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Criteria for Development of Emissions Averaging for Heavy-Duty Engines and Light-Duty Trucks

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Glenn Passavant
Chester France
John Anderson

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Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise and Radiation
U.S. Environmental Protection Agency

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I. Foreword

With the final implementation of the "bubble policy" for stationary sources, EPA is now investigating the possible implementation of an averaging concept for mobile source emissions. Emissions averaging is meant to provide motor vehicle manufacturers with greater flexibility in determining the mix of vehicles/engines to produce and the control technology to apply, while at the same time permitting no degradation in the air quality benefits derived from controlling motor vehicle emissions. This paper will examine the major benefits of the averaging concept and will identify the important design considerations which should affect the final form of any averaging concept. The analysis of these important design considerations will be used to identify design criteria which will be necessary for a successful averaging program.

II. Background

The idea that motor vehicle emissions should be averaged has been debated by the government and the motor vehicle industry since prior to the Clean Air Act Amendments in 1970. However, in more recent times, the concept of averaging was raised once again by General Motors and later by Volkswagen in response to the light-duty diesel particulate emission standard Notice of Proposed Rulemaking. The EPA staff thoroughly analyzed the two averaging concepts proposed by the manufacturers, but rejected both due to statutory, equity, enforcement, and localized impact problems. However, at the same time, the Agency took the position of remaining open to further consideration of averaging at a later date.1/

In response to the manufacturers' proposals and interest in averaging, a task force was established to investigate the possibility of an averaging approach to emissions compliance in association with the statutory light-duty truck (LDT) and heavy-duty engine (HDE) NOx emission standards for the 1985 model year.

The remainder of this paper will be devoted to an investigation of the averaging concept as it relates to motor vehicles. Instead of an analysis of specific averaging concepts, the more fundamental concerns and criteria will be addressed. With this as the goal, the remainder of this paper is divided into three sections. The first section will discuss some possible benefits of an averaging program. The second section will identify the important considerations in designing an averaging program. The third section will use the design considerations identified in the previous section to establish design criteria necessary to a successful averaging program.

Throughout the remainder of this paper the term "vehicle" will be used to represent both light-duty trucks and heavy-duty engines. Strictly speaking, however, manufacturers certify the entire vehicle for light-duty trucks but only the engine and emission control system for heavy-duty engines.

III. Benefits of Averaging

The major benefit of averaging is the increase in flexibility which emissions averaging affords a manufacturer. The manufacturer will have a much greater degree of flexibility in designing its own internal program to meet the emission standard under an averaging approach. The potential benefits of such a compliance approach can be divided into three broad areas: technical flexibility, economic advantages, and regulatory improvement.

A. Technical Flexibility

Probably the largest benefit of an averaging program for emissions is the increase in the technical flexibility available to the manufacturers. Instead of every family being certified to the same emission standard, the manufacturers would now be able to use a variety of control strategies to achieve compliance with an emission standard. For example, manufacturers can comply with a standard by achieving the required emission reductions in the families where they are most readily available and not seeking as great a reduction in families where control is more difficult. Clearly, the degree of difficulty and cost of achieving emissions reductions will vary from family to family.

In addition, an averaging approach would allow the manufacturers to make greater use of any emission trade-offs between NOx and the other pollutants. For example, if HC control was difficult in a family, the manufacturer could use the NOx-HC trade-off to reduce HC and increase NOx. The greater NOx levels could then be offset by averaging. To a large degree, the current approach limits the use of trade-offs in the manufacturer's control strategy.

The fact that an averaging concept allows emission offsets between lower and higher emitting families would increase the time available to decrease the emissions from the higher emitting families. The greater time available would allow the use of an optimized emission control system rather than the use of a quick fix approach which might be necessary if time was a prime factor in the choice of the emission control technology applied.

It is possible that an averaging approach would lead to a decrease in any fuel economy penalty which might be related to emission control. This is especially true in the case of NOx due to the relationship between NOx control and fuel economy. This potential savings is further enhanced by the fact that the quick fix technology which is sometimes used may also cause a fuel economy penalty (e.g., retarded timing). The higher emitting vehicles which would require the greatest total reductions under the current approach to emissions compliance could require less total reduction and would thus be able to minimize the fuel economy penalty which might otherwise be necessary with these higher emitting vehicles.

Finally, in the area of emission-related hardware, an averaging approach would allow the manufacturer to choose its own control stategy on a family by family basis, thus likely reducing the total emission control hardware costs and allowing the selective application of the most costly technology or hardware.

B. Economic Advantages

An averaging program would have economic advantages in the areas of marketing, corporate allocations of research and development (R&D) funds, and short-term corporate capital investment funds. Also more desirable cash flows could be maintained by the affected firms.

The use of an averaging approach would minimize the chance that any family would have to be dropped from production due to technology or control cost concerns. The higher emissions from these families could be offset by lower emissions from other families. This would have the added advantage of allowing longer use of non-recurring investments such as R&D and tooling for some families.

A second marketing benefit of an averaging program would be the potential change in marketing strategies. For example, it is easy to conceive a scenario in which a manufacturer certifies two versions of the same basic engine at two different emission levels. Version one could have lower emission levels and higher operating costs due to emission control. Version two could have higher emission levels and lower operating costs. Version one could be sold at an artificially lower price to encourage sales and at least partially offset the higher operating costs, while version two could be sold at an artificially higher price to discourage sales. The premium received on version two could actually be larger than the discount offered on version one, thus leaving the manufacturer with a larger net profit. This premium could actually increase as the manufacturer attempted to discourage sales of its higher emitting engines, thus pushing the potential net profit even higher.

In relation to marketing, an averaging program would allow the "market testing" of a limited number of new families without the relatively large fixed cost of R&D associated with emissions. The potentially higher emission limits of these low sales volume families could be offset by slightly lower emission limits from the higher sales volume families. However, as the sales of this family grew, emissions research and ultimately emission reductions could become necessary to continue production.

An averaging approach allows manufacturers to choose where their emission related R&D funds will be spent, and may allow the emission related expenditures to be spread more evenly over several years rather than lumped into the few years preceding the implementation of a revised standard.

One other potential savings is related to the flexibility a manufacturer has in establishing the emission limits for each family. For example, a manufacturer may choose to establish the emission limit for a family such that when produced it also conforms to the emission standards of one or more of its export markets. This would decrease both development and production costs.

