement.

A.1.1 Fleet Inventory

Exhibit A-1 provides an example of the year by year accounting of the fleet inventory, which in this example is assumed to remain constant at 200 HDVs. In keeping with the assumed ten year vehicle life, 20 HDVs are retired each year and replaced with 20 new vehicles. In the model it is assumed that in the first period there are ten age classes of vehicles. For example, 20 are one year old (age class 1), 20 are two years old (age class 2), etc. The New Vintage 1 class consists of those new vehicles purchased in year 1, New Vintage 2 represents those new vehicles purchased in year 2, etc. For example, at the end of year one, the 20 oldest vehicles are retired (age class 10) and replaced by 20 new vehicles in New Vintage 1. During the ten year time frame, 20 new vehicles replace 20 older vehicles each year. In year 10, the fleet consists of 200 HDVs, but the composition has changed with 180 vehicles of newer vintages and only 20 of the original class of vehicles.

A variation of this scheme is possible if vehicles with rebuilt engines are added into the mix. The vehicles with rebuilt engines would replace the older classes of vehicles as they are retired. Rebuilding would extend the vehicle life and would allow the firm to delay purchasing a new HDV. As a result, the firm would purchase fewer new HDVs each year. This option, termed the "rebuild option," is explained in more detail in Section A.1.5.

A.1.2 Revenues from Operations

Exhibit A-2 shows the accounting for operations over the ten year period. It is assumed for purposes of this model that revenues per vehicle decline with age. As discussed in Chapter 9, this is based on empirical data from the U.S. Census of Transportation's Truck Inventory and Use Survey. Total revenue for the fleet is kept constant in the base case model as the older, less efficient vehicles are systematically replaced with new vehicles. In this example, a systematic replacement policy is required to maintain revenues over time. This assumption is reasonable given that if older vehicles did not lose revenue producing potential there would be little incentive to buy new vehicles.

A.1.3 Operating Expenses

Exhibit A-3 provides the accounting of operating expenses for vehicles by age of HDV. It is assumed that as vehicles age, their maintenance expenses increase. These maintenance costs include vehicle servicing, engine repairs, and other repairs to the vehicle/engine that occur during the life of the HDV. Operating costs, however, tend to decrease as the vehicle ages. Many of these costs (e.g. insurance, registration fees) are related to the value of the HDV, which depreciates over time. In the microsimulation model, it is assumed that the increase in maintenance costs exceeds the decrease in operating costs as the vehicle ages, thereby resulting in a net increase in these costs. In order to keep operation expenses constant a systematic vehicle replacement policy is used by the firm. The exact profile of operating efficiency is hypothetical in this case but it is used to illustrate the principle involved.

A.1.4 Operating Statement

Exhibit A-4 provides an accounting of the firm's operations over the ten year time period. The revenue for operations is developed from Exhibit A-2, while vehicle age related expenses are from Exhibit A-3. It is assumed that some expenses are not related to age of vehicles, such as driver salaries, overhead and administrative costs. The proportions of vehicle age related and nonage related expenses are derived from data from the American Trucking Associations.[43] The remainder of this section provides definitions of some of the key terms shown in Exhibit A-4.

Definitions of Key Terms

Gross profit is the sum of revenue and expenses.

Depreciation is the amortization of the existing fleet (at year 1), which in this case is assumed to be on a ten year basis.

[43]Information on VMT and age is taken from the 1987 Census of Transportation, Truck Inventory and Use Survey.

Amortization of new vehicles is the annualized economic cost of the capital investment over a ten year amortization schedule. The depreciation of the older vehicles decreases over time as older vehicles are retired. Amortization costs increase each year because new vehicles are being added. However, in the base case model, total charges for depreciation and amortization are assumed to remain constant across the 10 year period.

Amortization of extra costs is a separate accounting for the additional costs which will be incurred when new, low-emission HDVs are purchased. In the microsimulation model, low-emission HDVs are assumed to cost $13,000 more than conventional HDVs based on data presented in Chapter 1 on regulatory compliance costs.

Amortization of vehicles with rebuilt engines is a separate accounting for the annualized economic capital costs for any vehicles with rebuilt engines in the fleet if the engine rebuild option is selected.

Rebasing expense is a separate accounting for the costs that would be incurred if the firm decided to set up an additional non-California base state. It represents costs for an office with a publicly listed telephone, a street address, and a full time representative of the firm. This expense would be an annual cost to the firm.

