Summary and Analysis of Comments to the Notice of Proposed Rulemaking:

"Evaporative Emission Regulation and Test Procedure for Gasoline-Fueled Heavy-Duty Vehicles"

April 30, 1980

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

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I. Introduction

The Environmental Protection Agency (EPA) published a Notice of Proposed Rulemaking (NPRM) on Wednesday, April 30, 1980. The NPRM proposed new regulations for the control of evaporative emissions from gasoline-fueled heavy-duty vehicles (HDGs). These proposed regulations included a 3.0 gram per test (g/test) standard to be implemented for 1983 and later model year HDGs. A public hearing on the NPRM was held Wednesday, June 25, 1980 at the Agency's Motor Vehicle Emissions Laboratory in Ann Arbor, Michigan.

This document summarizes and analyses the comments received at the public hearing as well as the final, written comments received after the public hearing. The NPRM, transcript of the public hearing, manufacturers' final, written comments, and all other relevant documents have been placed in the public docket for this rulemaking (Docket #OMSAPC-79-1). The public docket can be examined at EPA's Central Docket Section, W. Tower Lobby Gallery I, 401 M Street, S.W., Washington, D.C., 20460.

II. List of Commenters

1.	Chrysler Corporation	Chrysler
2.	Clayton Manufacturing Company	Clayton
3.	Ford Motor Company	Ford
4.	General Motors Corporation	GM
5.	Griffiths, Russell J.	
6.	Internatinal Harvester Corporation	IHC
7.	Motor Vehicle Manufacturers Association	MVMA
8.	National Automobile Dealers Association	NADA
9.	National Truck Equipment Association	NTEA
10.	Truck Body and Equipment Association	TBEA

A. Issue: Certification Procedure

Summary of Issue

The certification procedure proposed in the NPRM would have divided each manufacturer's product line into evaporative emission families and, then, subdivide these families into evaporative emission control systems. The criteria used to determine evaporative families were selected so that vehicles in the same family would be expected to emit about the same level of evaporative emissions if uncontrolled. To be classed in the same family, vehicles would have had to be identical with respect to nominal fuel tank capacity (within a 20 gallon or 25 percent range, whichever is greater) method of fuel/air metering (i.e., carburetion vs. fuel injection), and carburetor fuel bowl volume a 10cc range).

Evaporative emission familes would have been subdivided into evaporative emission control systems. The criteria used for this class- ification are parameters which affect the level of control of evaporative emission. To be classed in the same control system, vehicles would have to be identical with respect to the method of vapor storage, the vapor storage material, the vapor storage working capacity (within a 20-gram range). the method of purging stored vapors, and the method of carbuetor fuel bowl venting during both engine operation and engine off.

After a manufacturer's product line had been divided into evaporative families and systems, the Administrator would have selected one vehicle from each evaporative family-system combination for testing for evaporative emission data. The Administrator would also be able to select a maximum of two (2) additional vehicles within each evaporative emission family for testing.

Once the emission-data vehicle had been selected, the manufacturer would build and test the vehicles according to a full-SHED test procedure similar to the light-duty evaporative emissions test procedure. (See the issue titled "Test Procedure" in this document for a detailed discussion). The vehicle would be preconditioned over the proposed heavy-duty chassis driving cycle and then soaked indoors between 10 and 36 hours. After soaking, the fuel tank(s) would be drained and refilled to 40 percent capacity with chilled test fuel (60°F). Next, the vehicle would be pushed into the air-tight SHED (sealed housing for evaporative determination) and the 1-hour diurnal heat build would begin. During this part of the test, the fuel would be heated from 60°F to 84°F over a 1-hour period. At the end of the hour, the total grams of hydrocarbons (HC) emitted would be calculated from the concentrations of HC existing before and after the 1-hour diurnal heat build.

The next portion of the test consists of the vehicle being either pushed or driven onto a chassis dynamometer within 1 hour of the end of the diurnal portion of the test. The vehicle would then be operated over the heavy-duty chassis driving cycle. The purpose of this part of the test is threefold: 1) to warm-up the vehicle for the hot-soak test, 2) to purge the canisters and 3) to check running losses if necessary. After being driven over the cycle, the vehicle would be put back in the SHED (within ten minutes) where it is kept for one hour. At the end of the hour, the grams of HC emitted is calculated. This concludes the hotsoak portion of the test.

The grams of HC emitted during the diurnal heat build are added to the grams of HC from the hot-soak to arrive at the total test results. This total plus the d.f. would have to be less than the emission standard of 3.0 g/test.