Finally, and perhaps most importantly, the increased flexibility inherent in an averaging program could permit the manufacturer to achieve its overall emissions reductions for the least total cost. Although it is not possible to quantify the potential savings, it is clear that the total cost would probably be less than if averaging were not permitted, and in any case would probably not be more. This would lead to decreased short-term capital investments in emission control hardware and would be a great incentive for emission control system optimization. Although the incentive for emission control system optimization is also present in a nonaveraging approach to vehicle emission control, little importance is placed on optimizing a system to achieve the required emission reductions at the lowest cost, and it is not possible to optimize product-wide control strategies for total cost.

In summary, potential economic disruptions of emission control regulations may be minimized with the implementation of an averaging approach for compliance with emission standards. These economic benefits will be most pronounced for a manufacturer who markets a diverse product line. A manufacturer with numerous families will have much more flexibility than one with fewer families when optimizing compliance costs under an averaging approach.

C. Regulatory Improvement

Under the current control strategy there has been little incentive to achieve emission reductions below those required to meet the emission standards. Under an averaging approach, there will be a much greater incentive to achieve the greatest reduction possible, because the extra reductions can then be used to assure compliance of all the manufacturer's families/ combinations within the class or category of vehicles being averaged.

In addition, it would be beneficial if the averaging concept could incorporate additional incentives for the manufacturers to achieve maximum reductions. This might be achieved if a program for banking and trading of excess emission reductions could be implemented. Such a program could create a market in emissions, and could thus function to reduce compliance costs for the industry as a whole. Under programs such as these, manufacturers would be able to save some portion of their excess emission reductions for future use or perhaps trade or sell some portion of their excess reductions to other manufacturers. However, these programs may not be possible under the current Clean Air Act.

Finally, the implementation of an averaging program, especially in the long term, could result in a decrease in waiver requests which result under the current approach. Fewer waivers would mean less total emissions into the environment.

IV. Considerations in Designing an Averaging Program

In light of the considerable potential benefits which might be realized from an averaging approach to emissions compliance, it is worth considering some of the factors involved in designing such a program. To successfully attain even a significant share of those benefits will require a carefully conceived program. Such a program would interact with essentially all areas of existing heavy-duty engine and light-duty truck regulations. Many of the resulting concerns could probably be solved in a straight-forward manner. The important ones are discussed to give the reader a comprehensive picture of the complicated impacts an otherwise simple concept could have on EPA's existing programs. Any successfully designed averaging program should minimize any of these undesirable impacts.

A. General Considerations

Before dealing with specific needs, there are some general considerations. First, an averaging approach would represent a marked change in the way the Agency has to date applied the vehicle emission requirements of the Clean Air Act. The existing program requires that each vehicle in the class comply with the same emission standard. Although a more flexible approach may be possible under the Clean Air Act, either an averaging approach would have to be designed whch is harmonious with the present structure of the Act, or recommendations would have to be made to Congress for changes in the Act.

A second general consideration is the overall impact which a change to averaging could have on the entire motor vehicle control program. We shall see in subsequent discussion that a successful averaging program will impact nearly all current mobile source regulatory programs. The overall motor vehicle control program as currently structured is one which has been developed over many years with much trial and error. It is a mature program which has achieved a high rate of success in controlling motor vehicle emissions. Manufacturers' warnings notwithstanding, this has been done with no major disruption of the auto industry. The Agency has invested substantial resources in developing and refining this program to maximize its effectiveness.

Introduction of a major change in this program (i.e., averaging) can not be evaluated in a vacuum, neglecting the fact that the current approach is in fact in place and has been for many years. A choice which might be made if starting from ground zero with no existing program might not be the choice starting from our current position. The current program should not be reworked unless the changes show significant and compelling advantages.

A third area for consideration concerns the philosophy for standards setting embodied in the nonconformance penalty provisions of the Act. As shown by the legislative history, these provisons were intended to allow EPA to set standards based upon capabilities of what were identified as "technological leaders." "Technological laggards," which would not be able to comply with such standards, would be allowed to continue in production contingent upon payment of a nonconformance penalty. These concepts of technological leaders and laggards seem to assume a nonaveraging approach to compliance. In an averaging approach, a manufacturer's "laggards", often its bigger vehicle/engine sizes, could be balanced out by its "leaders." Where only average levels are important, those which are laggards or leaders would not be of concern or require special treatment. Introduction of averaging would therefore have to be reconciled with the Act's provisions for nonconformance penalties.

Lastly, it seems most likely that adoption of averaging could lead to more complicated regulatory procedures than currently exist. For example, accurate and timely sales forecasts and sales data would be required on a family/control system configuration basis. Heavy-duty engine manufacturers are not currently required to supply actual sales data. Light-duty truck manufacturers provide data for fuel economy purposes (CAFE), but it is not likely that the families for fuel economy would be the same as those for emissions. Since sales data would play a key role in evaluating compliance with an emission standard under averaging, sales would have to be monitored closely. Frequent updating would be needed to avoid the disruptive impact of a significant change in projected sales that went undetected for a long period. The costs of enforcing and monitoring vehicle compliance may increase under averaging. The amount of assembly line testing required to reach enforcement decisions may also increase.

The purpose of discussing the procedural complications and potential for more reporting burdens for manufacturers is to note this aspect of an averaging program which could run counter to the current thrust within the Federal government to simplify and reduce regulatory requirements. The above possible procedural complications will have to be carefully studied and minimized in the design of an averaging program. EPA has adequate experience with current certification programs and has made substantial progress in reducing burdens on manufacturers without compromising program objectives (i.e., abbreviated certification). Abbreviated certification may have to be abandoned for at least the first few years of an averaging program to provide both EPA and the manufacturers assurance that the averaging provisions are being properly implemented and that undetected loopholes and inconsistencies are corrected in a timely manner.

B. Specific Program Considerations

The various EPA motor vehicle emissions control programs will now be examined to identify those aspects of each program affected by an averaging concept. The purpose is to identify needs or aspects of those programs with which a successful averaging program will have to deal. Once these have been identified, specific criteria for designing an averaging program can be developed. The programs will be reviewed basically in the order in which they come in the life cycle of a typical certification family.

1. Certification

The certification program is designed around the requirements of Section 206(a) of the Act. This section requires that EPA issue a certificate of conformity upon a showing by the manufacturer that any new motor vehicle or engine conforms to the applicable emission regulations. This certificate is required before the manufacturer can sell or introduce into commerce its vehicles or engines. Adoption of an averaging approach would have a major impact on the current certification program.