Net income before taxes is what is left to the firm after all expenses, including all amortization, are deducted from gross revenues. Net income after taxes is the income after state and federal taxes are paid. This income is the "bottom line" for the business. All of the factors discussed up to this point affect the firm's bottom line of profitability.

Net present value (NPV) is the discounted present value of the stream of after tax income available to the firm. The microsimulation model uses a ten percent discount rate in evaluating all of the various scenarios. The NPV moves in tandem with profitability. It is a more comprehensive method for measuring the impacts of the various scenarios over time than using other measures, such as annual cost estimates.

A.1.5 Alternative Scenarios

This accounting simulation model can be run for a variety of scenarios such as: varying the costs of the addition of low-emission HDVs, varying the fleet mix, varying the number of vehicles with rebuilt engines in the fleet, and the costs of the rebasing option. These scenarios attempt to model the behavior of HDV operators in cases where operators either choose to refurbish HDVs, rebase outside of California, or decide to purchase low-emission vehicles. In addition, alternative regulatory scenarios have also been modeled, including fees and rebates, and tax incentives. Each scenario produces a different bottom line profit and net present value (NPV) which is then used in the macrosimulation model to determine the ending fleet inventory.

Rebuilding HDV Engines

The microsimulation model can be modified to account for rebuilding heavy-duty engines. The inventory spreadsheet can accommodate a new category for vehicles with rebuilt engines as is done in Exhibits A-5 through A-8. A variation of this scheme is possible if vehicles with rebuilt engines are added into the mix. These vehicles would replace the older classes of vehicles as they are retired. In the case represented by Exhibits A-5 through A-8, the firm's HDV inventory would contain fewer new vehicles but would still remain at the 200 vehicle size fleet.

Rebasing Out-of-state

Exhibit A-9 is used to demonstrate how the base case model is modified to account for the costs of rebasing. The fleet inventory changes on schedule to keep the size constant at 200 trucks. However, there no charges for environmental upgrades for the new trucks since it is assumed that they will be purchased out-of-state. The annual cost for rebasing is included in the Operating Statement, shown in Exhibit A-9. The derivation of these costs is discussed in Section 10.1.1. $100,000 was used as a midpoint for the rebasing cost.

Purchasing Low-Emission Vehicles

Exhibit A-10 demonstrates how the model evaluates the financial aspects of purchasing new low-emitting vehicles. It is assumed that the old vehicles are regularly retired and replaced with ten new low-emitting vehicles each year, keeping the fleet constant at 200 vehicles. There is an amortization cost of $1,300 per vehicle, which is based on a total incremental cost for the upgraded engine of $13,000, amortized over a ten year period.

The amount for amortization is cumulative over the ten year period. For example, after the first year, the amortization for the first ten new vehicle upgrades is $13,000. The next year the total amortization for the new reduced-emitting vehicles is $13,000 for the previous year's purchases and an additional $13,000 for the current purchases. Amortization for the new reduced-emitting vehicles reaches a peak in the tenth year, and would remain constant if the replacement policy and costs remained constant.

Fees and Rebates

Exhibit A-11 demonstrates how the scheme of fees and rebates was modeled. The basic assumption of regular replacement of ten percent of the fleet annually was assumed. Each old vehicle that does not conform to the low-emission standard in the fleet is assessed a fee. The annual fee is the number of old vehicles times the amount of the fee. That figure decreases over time as the number of older vehicles that do not conform to the low-emission standard are retired.

For new low-emission vehicles purchased, firms receive a rebate equal to the rebate price times the number of new vehicles purchased. Over time, the value of the rebates for low-emission vehicles exceeds the annual fee for non compliance. These results demonstrate that rebates may not be a cost-effective option for the ARB.

The schedule of fees and rebates can be adjusted for any combination. Each combination produces a NPV which can be compared with the NPV of the base case. Thus the "optimum" combination of fees and rebates would be that combination which approximates the base case.

Tax Incentives

Tax incentives can be modeled in a similar manner as the other alternatives. Exhibit A-12 shows the results of the Operating Statement when tax provisions are inserted. The only difference is that the tax computation includes the alternative tax provision. For example, if a tax credit of a certain percentage (say, five percent) is used, the tax owed by the firm is reduced by an amount equal to the credit times the amount of vehicle purchase. If ten low emitting vehicles with a cost of $103,000 each are purchased in a given year (total annual cost of $1,030,000) the tax credit is $51,500. The credit reduces taxes paid to the government and increases the after tax return. Each proposed level of tax credit produces a NPV which can be compared with the status quo alternative. Sales tax rebates or any other taxing scheme can be evaluated in the same manner.