The first basic consideration is that the program chosen must be able to be implemented in a straightforward and uncomplicated fashion. With some kinds of averaging it could be difficult or impossible to make a compliance/noncompliance decision for individual engine families. If only average values encompassing numerous families were important, then individual family emission rates would have little meaning, and in fact might fluctuate with time as a manufacturer used the flexibility of averaging to minimize emission constraints from his viewpoint. Changes would also occur as sales projection updates were made. Such an environment of "moving targets" would make it very difficult to operate a meaningful certification program and at the same time avoid burdensome and complicated paperwork. Some compromises on maximum flexibility might be needed in favor of a workable program.

Some of these considerations raise a more basic question of what the role of certification would be in an averaging program. Assembly line testing to evaluate actual production emission levels could be used to provide accurate emissions data for averaging. Data from preproduction certification vehicles could quickly outgrow its usefulness as it was replaced by results of assembly line emission testing under Section 206(b)(1) of the Act (hereafter, assembly line testing). After that, the approval of running changes, for example, might have to depend on new assembly line testing to evaluate the effect of the changes.

Under some averaging concepts, the entire body of certification regulations would have to be redesigned away from the current individualized approach to vehicle and engine certification. This would entail a comprehensive review of both the existing regulations and the associated complex of advisory circulars. All of these are now oriented toward isolated decisions on a family basis. Under averaging, the effect of a given family's emission level could not be determined without considering all other families from the same manufacturer and associated sales weights for each. An emission level that was acceptable at one time might not be at another. Such a possibility could play havoc with attempts at an orderly certification process as now understood. In addition, certification could conceivably be a single go/no-go decision for the manufacturer's entire product line, with the threat being that no vehicles could be produced if the projected average exceeded the emission standard. The manufacturer would then have to reshuffle its product line on a crisis basis to reduce his average. This is a high level of jeopardy which because of its consequences might be very difficult to invoke. It would certainly be undesirable from the manufacturer's viewpoint.

This paper has previously mentioned the fact that the increased complexity of certification would probably result in the abandonment of abbreviated certification for at least the first several years of the new program. There would be an increased certification workload to: 1) develop new procedures, 2) implement and manage the new procedures, and 3) handle the increased data requirements (e.g., projected and actual sales figures). In addition, it is reasonable to expect that the learning process under an averaging system would consume resources in refinement of the program. This would cover such areas as closing loopholes and dealing with unforeseen complications.

A final area of consideration concerns establishment of vehicle families and their emission levels. In a situation where only average emissions count, the appropriateness and need for the current system of family/control system determinations would need to be reviewed. An added complication from the manufacturer's point of view is the fact that in establishing emission levels, it may no longer have fixed standards against which to design. While allowing more flexibility, averaging would also increase the complexity of the task of establishing target levels.

Many of the possible disruptions and changes to the certification process could be minimized or eliminated if each family was certified to a manufacturer specified level known as the family emission limit. The family emission limits would apply to each vehicle within the respective families and when sales-weighted could not exceed the applicable emission standard for the vehicles under consideration.

2. Assembly Line Testing

Under the current approach, some families have emission levels well below the standard while other families exhibit more marginal emission levels. In this scenario, it is possible to focus assembly line testing activities on the marginal families to ensure that they conform to emission standards. An SEA (Selective Enforcement Auditing) approach could be implemented under some averaging concepts where there are a small number of marginal families. Under certain averaging concepts, however, it is expected that manufacturers would have increased incentive to establish each engine family emission limit (limits to which each vehicle in a given family must adhere) closer to the engine family's actual emission level, thus increasing the number of marginal families that EPA may wish to test on the assembly line. In addition, some averaging concepts could encourage manufacturers to establish a larger number of families than those that currently exist, so that the manufacturer could closely tailor its compliance with the emission standard by using the emission level of a number of specific groups of vehicles. This could conceivably maximize a manufacturer's ability to offset the high emission limit of one family against the low emission limit of another family. Consequently, the Agency may need to increase the number of vehicles it tests on the assembly line to maintain the same confidence that vehicles are meeting the applicable emission limits which the Agency has under the current approach. The lowest administrative cost to EPA and the industry for this increased testing requirement may occur if EPA required manufacturers to continually test a portion of their production (perhaps 1 to 2 percent) using a sampling plan EPA designs to assure that a manufacturer tests a cross section of its production.

Under the current approach, EPA envisions the continued use of an assembly line testing program that allows the Agency to make pass/fail decisions regarding whether vehicles comply with emission limits using a 10 percent AQL. In certain averaging approaches, however, the assembly line testing program may be required to establish the 90th percentile emission level for each family which could require more extensive test data than that required under a pass/fail program.

The sanctions applicable to a manufacturer when assembly line test data indicate that a family fails to meet a family emission limit, or when the manufacturer in effect exceeds the applicable emission standard (i.e., when the average, sales-weighted emissions from the manufacturer's fleet exceeds the applicable emission standard), must be articulated in any averaging program. In certain circumstances a family failure could cause a manufacturer to exceed the standard. In other cases, it may not be practicable for EPA to make any decisions regarding a manufacturer's "average" compliance status until the end of the model year. Averaging schemes must somehow address this problem.

3. <u>Nonconformance Penalties (NCPs)</u>

The payment of nonconformance penalties is intended to allow heavy-duty engines and light-duty trucks with GVWR above 6,000 lbs. to be produced under certain circumstances even though they cannot meet established emission standards but can meet established upper limits. (The Act does not provide for NCPs for light-duty trucks under 6,000 lbs. GVWR.) In averaging a manufacturer balances its higher emitting vehicles against its lower emitting vehicles to meet an emission standard. Therefore, nonconformance penalties as currently perceived by EPA may not be applicable to an averaging situation. However, an averaging approach with a stringent emission standard and stringent assembly line compliance requirements may still leave some manufacturers with a need for NCPs. Indeed, some manufacturers could receive little or no benefit from some averaging concepts and thus, could in effect still be operating under the current approach.

NCPs may have to be modified for use with averaging. For example, when an averaging approach uses family emission limits (limits each vehicle in the family must meet), the NCPs might be used for those families which exceeded their limits. Or NCPs might be applied in a broader way to a manufacturer's whole product line. This would happen at the end of the model year in the case where, based upon revised sales volume data or emissions data, a manufacturer's sales-weighted average of family emission limits exceed the applicable emission standard. In any case, payment of an NCP should remove a manufacturer's competitive advantage over another manufacturer that has achieved compliance.

NCPs could be a very important part in any averaging approach to emissions control. NCPs could provide much relief from the jeopardy manufacturers might encounter as sales change throughout the model year.

4. Recall

The present recall program functions by identifying a potentially nonconforming group of vehicles; testing vehicles from that group and, if a determination is made that a substantial number are not meeting an applicable standard, requiring that all vehicles in that group be modified to meet the standard. It may be possible to continue to operate the recall program in this manner under an averaging approach if family emission limits are established. If, however, under averaging, family emission limits are set nearer actual emission levels or the number of families increases, an equally effective recall program may be more complicated and necessitate more in-use testing. The need for more tests may make it infeasible to conduct a heavy-duty engine recall program. EPA anticipates that it will be extremely difficult to procure in-use heavy-duty engines for recall testing. Therefore, if the testing burden increases, the heavy-duty engine recall program may become impractical.

An averaging program could also complicate a manufacturer's remedy for the nonconforming in-use vehicles the recall program identifies. For example, a manufacturer may not wish to recall the nonconforming family but, instead, recall a family more amenable to emission reduction at lower cost. In that case, EPA would have to approve the manufacturer's remedial plan and may require the manufacturer to conduct additional emissions tests on the vehicles the manufacturer elects to recall to determine the emission level of the fix. If a recall of new vehicles or engines is involved when assembly line testing reveals that a family is not meeting its family emission limit an averaging program may complicate the recall of these vehicles. This is because for recalls of current model year vehicles it may be impossible to know what a manufacturer's final average emission level will be during the model year. It may be necessary to base recalls of current model year vehicles or engines solely on family emission limits based on projections. If, however, these projections were not accurate, it may result in EPA ordering recalls that were not necessary, or having to order a second recall on a family because the original fix did not reduce the emissions to a level which would allow the manufacturer to meet the applicable emission standard under an averaging approach.

Another issue under an averaging concept is how to credit the manufacturer for the vehicles or engines in the recalled class when determining overall compliance with the emission standard. In most recalls not every nonconforming vehicle or engine is repaired. Sales volume is a factor in determining compliance with the emission standard. Therefore, a manufacturer should be accountable for the emissions and number of vehicles that are not actually repaired in a recall.

5. Inspection and Maintenance Programs (I/M)

In the present case, where EPA is looking only at NOx averaging, there would be very little impact on I/M programs. This is because I/M programs presently measure only HC and CO emissions. A physical inspection might be used to look for damaged EGR valves, but this would not be affected by use of averaging concepts. I/M is also not currently applied to heavy-duty vehicles. However, it would include light-duty trucks.

On a broader perspective, where potential future applicability to pollutants other than NOx is considered, the impact of an averaging concept on I/M programs could be radical. This is because I/M enforcement is inherently on a vehicle by vehicle basis. Each vehicle must go through a pass/fail decision process to determine if corrections are needed. Therefore, the operators of an I/M program require clear limits which they may apply to each vehicle passing through an inspection station. Averaging may result in the multiplication of limits to a myriad of values applicable to different families. This could then create the need for determining separate idle test cut points for each of these limits. To evaluate the status of a vehicle could involve identification of the family and perhaps the control system configuration as well as the make and model year. Such identification would probably have to be added to the engine label by the manufacturer. The engine family identity would then lead to an applicable family emission limit.

Prospects such as these just outlined could threaten the viability of workable I/M programs. I/M programs now form key elements of the State Implementation Plans of many states, and their number is increasing rapidly. Their role in the control of in-use emissions must not be jeopardized. Any emissions averaging program must be chosen to be compatible with workable I/M programs.

6. Allowable Maintenance/Parameter Adjustment Provisions

Both of these areas apply by nature to individual families. Changing standards compliance to an averaging approach should have no effect on either one.

7. Proposed Durability Procedure

This program is also carried out on a family specific basis to determine deterioration factors (dfs).2/ Therefore, averaging would not directly impact its operation. However, there are ways in which averaging would affect the application of the durability program results. For example, because of the ability to trade off high emissions for one family against low emissions for another, averaging would reduce the jeopardy to individual families which could result from adverse performance of an in-use fleet. On the other hand, as preliminary dfs are replaced by in-use dfs, averaging would complicate the consequences of an erroneous preliminary df. If the in-use dfs indicated that the true average of a prior year's production exceeded the standard, then it is not clear what the options would be. Under non-averaging regulations, EPA might verify the revised emissions for the erroneous family df by selective in-use testing from that family. However, with averaging that might be insufficient. This is because the actual existence of a non-compliance situation could in some averaging concepts also depend on the true in-use emissions of all the other families produced by the same manufacturer. Determining those values could be prohibitively costly in terms of testing resources.

Durability may also impact the flexibility of averaging via its impact on dfs. Each year the dfs would be changed to reflect the results of more recent in-use data. These changing dfs will affect the manufacturer's flexibility in establishing emission targets for the new year's production, and thus, may serve to reduce the benefits of averaging.

C. Equity Considerations

It is clear that ideally any averaging approach which is implemented for NOx or any other pollutant should not put any manufacturer at a disadvantage nor give any other manufacturer an advantage. All manufacturers of light-duty trucks or heavy-duty engines should receive fair treatment if an averaging program is implemented. This section will investigate possible inequitable situations which must be avoided if at all possible when designing an emissions averaging program. As an introduction, a brief industry overview will provide the background information necessary to support this discussion.

1. Industry Overview

Thirteen foreign and ten domestic manufacturers produced and sold approximately 3,530,000 light-duty trucks and heavy-duty vehicles in 1979. Table 1 contains a general overview of the corporations competing in this market.3/ Table 2 contains approximate sales in each of the vehicle and engine classes under consideration, for the year 1979.4/

As can be seen in the tables, the light-duty truck (LDT) market is spread among twelve manufacturers, with the vast majority of the sales still held by the large domestic manufacturers (85 percent of the 1979 market). The captive imports of the domestic manufacturers and the other remaining imports were 15 percent of the 1979 market. This fraction has been gradually increasing and may continue to increase in the years ahead.

Only domestic manufacturers sell heavy-duty gasoline-powered (HDG) engines in the U.S. This market is clearly led by General Motors and Ford, but no manufacturer has less than ten percent of the market. Three of the four manufacturers in this group also sell gasoline-powered buses.

The heavy-duty diesel (HDD) engine market is dominated by domestic manufacturers. Domestic manufacturers produce about 95 percent of the heavy-duty diesels sold in the U.S. each year. This market is led by Cummins Engine Co. and General Motors (DDA), but Caterpillar, International Harvester (IHC) and Mack Trucks also hold substantial market shares. General Motors, Cummins, and IHC are the primary producers of heavy-duty diesel engines for buses.

The remainder of this section will discuss several equity conflicts which may arise and should be avoided or minimized in the formulation and implementation of any averaging program.