A.2. DETAILS OF THE MACROSIMULATION INVENTORY MODEL

Decisions by firms as to whether or not to replace or refurbish older vehicles, buy new vehicles, rebase vehicles out of the state and/or downsize operations have an impact on the inventory of HDVs in the state. In particular, these decisions affect the ultimate composition of the fleet and determine the proportion of the fleet (and vehicles operating in the state) that meet potential low-emission regulations. The macroeconomic simulation model can be used to determine how different regulatory scenarios affect the overall HDV inventory. The macrosimulation inventory model consists of spreadsheets which calculate the ending fleet inventory based on assumptions concerning the changes in the fleet inventory over time.

This section shows some sample model runs in which the degree to which firms rebase is varied. The number of trucks that are rebased directly impacts the number of low-emission HDVs in the fleet inventory. Presumably, as more vehicles are rebased, less low-emission HDVs will be purchased, frustrating efforts to reduce emissions from HDVs.

A.2.1 Base Case Scenario

Exhibit A-13 shows the base case scenario. The total number of trucks in the beginning fleet inventory is derived from sources described in Chapter 9. The ending inventory totals assume a one percent growth per year in the number of trucks serving California. It is assumed that there would be some amount of engine rebuilding to extend the lives of some vehicles even

in the absence of potential more stringent low-emission standards in addition to those adopted for 1998. Engine rebuilding was set at approximately 10 percent of the fleet. Large firms are assumed to be less likely to extend the lives of old vehicles than are the small firms due to their relatively stronger capital position.

There is no rebasing or fleet downsizing in the base case. There are also no additional out-of-state firms entering the California market as firms in the state downsize. The number of new trucks purchased is the residual after allowances are made for vehicle life extensions, rebasing and downsizing.

A.2.2 Alternative Scenarios

Exhibits A-14 through A-16 provide details for three alternatives to the base case. These three alternatives are for the rebasing option in which large trucking firms rebase a portion of their fleet. Based on the microsimulation model results, rebasing is not an economically viable option for small firms under 100 trucks. As a result, no rebasing for small firms is accounted for in Exhibit A-14 through A-16; these three exhibits represent cases in which large trucking firms are assumed to rebase 25, 50, and 75 percent of their fleet, respectively. The downsizing of firms would produce additional market opportunities for both California firms and out-of-state firms. The macrosimulation model assumes that California firms will replace half the vehicles lost by downsizing and that out-of-state firms will account for the other half.

Exhibit A-14 assumes that 25 percent of large trucking firms rebase. It is also assumed that if a new regulation is promulgated, trucking firms would increase their rate of refurbishing and rebuilding to 30 percent rather than the base case of 10 percent. This figure is based on the results of the microsimulation model which demonstrated that it is in the firm's economic interests to extend the life of vehicles for as long as possible. The imposition of the regulations would cause some firms to downsize. A figure of 10 percent was used for downsizing from small firms. As shown in Exhibit A-14, 25 percent of the ending fleet inventory consists of new vehicles, while 9 percent of vehicles are refurbished.

Using the same assumptions for large and small firms with respect to their purchasing decisions, other scenarios were developed in which more large trucking firms are assumed to rebase. Exhibit A-15 assumes that 50 percent of large trucking firms rebase while Exhibit A-16 assumes that 75 percent of large trucking firms rebase. In Exhibit A-15, 20 percent of the ending fleet inventory consists of new vehicles that are purchased, while seven percent of vehicles are refurbished and 12 percent of vehicles are rebased. In the 75 percent rebase scenario, these percentages are 16, 6 and 18, respectively.

Exhibit A-1: HDV Inventory by Vintage Year and Age

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
New Vintage 9										20
New Vintage 8									20	20
New Vintage 7								20	20	20
New Vintage 6							20	20	20	20
New Vintage 5						20	20	20	20	20
New Vintage 4					20	20	20	20	20	20
New Vintage 3				20	20	20	20	20	20	20
New Vintage 2			20	20	20	20	20	20	20	20
New Vintage 1		20	20	20	20	20	20	20	20	20
Age Class 1	20	20	20	20	20	20	20	20	20	20
Age Class 2	20	20	20	20	20	20	20	20	20	
Age Class 3	20	20	20	20	20	20	20	20		
Age Class 4	20	20	20	20	20	20	20			
Age Class 5	20	20	20	20	20	20				
Age Class 6	20	20	20	20	20					
Age Class 7	20	20	20	20						
Age Class 8	20	20	20							
Age Class 9	20	20								
Age Class 10	20									
Total Vehicles	200	200	200	200	200	200	200	200	200	200

Exhibit A-2: Revenue from Operations ($ thousands)

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
New Vintage 9										4,494
New Vintage 8									4,494	4,173
New Vintage 7								4,494	4,173	3,852
New Vintage 6							4,494	4,173	3,852	3,531
New Vintage 5						4,494	4,173	3,852	3,531	3,210
New Vintage 4					4,494	4,173	3,852	3,531	3,210	3,210
New Vintage 3				4,494	4,173	3,852	3,531	3,210	3,210	2,889
New Vintage 2			4,494	4,173	3,852	3,531	3,210	3,210	2,889	2,568
New Vintage 1		4,494	4,173	3,852	3,531	3,210	3,210	2,889	2,568	2,247
Age Class 1	4,494	4,173	3,852	3,531	3,210	3,210	2,889	2,568	2,247	1,926
Age Class 2	4,173	3,852	3,531	3,210	3,210	2,889	2,568	2,247	1,926	
Age Class 3	3,852	3,531	3,210	3,210	2,889	2,568	2,247	1,926		
Age Class 4	3,531	3,210	3,210	2,889	2,568	2,247	1,926			
Age Class 5	3,210	3,210	2,889	2,568	2,247	1,926				
Age Class 6	3,210	2,889	2,568	2,247	1,926					
Age Class 7	2,889	2,568	2,247	1,926						
Age Class 8	2,568	2,247	1,926							
Age Class 9	2,247	1,926								
Age Class 10	1,926									
Total Revenue	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100

Exhibit A-3: Expenses - Vehicle Age Related ($ thousands)

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
New Vintage 9										237
New Vintage 8									237	276
New Vintage 7								237	276	315
New Vintage 6							237	276	315	355
New Vintage 5						237	276	315	355	394
New Vintage 4					237	276	315	355	394	394
New Vintage 3				237	276	315	355	394	394	434
New Vintage 2			237	276	315	355	394	394	434	473
New Vintage 1		237	276	315	355	394	394	434	473	513
Age Class 1	237	276	315	355	394	394	434	473	513	552
Age Class 2	276	315	355	394	394	434	473	513	552	
Age Class 3	315	355	394	394	434	473	513	552		
Age Class 4	355	394	394	434	473	513	552			
Age Class 5	394	394	434	473	513	552				
Age Class 6	394	434	473	513	552					
Age Class 7	434	473	513	552						
Age Class 8	473	513	552							
Age Class 9	513	552								
Age Class 10	552									
Total Age Related Vehicle Expense	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943

Exhibit A-4: Statement of Operations

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
Total Revenue	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100
Total vehicle expense age related	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943
Total vehicle expense not age related	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926
Total operating expenses	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870
Gross profit from operations	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230
Depreciation (existing fleet)	1,800	1,620	1,440	1,260	1,080	900	720	540	360	180
Amortization (new vehicles)	180	360	540	720	900	1,080	1,260	1,440	1,620	1,800
Amortization of extra costs	0	0	0	0	0	0	0	0	0	0
Amortization of vehicles with rebuilt engines	0	0	0	0	0	0	0	0	0	0
Rebasing expense	0	0	0	0	0	0	0	0	0	0
Net income Before taxes	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250
Return on income before taxes	3.90%	3.90%	3.90%	3.90%	3.90%	3.90%	3.90%	3.90%	3.90%	3.90%
Net income after taxes	813	813	813	813	813	813	813	813	813	813
Return on income after taxes	2.53%	2.53%	2.53%	2.53%	2.53%	2.53%	2.53%	2.53%	2.53%	2.53%
Net present value (@ 10%)										4,994

Exhibit A-5: HDV Inventory by Vintage Year and Age: Engine Rebuild Option

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
Vehicles with rebuilt engines									20	20
Vehicles with rebuilt engines								20	20	20
Vehicles with rebuilt engines							20	20	20	20
Vehicles with rebuilt engines						20	20	20		
Vehicles with rebuilt engines					20	20	20			
Vehicles with rebuilt engines				20	20	20				
Vehicles with rebuilt engines			20	20	20					
Vehicles with rebuilt engines	0	20	20	20						
New Vintage 9										
New Vintage 8										20
New Vintage 7									20	20
New Vintage 6								20	20	20
New Vintage 5							20	20	20	20
New Vintage 4						20	20	20	20	20
New Vintage 3					20	20	20	20	20	20
New Vintage 2			0	0	0	0	0	0	0	0
New Vintage 1		0	0	0	0	0	0	0	0	0
Age Class 1	20	20	20	20	20	20	20	20	20	20
Age Class 2	20	20	20	20	20	20	20	20	20	
Age Class 3	20	20	20	20	20	20	20	20		
Age Class 4	20	20	20	20	20	20	20			
Age Class 5	20	20	20	20	20	20				
Age Class 6	20	20	20	20	20					
Age Class 7	20	20	20	20						
Age Class 8	20	20	20							
Age Class 9	20	20								
Age Class 10	20									
Total Vehicles	200	200	200	200	200	200	200	200	200	200