2. Averaging by Engine and Vehicle Type

An ideal averaging program for NOx or any other pollutant should deal fairly with all manufacturers affected. In terms of equity, a fundamental question arises. Should averaging be permitted across vehicle type, engine type, both, or none?

Averaging across vehicle type implies that a manufacturer would be permitted to offset higher emissions in one vehicle class by lower emissions within another vehicle class. This would ultimately mean that the sales-weighted emission levels of one class with higher emission levels would be offset by the lower sales-weighted emission levels from another class. Thus, for example, higher heavy-duty engine emissions could be offset by lower light-duty truck emissions, such that the sales-weighted average emission level would meet the emission standard. This concept could be exclusive by engine type (i.e., gasoline-fueled only) or include both engine types. Averaging by engine type means

Table 1

1979 Truck and Bus Producers 1/

Manufacturer	Produces LDV	Produces LDT	Produces LDDT	Produces HDG Engines	Produces HDD Engines	Produces HDD Bus Engines	Produces HDG Bus Engines
AMC	X	X					
Caterpillar					X	X	
Chrysler	X	X		X			
Cummins					X	X	
Deutz					X		
Ford	X	X		X			X
GM	X	X	X	X	X	X	X
Hino					X		
IHC		X	X	X	X	X	X
Isuzu		X			X		
Iveco-Fiat	X				X		
MAN						X	
Mack					X		
Mercedes	X				X		
Mitsubishi	X	X			X		
Nissan	X	X			X		
Scania Vabis	X	X					
Suzuki		X					
Toyo Kogyo	X	X					
Toyota	X	X					
VW	X	X	X				
Volvo	X				X		
White					X		

1/ Data gathered from EPA Certification Division.

Table 2

1979 Estimated U.S. Sales 1/

Manufacturer	LDT 2/	HDG Engines 3/	HDD Engines 3/	HDG Bus Engines	HDD Bus Engines
AMC	159,000	-	-	-	-
Caterpillar	-	-	30,500	-	150
Chrysler	250,000	19,000	-	-	-
Cummins	-	-	70,300	-	-
Deutz	-	-	<2,000	-	-
Ford	987,000	46,500	-	4,500	-
GM	1,285,000	58,000	51,800	6,700	2,900
Hino	-	-	-	-	-
IHC	23,000	22,000	15,000	13,000	1,100
Isuzu	97,000	-	<2,000	-	-
Iveco-Fiat	-	-	700	-	-
MAN	-	-	-	-	160
Mack	-	-	26,800	-	-
Mercedes	-	-	3,300	-	-
Mitsubishi	45,000	-	<500	-	-
Nissan	99,000	-	-	-	-
Scania Vabis	-	-	600	-	-
Suzuki	<2,000	-	-	-	-
Toyo Kogyo	83,500	-	-	-	-
Toyota	129,000	-	-	-	-
VW	2,000	-	-	-	-
Volvo	-	-	700	-	-
White	-	-	<2,000	-	-

1/ Calendar Year 1979.

2/ 0-10,000 lbs. GVWR: Data was obtained from MVMA, Automotive News, March 24, 1980, and discussions with several manufacturers.

3/ >10,000 lbs. GVWR - estimated from MVMA data.

that a manufacturer can offset higher emissions in one engine subclass (e.g., heavy-duty diesel) with lower emissions in the other subclass (e.g., heavy-duty gasoline-fueled engine). The same comparison could hold for light-duty trucks.

Thus, there are four combinations to consider: 1) averaging limited by vehicle class and engine type (within heavy-duty diesel families only), 2) averaging limited by vehicle class (within heavy-duty engines only), 3) averaging limited by engine type only (diesel only - but both light-duty trucks and heavy-duty engines) and finally, 4) unrestricted averaging (all four vehicle and engine types could be averaged).

As is probably obvious, there are certain equity problems tied to any one of the four approaches. Averaging limited by vehicle class and engine type would provide the most increased flexibility to the manufacturer with a diverse product line, and for some manufacturers would provide virtually no increase in flexibility. Table 3 shows the number of families each manufacturer certified in each class and thus, demonstrates the problems with this approach.

Averaging restricted by vehicle class would create some of the same problems but to a greater degree in the case of heavy-duty engines. Table 3 shows that of the 17 companies which certified heavy-duty engines in 1979, 2 certified gasoline-fueled engine only, 13 certified diesel engines only, and 2 certified both engine types. In the case of heavy-duty engines allowing averaging within a vehicle class would provide increased flexibility for only 2 of the 17 companies involved.

The case is much the same for light-duty trucks. Of the twelve companies which certified light-duty trucks in 1979 only 3 certified light-duty diesel trucks. Thus, only 3 of the 12 manufacturers would have any increased flexibility. However, for those 3 the benefits could be quite great. The high ratio of gasoline to diesel light-duty truck sales for these manufacturers would greatly aid in the minimization of any problems related to diesel gaseous emissions.

Averaging limited by engine type would have some positive implications. For the gasoline-powered vehicles, all of the manufacturers of heavy-duty gasoline-fueled engines also produce gasoline-powered light-duty trucks. Thus, 4 of the 12 producers of light-duty trucks would also have heavy-duty gasoline-fueled engines to include in averaging. No increase in flexibility would accrue to the other eight manufacturers of light-duty trucks.

For diesel engines even less of an increase in flexibility results. Of the 3 light-duty diesel truck manufacturers only two also produce heavy-duty diesel engines. Thus, only 2 of the 12 light-duty truck and 2 of the 15 heavy-duty diesel engine manufacturers would have increased flexibility.

Unrestricted averaging would provide a great increase in flexibility, but most certainly some companies would benefit substantially more than others. Large, diverse companies would be able to average all of their product lines and the more specialized would have far more limited benefits.

It may not be possible to develop an entirely equitable averaging program. Indeed, at least 5 of the manufacturers in Table 3 would not benefit from any averaging approach, because they certify only one family. Under any of the 4 combinations described above, the manufacturers with diverse product lines and many families will benefit more than the specialized or more limited manufacturers. In the long run it may be that no approach would benefit all manufacturers or benefit them all to the same degree.

3. Production Volumes and Characteristics

As shown in Table 2 the sales of light-duty trucks and heavy-duty engines are not spread evenly over all manufacturers involved. For example, the four major domestic manufacturers sold over 85 percent of the light-duty trucks and one manufacturer alone accounted for over 40 percent of the market.

For heavy-duty engines, the scenario is similar. General Motors and Ford each sell about fifty percent more heavy-duty gasoline-fueled engines than International Harvester or Chrysler. In the heavy-duty diesel market, Cummins and General Motors - Detroit Diesel Allison (DDA) each sell at least 70 percent more than their nearest competitors, Caterpillar, Mack, and IHC.

Sales volume is important primarily because of the flexibility it gives manufacturers. A manufacturer such as General Motors which has a large share of each of the three markets under consideration potentially has a great advantage in that its required reductions could be spread over many sales and diverse product lines. Large emission reductions required by some families could be offset by obtaining a small increment of additional reduction from another family which is easier to control, and has a large sales volume. In contrast, this same flexibility is available to International Harvester, but its sales are so much lower that its flexibility is greatly reduced as compared to General Motors. This potential inequity exists for light-duty trucks and both types of heavy-duty engines.

In addition to the broader equity areas discussed previously, the characteristics of the different manufacturers' product lines must also be considered. Probably the single most important consideration is the number of LDT, HDG, and HDD certification families of each manufacturer. Table 3 contains the number of families certified by each manufacturer for 1979. The number of families is especially important because it is a strong indicator of the flexibility available to the manufacturers for averaging emissions. Engines within a family are expected to have similar

Table 3

1979 Engine Families 1/

Manufacturer	LDT	LDDT	HDG	HDD
AMC	6	-	-	-
Caterpillar	-	-	-	11
Chrysler	6	-	2	-
Cummins	-	-	-	10
Deutz	-	-	-	2
Ford	5	-	6	-
GM	5	1	4	9
Hino	-	-	-	1
IHC	3	1	4	3
Isuzu	2	-	-	2
Iveco-Fiat	-	-	-	2
MAN	-	-	-	1
Mack	-	-	-	4
Mercedes	-	-	-	3
Mitsubishi	3	-	-	1
Nissan	2	-	-	-
Scania Vabis	-	-	-	1
Suzuki	1	-	-	-
Toyo Kogyo	2	-	-	-
Toyota	4	-	-	-
VW	3	1	-	-
Volvo	-	-	-	3
White	-	-	-	1

1/ Based on data gathered from EPA Certification Division.

emission characteristics, while engine families are expected to have different emission characteristics. A manufacturer with a variety of families will probably have some families from which reductions are easily obtained, and some other families whose emissions are much more difficult to reduce. This manufacturer will have more flexibility than a manufacturer whose product line is much smaller. Examples of this situation are demonstrated by Caterpillar and Mack in the HDD market and Ford and Chrysler in the HDG market.

A second area of product line characteristics which should be considered is the type of drivetrain (i.e. 2 wheel drive, 4 wheel drive) used in light-duty trucks. Since the LDT emission testing procedure is a vehicle test, the type of drivetrain is an important factor in the ability of the vehicle to meet the emission standards. Of the five major domestic manufacturers, all sell four wheel drive light-duty trucks but three also sell two-wheel drive LDTs.3/ Thus the manufacturers which sell only four wheel drive LDTs (AMC, IHC) may have less flexibility in complying with an averaging program than manufacturers which sell both two and four wheel drive LDTs. Table 4 contains a breakdown of the manufacturers by drivetrain type.

A third area of product line characteristics which should be considered is the engine size mix (See Table 4). This is especially true for LDTs which certify to a grams per mile standard. A manufacturer which has a limited product line, with primarily large engines, will be at a disadvantage when compared to a manufacturer which has a much more diverse engine size mix. For example, Chrysler has six engine families ranging from 225 CID to 360 CID while Ford has five engine families ranging from 300 CID to 460 CID.

The same argument might be made for heavy-duty engines, but the fact that the heavy-duty standards are on a g/bhp-hr basis somewhat decreases the inequity. A gram/brake-horsepower emission standard allows an engine which does more work (produces more power) to have a higher engine-out emission rate. As a general rule, as CID increases horsepower increases, but not at the same rate, so there is still the possibility that inequities could exist due to the need to average heavy-duty emissions on a mass basis.

A final product line characteristic which should be considered is the variety of vehicle inertia weights available for the producers of LDTs and the impact of these inertia weights on the emission levels (See Table 4). LDTs with higher inertia weights usually also have larger CID engines. These two factors together make it more difficult for the larger vehicles to meet a grams per mile emission standard. A manufacturer with a wide range of available inertia weights within each engine family and within a manufacturer's product line would have increased flexibility when compared with a manufacturer with a more limited product line.

Table 4

1979 LDT Fleet Characteristics 1/

Manufacturer	2WD	4WD	CID Range	Inertia Weight Classes Range
AMC		X	121-360	2950-5000
Chrysler	X	X	225-360	4000-5000
Ford	X	X	300-460	4000-6000
GM	X	X	250-454	4000-6000
IHC		X	196-345	4000-4500
Isuzu	X	X	111	2750-3000
Mitsubishi	X		122-156	2750
Nissan	X		119	2750-3500
Suzuki	X		49	2000-2250
Toyo Kogyo	X		120-140	3000
Toyota	X	X	134-258	2750-4500
VW	X		120	3500

1/ Based on data gather from EPA Certification Division.

2/ IHC certified two 2WD configurations in 1979, but sales were negligible.

4. Foreign and Domestic Manufacturers

The final potential inequity which needs consideration is the possibility that an averaging program might discriminate against either foreign or domestic manufacturers, by changing their relative market positions. Based on the number of families involved, it may appear that the relative position of the domestic manufacturers would improve. However, what must also be considered is the relative ease with which most of the imported LDTs meet the emission standards due to their smaller engine sizes and lighter vehicle inertia weights. In terms of diesels, the foreign manufacturers would not receive as much flexibility as the domestic manufacturers because of the smaller variety of engine families.

D. Environmental Impact

The implementation of an averaging program for light-duty trucks and heavy-duty engines may have both nationwide and localized air quality impacts which must be studied.

1. Nationwide Air Quality Impacts

Assessment of the impact of an averaging program on the national ambient air quality is directly tied to the change in the per vehicle emission rate which occurs as a result of going from the current approach to an averaging approach to compliance with the emission standard. The per vehicle emission rate, in turn, is tied to the low mileage production targets.

Several different factors may affect the low mileage targets. Obviously the most important factor which affects the value of the low mileage target is the actual value of the emission standard. Under the current approach, every vehicle must meet the emission standard. Consequently, the vehicle should be at or below the emission standard for its full useful life. Under some forms of averaging, only the average emissions of a manufacturer's production must be below the standard, so the overall fleetwide emission levels may be higher than under the current approach. This increase in overall emission rates would have unacceptable environmental consequences, so any averaging program which allows an increase in the average per vehicle lifetime emissions would not be acceptable.