Exhibit A-6: Revenue from Operations: Engine Rebuild Option

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
Vehicles with rebuilt engines									4,173	3,553
Vehicles with rebuilt engines								4,173	3,531	2,500
Vehicles with rebuilt engines							4,173	3,531	2,500	2,247
Vehicles with rebuilt engines						4,173	3,531	2,500		
Vehicles with rebuilt engines					4,173	3,531	2,500			
Vehicles with rebuilt engines				4,173	3,531	2,500				
Vehicles with rebuilt engines			4,173	3,531	2,500					
Vehicles with rebuilt engines	0	4,173	3,531	2,500						
New Vintage 9										
New Vintage 8										4,494
New Vintage 7									4,494	4,173
New Vintage 6								4,494	4,173	3,852
New Vintage 5							4,494	4,173	3,852	3,531
New Vintage 4						4,494	4,173	3,852	3,531	3,210
New Vintage 3					4,494	4,173	3,852	3,531	3,210	3,210
New Vintage 2			0	0	0	0	0	0	0	0
New Vintage 1		0	0	0	0	0	0	0	0	0
Age Class 1	4,494	4,173	3,852	3,531	3,210	3,210	2,889	2,568	2,247	1,926
Age Class 2	4,173	3,852	3,531	3,210	3,210	2,889	2,568	2,247	1,926	
Age Class 3	3,852	3,531	3,210	3,210	2,889	2,568	2,247	1,926		
Age Class 4	3,531	3,210	3,210	2,889	2,568	2,247	1,926			
Age Class 5	3,210	3,210	2,889	2,568	2,247	1,926				
Age Class 6	3,210	2,889	2,568	2,247	1,926					
Age Class 7	2,889	2,568	2,247	1,926						
Age Class 8	2,568	2,247	1,926							
Age Class 9	2,247	1,926								
Age Class 10	1,926									
Total Revenue	32,100	31,779	31,137	29,785	30,748	31,711	32,353	32,995	33,637	32,696

Exhibit A-7: Expenses - Age Related: Engine Rebuild Option

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
Vehicles with rebuilt engines									276	355
Vehicles with rebuilt engines								276	394	500
Vehicles with rebuilt engines							276	394	500	500
Vehicles with rebuilt engines						276	394	500		
Vehicles with rebuilt engines					276	394	500			
Vehicles with rebuilt engines				276	394	500				
Vehicles with rebuilt engines			276	394	500					
Vehicles with rebuilt engines	0	276	394	500						
New Vintage 9										
New Vintage 8										237
New Vintage 7									237	276
New Vintage 6								237	276	315
New Vintage 5							237	276	315	355
New Vintage 4						237	276	315	355	394
New Vintage 3					237	276	315	355	394	394
New Vintage 2			0	0	0	0	0	0	0	0
New Vintage 1		0	0	0	0	0	0	0	0	0
Age Class 1	237	276	315	355	394	394	434	473	513	552
Age Class 2	276	315	355	394	394	434	473	513	552	
Age Class 3	315	355	394	394	434	473	513	552		
Age Class 4	355	394	394	434	473	513	552			
Age Class 5	394	394	434	473	513	552				
Age Class 6	394	434	473	513	552					
Age Class 7	434	473	513	552						
Age Class 8	473	513	552							
Age Class 9	513	552								
Age Class 10	552									
Total vehicle expense age related	3,943	3,983	4,101	4,285	4,167	4,049	3,970	3,891	3,812	3,879

Exhibit A-8: Statement of Operations: Engine Rebuild Option

Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year

	Year									
	1	2	3	4	5	6	7	8	9	10
Total Revenue	32,100	31,779	31,137	29,785	30,748	31,711	32,353	32,995	33,637	32,696
Total vehicle expense age related	3,943	3,983	4,101	4,285	4,167	4,049	3,970	3,891	3,812	3,879
Total vehicle expense not age related	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926
Total operating expenses	28,869	28,909	29,027	29,211	29,093	28,975	28,896	28,817	28,738	28,805
Gross profit from operations	3,231	2,870	2,110	574	1,655	2,736	3,457	4,178	4,899	3,891
Depreciation (existing fleet)	1,800	1,620	1,440	1,260	1,080	900	720	540	360	180
Amortization (new vehicles)	0	0	0	0	180	360	540	720	900	1,080
Total Amount new vehicles										
Amortization of extra costs	0	0	0	0	0	0	0	0	0	0
Amortization of vehicles with rebuilt engines*	0	33.3	67	100	100	100	100	100	100	100
Rebasing expense	0	0	0	0	0	0	0	0	0	0
Net income Before taxes	1,431	1,184	570	(966)	115	1,196	1,917	2,638	3,359	2,151
Return on income before taxes	4.46%	3.73%	1.83%	-3.24%	0.37%	3.77%	5.93%	7.99%	9.99%	6.58%
Net income after taxes	930	769	371	(628)	75	777	1,246	1,715	2,183	1,398
Return on income after taxes	2.90%	2.42%	1.19%	-2.11%	0.24%	2.45%	3.85%	5.20%	6.49%	4.28%
Net present value (@ 10%)										4,720

*Engine rebuilding is assumed to increase expected vehicle life by 3 years

Exhibit A-9: Rebase Option
Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year
Operating Statement Summary

	Year									
	1	2	3	4	5	6	7	8	9	10
Total vehicle expense age related	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943
Total vehicle expense not age related	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926
Total operating expenses	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870
Gross profit from operations	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230
Depreciation (existing fleet)	1,800	1,620	1,440	1,260	1,080	900	720	540	360	180
Amortization (new vehicles)	180	360	540	720	900	1,080	1,260	1,440	1,620	1,800
Amortization of extra costs	0	0	0	0	0	0	0	0	0	0
Amortization of vehicles with rebuilt engines	0	0	0	0	0	0	0	0	0	0
Rebasing expense*	100	100	100	100	100	100	100	100	100	100
Net income Before taxes	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Return on income before taxes	3.58%	3.58%	3.58%	3.58%	3.58%	3.58%	3.58%	3.58%	3.58%	3.58%
Net income after taxes	748	748	748	748	748	748	748	748	748	748
Return on income after taxes	2.33%	2.33%	2.33%	2.33%	2.33%	2.33%	2.33%	2.33%	2.33%	2.33%
Net present value (@ 10%)										4,595

*assumes rebasing cost of $100,000 per year

Exhibit A-10: Absorb Cost Option - Purchase Low-Emission Vehicles
Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year
Operating Statement Summary

	Year									
	1	2	3	4	5	6	7	8	9	10
Total vehicle expense age related	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943
Total vehicle expense not age related	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926
Total operating expenses	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870
Gross profit from operations	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230
Depreciation (existing fleet)	1,800	1,620	1,440	1,260	1,080	900	720	540	360	180
Amortization (new vehicles)	180	360	540	720	900	1,080	1,260	1,440	1,620	1,800
Amortization of extra costs*	26	52	78	104	130	156	182	208	234	260
Amortization of vehicles with rebuilt engines	0	0	0	0	0	0	0	0	0	0
Rebasing expense	0	0	0	0	0	0	0	0	0	0
Net income before taxes	1,224	1,198	1,172	1,146	1,120	1,094	1,068	1,042	1,016	990
Return on income before taxes	3.81%	3.73%	3.65%	3.57%	3.49%	3.41%	3.33%	3.25%	3.17%	3.09%
Net income after taxes	796	779	762	745	728	711	694	678	661	644
Return on income after taxes	2.48%	2.43%	2.37%	2.32%	2.27%	2.22%	2.16%	2.11%	2.06%	2.01%
Net present value (@ 10%)										4,503

*Extra cost of $1,300 per vehicle for 20 vehicles, amortized over 10 years

Exhibit A-11: Fee and Rebate Option - Purchase Low-Emission Vehicles
Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year
Operating Statement Summary