The second factor which has a strong impact on the low mileage emission target is the deterioration factor. In the past engine out NOx emissions have shown little deterioration, but the use of add on devices (such as catalysts) to control NOx emissions may lead to an increase in this deterioration. This has generally been the case with EGR and 3-way catalyst systems. Under the current approach the compliance strategies for different families have been similar, so the deterioration factors have also been approximately the same value. However, under an averaging approach, the increased flexibility may allow a marked increase in the NOx control strategies used. This occurrence could lead to a change in the characteristically uniform values of most deterioration factors. This in turn would increase the potential that families with substantial deterioration will go undetected.

A third factor influencing the level of the low mileage target is the value of the acceptable quality level (AQL) which must be achieved during production. Under the current approach, a 10 percent AQL is required for heavy-duty engines and light-duty trucks. This 10 percent AQL requires that virtually all engines meet the emission standards. Variability during engine production will cause some uncertainty as to the ability of a manufacturer's families to pass assembly line testing. To account for this production variability manufacturers generally decrease low mileage targets by a small increment. In addition, it is often the case that manufacturers adjust their low mileage targets to provide themselves statistical confidence in their ability to pass assembly line testing. Under an averaging approach, if the 10 percent AQL is dropped or altered, the potential exists for a loss in air quality benefits due to the slight increase in the per vehicle emission rate. However, if the 10 percent AQL concept were retained under an averaging approach then the air quality benefits could be retained. This could be done if, for example, a 10 percent AQL were applied to each family emission limits.

In summary, three potential losses of emission reductions must be avoided. First, average per vehicle emissions over the useful life must remain below the applicable standard. Secondly, to retain the level of air quality benefits achieved under the current approach emissions deterioration must be closely monitored and controlled for all of the families included. And, finally, the "cushion" the manufacturers use because of the 10 percent AQL and assembly line testing must be retained. All of these components could be retained virtually intact if every family certified to some predetermined emission limit.

2. Localized Impacts

Local or perhaps regional impacts would occur if a disproportionate number of vehicles emitting above the emission standard were operated within a limited geographical area. There are several heavy-duty vehicle types which may have a tendency to be operated primarily within an urban area. The most logical example is transit buses used in urban/ metropolitan areas. In 1977 transit buses accounted for over 70 percent of all non-school buses.5/ These buses accumulate over 60 percent of their miles in urban areas.6/ Clearly, if diesel bus engines emit above any standard under averaging, the potential for air quality degradation exists. This problem is compounded by the fact that the number of transit buses in use should increase in the coming decade.

A second area of potential problems is medium-duty diesel trucks. These trucks are primarily Class VI (19,500-26,000 lb GVWR) and are primarily competing in the gasoline-powered heavy-duty truck and bus market. This class of vehicles is especially important for several reasons. Diesel engines used in this type of vehicle are high speed-low horsepower, with a tendency toward higher emissions, and a higher cost to reduce these emissions. It is quite likely that the engines in this type of vehicle would be certified above the standard. Another important aspect of the medium-duty diesel group is the percentage of the time which this type of vehicle spends in urban areas. Whereas the bulk of the heavy-duty diesel trucks accumulate less than 25 percent of their mileage in urban areas, medium-duty diesels accumulate about 35 percent of their mileage in urban areas.7/ Finally, both EPA and the manufacturers expect a marked increase in the use of diesel engines in Class VI trucks and buses. The percentage is expected to grow from 8 percent in 1978 to about 41 percent in 1988.8/ These three factors, inherently high emissions, greater than average urban vehicle miles, and increasing sales, may lead to localized negative air quality impacts.

A third group of vehicles which may impact local air quality is the heavier light-duty trucks (6,001-8,500 lb GVWR). Higher inertia weight trucks such as standard pick-ups and vans are used more in urban areas than their lighter inertia weight counterparts. This is primarily because these vehicles are used for business purposes such as hauling and delivery and not as much for personal transportation. The emissions from these heavier vehicles (especially those with larger CID engines) are more difficult to reduce than those from compact trucks and mini-vans. With the concentration of the heavier light-duty trucks in urban areas and their inherently higher emission rates, the potential exists for air quality degradation.

Finally, negative regional impacts associated with a concentration of light-duty trucks within a given area may occur. For example, cities such as Buffalo, Pittsburgh, and Cleveland which receive heavy snow falls and sometimes have quite hilly terrain, will have a larger concentration of four wheel drive (4WD) light trucks. The concentration of these vehicles in urban areas, and the slightly higher emissions of 4WD vehicles over their 2 wheel drive counterparts may lead to increased emissions in these areas over what would occur if every vehicle had to meet the emission standard. If averaging was being considered for light-duty vehicles, the effect of increased use of diesel engines in taxicab fleets would also have to be investigated.

3. Heavy-Duty Emissions

The fact that heavy-duty emission standards are on a g/bhp-hr basis introduces one additional complication under emissions averaging. Because the standard is based on a work amount, the engine which produces more horsepower and thus does more work, is allowed to have a larger amount of emissions in terms of mass. Thus, this engine could produce more emissions and do more useful work, but still have the same g/bhp-hr emission level as a different engine which produces less emissions and does less work.

The g/bhp-hr type of emission standard with its inherent trade-off between useful work and emission's mass already incorporates a form of averaging into the heavy-duty class. The larger more powerful heavy-duty engines which normally produce a greater mass of emissions than their smaller, less powerful counterparts are not penalized in demonstrating compliance with the emission standards, beacuse their greater emission's mass is offset by more horsepower. Conversely, however, this is not the case for vehicles such as light-duty trucks which must demonstrate compliance with a grams per mile emission standard. The larger vehicles/engines must comply with the same emission standards as their smaller counterparts. Each vehicle in the class is limited to the same amount of emissions per distance traveled. The larger vehicles/engines would have a more difficult time complying with the emission standards than their smaller counterparts. For vehicles classes complying with the grams per mile type of emission standards, averaging is especially advantageous because the smaller and larger vehicles/engines within the class can be offset against one another.

To protect air quality we would want to be sure that the total mass of emissions emitted did not increase under an averaging approach. Direct trade-offs by g/bhp-hr between two or more families would not provide this protection because the absolute mass of emissions per engine would vary from family to family.

To allow emissions averaging with heavy-duty engines under a g/bhp-hr emission standard, the averaging would have to be done using a mass-based system, for example, total grams of NOx per test or grams per mile of NOx based on some average emission factor or some average distance covered per test cycle. However, this could have the effect of decreasing the benefits some manufacturers could gain from an averaging program.

E. Technological Innovation

Although an averaging program will increase the manufacturer's compliance options, this flexibility will probably lead to a reduction in innovation in the emission control technology field. Any reduction in technology forcing is probably counter to Congress's intent in the provisions of the Clean Air Act. Averaging may discourage innovation, because of the emissions offset strategy available to the manufacturers. Instead of a manufacturer investing emission related R&D funds to attempt to bring every family into compliance, it will be able to offset higher emissions from some families with lower emissions from other families. This emissions offset option removes much of the incentive to reduce emissions from the higher emitting families. Implementing an averaging approach to compliance will also allow the manufacturers the option of manipulating the sales volume in each family to assure compliance with the standard and at the same time continue to permit the production of higher emitting families. The implementation of an averaging program may lead to stagnation in the drive to develop cleaner engines. Conversely, emissions averaging would allow the manufacturers to innovate on just a few engines in perhaps one family with little consequences from any failure.

As mentioned previously, technological innovation could probably be encouraged, if a system of banking and perhaps trading of emissions reductions could be included. This system could provide additional incentive to spur technological innovation.

F. Long Term Market Effects

As was shown in the equity discussion presented previously, the potential exists for market disruption due to the inherent characteristics of an averaging program. Under some averaging approaches, large and diverse manufacturers would have a clear advantage over small or more specialized manufacturers. If this discrepancy were to continue, the position of the large manufacturers in the marketplace would be enhanced as they used their greater resources and sales to manipulate the market. In the long term the sales of the more specialized companies could be decreased as a result of competition with a competing product from a larger manufacturer.

In the area of foreign versus domestic producers, it appears that an averaging program would favor domestic manufacturers. In the area of heavy-duty diesel engines, there is no doubt that the greater sales and diversification of the domestic producers would allow them to improve their market positions.

The domestic producers of light-duty trucks may be slightly favored under an averaging program due to their greater product diversification. This product diversification would allow them to use the lower emissions from their smaller trucks to offset the higher emissions from their larger trucks. Foreign manufacturers sell more limited product lines, and the characteristics of their vehicles and engines would probably allow all foreign manufacturers to meet the standards under the current approach or an averaging approach. Any averaging program should strive to minimize these equity concerns and the problems they create. However, a completely equitable emissions averaging program may not be possible.

V. Design Criteria for a Successful Averaging Program

Having identified the benefits and design considerations in an averaging program it is now possible to isolate specific design criteria which should ideally be met for a successful averaging program. These criteria have been determined primarily from the design considerations which were discussed in the preceding section, and are aimed at minimizing if not eliminating the potential problems of an emission control strategy based on averaging.

The design criteria identified are outlined below, together with an explanatory paragraph.

1. Any averaging approach implemented for mobile source emissions must have a valid legal base. The averaging approach must be consistent with the statutory requirements for setting standards, including the requirement in section 202(a)(1) to set standards applicable to emissions from "any class or classes of new motor vehicles or new motor vehicle engines." The averaging approach must adhere to statutory limits for the affected vehicle and engine classes.

2. Any averaging program ultimately implemented must be administratively practical and compatible with existing EPA programs. The program should be designed such that: compliance can be clearly determined, there is a point (or points) at which a manufacturer is held accountable for the emissions performance of its production, the sanctions (including NCPs) for noncompliance are clearly defined and the in-use emission program is not rendered ineffective. The concepts of family-based certification, assembly line testing (SEA), NCPs, Recall and I/M must remain relatively unchanged due to their critical role in the total mobile source control strategy.

3. Each family should have a fixed certification emission level which it must maintain throughout the model year at a high pass rate. This design criterion is necessary to ensure the continued effectiveness of certification, SEA, NCP, Recall, and I/M, as well as to assure consistency with the structure of the act. Without a fixed emission level, certification would be almost worthless, and enforcement and I/M would become virtually impossible.

4. Any averaging program must give equivalent air quality benefit to a nonaveraging approach and must not allow any substantial localized impacts. Air quality degradation can be minimized, if not eliminated, by establishing as strict an emission standard as feasible, and setting a maximum level on the emissions allowed from any family. This maximum level will especially address possible local impacts.

5. Any averaging program should be true "regulatory reform," it should make compliance less difficult for the industry and reduce compliance costs for consumers and industry alike. Changes, just for the sake of changing, do little more than cause confusion. Any averaging program should provide a substantial increase in flexibility as compared to the current approach. The program should be designed and implemented in as simple a manner as possible so as to, at the very least, not increase the administrative burden on the regulated industry or EPA. Above all, the average

per vehicle cost of compliance, including fixed costs, should not be higher than that for the current approach. An averaging approach should be at least as cost effective as compliance under the current approach.

6. An averaging program should not increase any manufacturer's economic jeopardy which might be caused by emission control regulations. EPA expects that manufacturers will easily be able to predict the emission levels of the families they certify, but sales projections eighteen or more months into the future are difficult. Some mechanism must be available to allow the manufacturers to accommodate errors in their sales projections. Also, the failure of an individual family in an assembly line testing (SEA) program should not jeopardize the production of other families. NCPs or perhaps other mechanisms could aid in minimizing jeopardy.

7. Any averaging program should benefit members of the regulated industry without causing a disproportionate level of advantage or disadvantage. Ideally, no competitor in the marketplace should have its relative position in the market significantly affected by emissions averaging. However, due to the characteristics of the manufacturers in the marketplace, it may not be possible to develop a completely equitable approach to emissions averaging. It is desirable, however, to provide increased flexibility to as many manufacturers as possible provided that significant marketplace disruptions do not occur in the short or long term.

References

1/ See 45 FR 14496, (March 5, 1980).

2/ See 44 FR 40784, (July 12, 1979) and 44 FR 9464, (February 13, 1979) for more information on in-use durability testing.

3/ Data gathered from EPA's Certification Division, and Summarized in 44 FR 42444, (July 19, 1979).

4/ Sales data was taken from MVMA data, R.L. Polk data published in Automotive News, and supplemented by conversations with manufacturers when necessary.

5/ Motor Vehicle Facts and Figures, 1978, MVMA data.

6/ EPA memo, Urban/Rural Vehicle Miles Travelled by Mobile Source Category, Marcia Williams, December 4, 1975.

7/ The Development of an Emission and Fuel Economy Computer Model for Heavy-Duty Trucks and Buses, John H. Johnson and Anil B. Jambekar, SAE paper 780630.

8/ Regulatory Analysis and Environmental Impact of Final Emission Regulations for 1984 and Later Model Year Heavy-Duty Engines, U.S. EPA, OMSAPC, December 1979.