	Year									
	1	2	3	4	5	6	7	8	9	10
Total revenue	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100
Total vehicle expense age related	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943
Total vehicle expense not age related	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926
Total operating expenses	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870
Gross profit from operations	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230
Depreciation (existing fleet)	1,800	1,620	1,440	1,260	1,080	900	720	540	360	180
Amortization (new vehicles)	180	360	540	720	900	1,080	1,260	1,440	1,620	1,800
Amortization of extra costs*	26	52	78	104	130	156	182	208	234	260
Amortization of vehicles with rebuilt engines	0	0	0	0	0	0	0	0	0	0
Rebasing expense	0	0	0	0	0	0	0	0	0	0
Emission fee on old vehicles ($500)	100	90	80	70	60	50	40	30	20	10
Rebate on new vehicles ($8,000)	0	160	160	160	160	160	160	160	160	160
Net income before taxes	1,124	1,268	1,252	1,236	1,220	1,204	1,188	1,172	1,156	1,140
Return on income before taxes	3.50%	3.95%	3.90%	3.85%	3.80%	3.75%	3.70%	3.65%	3.60%	3.55%
Net income after taxes	731	824	814	804	793	783	772	762	752	741
Return on income after taxes	2.28%	2.57%	2.54%	2.50%	2.47%	2.44%	2.41%	2.37%	2.34%	2.31%
Net present value (@ 10%)										4,797

*Extra cost of $1,300 per vehicle for 20 vehicles, amortized over 10 years

Exhibit A-12: Tax Credit Option - Purchase Low Emission Vehicles
Fleet of 200 HDVs, Replacement of 20 Vehicles Every Year
Operating Statement Summary

	Year									
	1	2	3	4	5	6	7	8	9	10
Total revenue	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100	32,100
Total vehicle expense age related	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943	3,943
Total vehicle expense not age related	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926	24,926
Total operating expenses	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870	28,870
Gross profit from operations	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230	3,230
Depreciation (existing fleet)	1,800	1,620	1,440	1,260	1,080	900	720	540	360	180
Amortization (new vehicles)	180	360	540	720	900	1,080	1,260	1,440	1,620	1,800
Amortization of extra costs*	26	52	78	104	130	156	182	208	234	260
Amortization of vehicles with rebuilt engines	0	0	0	0	0	0	0	0	0	0
Rebasing expense	0	0	0	0	0	0	0	0	0	0
Tax Credit (5%)	107	107	107	107	107	107	107	107	107	107
Net income before taxes	1,224	1,198	1,172	1,146	1,120	1,094	1,068	1,042	1,016	990
Return on income before taxes	3.81%	3.73%	3.65%	3.57%	3.49%	3.41%	3.33%	3.25%	3.17%	3.09%
Net income after taxes	903	886	869	852	835	818	801	785	768	751
Return on income after taxes	2.81%	2.76%	2.71%	2.65%	2.60%	2.55%	2.50%	2.44%	2.39%	2.34%
Net present value (@ 10%)										5,161

*Extra cost of $1,300 per vehicle for 20 vehicles, amortized over 10 years

Exhibit A-13: Base Case Scenario - Status Quo

Changes in the HDV Inventory with 1% Growth

	Vehicle Inventory Component						
Owner	Beginning Fleet Inventory	New Vehicles Purchased	Life Extend Vehicles	Rebased Out State	Lost by Downsizing	Imported into State	Ending Fleet Inventory
Government	68,259	61,433	6,826	0	0	0	75,400
Interstate							
Non. Calif. Based	561,168	0	0	0	0	0	619,879
Interstate							
Calif. Based							
Number of HDVs per Firm							
1	4,361	3,925	436	0	0	0	4,817
5	8,722	7,850	872	0	0	0	9,634
50	21,804	19,624	2,180	0	0	0	24,086
200	38,625	34,763	3,863	0	0	0	42,666
400	51,085	45,976	5,108	0	0	0	56,429
	124,597	112,137	12,460	0	0	0	137,633
Intrastate							
Calif. Based							
Number of HDVs per Firm							
1	8,704	7,833	870	0	0	0	9,614
5	17,407	12,185	5,222	0	0	0	19,228
50	43,518	39,166	4,352	0	0	0	48,071
200	77,089	69,380	7,709	0	0	0	85,154
400	101,956	91,760	10,196	0	0	0	112,623
	248,673	220,324	28,349	0	0	0	274,690
Total	1,002,697	393,895	47,634	0	0	0	1,107,601
		36%	4%	0%	0%	0%	100%

Exhibit A-14: Implementation Without Offsetting Incentives (25% Rebasing)

Changes in the HDV Inventory with 1% Growth

	Vehicle Inventory Component						
Owner	Beginning Fleet Inventory	New Vehicles Purchased	Life Extend Vehicles	Rebased Out State	Lost by Downsizing	Imported into State	Ending Fleet Inventory
Government	68,259	61,433	6,826	0	0	0	75,400
Interstate							
Non. Calif. Based	561,168	0	0	0	0	0	619,879
Interstate							
Calif. Based							
Number of HDVs per Firm							
1	4,361	2,180	2,180	0	0	0	4,817
5	8,722	6,105	2,617	0	872	872	9,634
50	21,804	15,263	6,541	0	2,180	2,180	24,086
200	38,625	20,278	8,691	9,656	3,863	3,863	42,666
400	51,085	26,820	11,494	12,771	5,108	5,108	56,429
	124,597	70,646	31,523	22,427	12,024	12,024	137,633
Intrastate							
Calif. Based							
Number of HDVs per Firm							
1	8,704	4,352	4,352	0	0	0	9,614
5	17,407	12,185	5,222	0	1,741	1,741	19,228
50	43,518	30,462	13,055	0	4,352	4,352	48,071
200	77,089	40,472	17,345	19,272	7,709	7,709	85,154
400	101,956	53,527	22,940	25,489	10,196	10,196	112,623
	248,673	140,998	62,914	44,761	23,997	23,997	274,690
Total	1,002,697	273,077	101,263	67,189	36,021	36,021	1,107,601
		25%	9%	6%	3%	3%	100%

Exhibit A-15: Implementation Without Offsetting Incentives (50% Rebasing)

Changes in the HDV Inventory with 1% Growth

	Vehicle Inventory Component						
Owner	Beginning Fleet Inventory	New Vehicles Purchased	Life Extend Vehicles	Rebased Out State	Lost by Downsizing	Imported into State	Ending Fleet Inventory
Government	68,259	61,433	6,826	0	0	0	75,400
Interstate							
Non. Calif. Based	561,168	0	0	0	0	0	619,879
Interstate							
Calif. Based							
Number of HDVs per Firm							
1	4,361	2,180	2,180	0	0	0	4,817
5	8,722	6,105	2,617	0	872	872	9,634
50	21,804	15,263	6,541	0	2,180	2,180	24,086
200	38,625	13,519	5,794	19,313	3,863	3,863	42,666
400	51,085	17,880	7,663	25,542	5,108	5,108	56,429
	124,597	54,947	24,795	44,855	12,024	12,024	137,633
Intrastate							
Calif. Based							
Number of HDVs per Firm							
1	8,704	4,352	4,352	0	0	0	9,614
5	17,407	12,185	5,222	0	1,741	1,741	19,228
50	43,518	30,462	13,055	0	4,352	4,352	48,071
200	77,089	26,981	11,563	38,544	7,709	7,709	85,154
400	101,956	35,685	15,293	50,978	10,196	10,196	112,623
	248,673	109,665	49,486	89,522	23,997	23,997	274,690
Total	1,002,697	226,045	81,107	134,377	36,021	36,021	1,107,601
		20%	7%	12%	3%	3%	100%

CARB LIBRARY
10742

Exhibit A-16: Implementation Without Offsetting Incentives (75% Rebasing)

Changes in the HDV Inventory with 1% Growth

	Vehicle Inventory Component						
Owner	Beginning Fleet Inventory	New Vehicles Purchased*	Life Extend Vehicles	Rebased Out State	Lost by Downsizing	Imported into State	Ending Fleet Inventory
Government	68,259	61,433	6,826	0	0	0	75,400
Interstate							
Non. Calif. Based	561,168	0	0	0	0	0	619,879
Interstate							
Calif. Based							
Number of HDVs per Firm							
1	4,361	2,180	2,180	0	0	0	4,817
5	8,722	6,105	2,617	0	872	872	9,634
50	21,804	15,263	6,541	0	2,180	2,180	24,086
200	38,625	6,759	2,897	28,969	3,863	3,863	42,666
400	51,085	8,940	3,831	38,314	5,108	5,108	56,429
	124,597	39,248	18,067	67,282	12,024	12,024	137,633
Intrastate							
Calif. Based							
Number of HDVs per Firm							
1	8,704	4,352	4,352	0	0	0	9,614
5	17,407	12,185	5,222	0	1,741	1,741	19,228
50	43,518	30,462	13,055	0	4,352	4,352	48,071
200	77,089	13,491	5,782	57,816	7,709	7,709	85,154
400	101,956	17,842	7,647	76,467	10,196	10,196	112,623
	248,673	78,332	36,058	134,283	23,997	23,997	274,690
Total	1,002,697	179,013	60,950	201,566	36,021	36,021	1,107,601
		16%	6%	18%	3%	3%	100%