Summary of Comments

Comments were received from the four primary HDG manufacturers (i.e., GM, Ford, Chrysler and IH), MVMA and two secondary manufacturer trade associations (i.e., Truck Body and Equipment Association (TBEA) and National Automobile Dealers Association (NADA)). MVMA, GM, Ford, IH and NADA all commented that EPA should form a joint Industry/EPA workgroup to develop a HDG evaporative emission test procedure. These commenters all suggest that a component test procedure could be developed which would correlate well with the full-SHED test procedure. They also suggest that in the interim EPA adopt an "engineering evaluation" type of certification procedure similar to that currently in use in California. Chrysler and TBEA commented that an "engineering evaluation" should be the final form of the regulation.

GM included a relatively detailed discussion of a component test procedure that it developed. GM's component test procedure is divided into seven parts which follow.

1. Diurnal losses from the fuel tank. Each different fuel tank would be mounted on a steel frame, placed in a SHED and filled to 40 percent capacity with chilled test fuel. Then the fuel would be heated in the same manner as a full-SHED diurnal test from 60°-84°F. The hydrocarbon (HC) emissions are calculated and the result would be the uncontrolled level of HC emissions from that fuel tank.

2. Storage system working capacity. The first part of this procedure is designed to equilibrate the storage system. In GM's case the storage system is a charcoal cannister. The canister is loaded with gasoline vapors and purged with air a total of 12 times. The loading consists of vapor being fed into the canister at a rate of 4 scfh for 10 minutes. Purging

consists of an air flow of 50 scfh for 20 minutes. The second part of this procedure establishes the working capacity of the storage system. The canister is loaded until a breakthrough of 2 grams HC occurs. Then the canister is weighed. Next, the canister is purged by a 15" Hg vacuum for 30 minutes. Finally, the purged canister is weighed. The weight difference between the loaded canister and the purged canister would be the storage system working capacity.

3. Regeneration of storage system. In this procedure an engine dynamometer test cycle (most probably the transient test cycle for exhaust emissions is used to purge the canister. After the canister is saturated to the 2 gram HC breakthrough level, it is purged with one engine test cycle. If the weight loss of the canister is greater than the grams of HC emitted during one carburetor hot-soak test (see below), then the purging system is deemed to work adequately for hot-soak emissions. After 3 engine dynamometer cycles, the weight loss must exceed the sum of the one fuel tank diurnal and one, one-hour carburetor hot-soak.

4. Carburetor hot-soak emissions. In this procedure the carburetor, its mounting gasket, air cleaner and storage canister are all connected to a steel frame in their relative positions and placed in a SHED. The carburetor is attached to a solid aluminum block which rests on an electric heat source. All elevations, angles and pressures that would occur if the system were on a vehicle would be maintained. After the canisters and/or carbon air cleaners had been purged with 3 engine dynamometer test cycles, the electric heater raises the temperature of the aluminum block which, in turn, raises the temperature of the fuel in the carburetor fuel bowl. The temperature profile of the fuel in the bowl would be the same as that for the fuel bowl on a vehicle during the 1-hour hot-soak part of the full-SHED test. The HC emissions are calculated after one hour and the heat source is turned off. The system is allowed to cool for 12 hours with the SHED open. During the twelfth hour the HC emissions from the cold carburetor assembly would be measured. These carburetor cold-soak emissions represent a measurable part of the full-SHED diurnal test.

5. Running losses. During engine operation all evaporative emissions should be consumed in the engine. Schematic layouts and designs of all liquid and vapor lines as well as gas cap seals and pressure relief valves should indicate adequate design against leakage. Fuel tank seams and fuel level gauge seals could be checked by an air pressure loss test.

6. Hose permeation (background). A 2 foot length of fuel hose is filled 75 percent full with test fuel and the ends are sealed. It is laid horizontally on a surface and weighed

daily for 2 weeks. The rate of weight loss between the third and sixth day is converted to an hourly rate per linear foot of internal wetted area. This is the cold-soak permeation rate. GM claims that experience has shown that a good rule of thumb is 2.5 X cold-soak permeation rate will be the hot-soak permeation rate. Thus, the "effective length" of liquid fuel lines is multiplied by 3.5 and the cold-soak permeation rate to obtain the test result. The "effective length" of a hose is the length between unsupported ends of the metal tubes or connectors.

7. Summation of component test data. The final part of GM's component test procedure is the manipulation of the above 6 parts to arrive at a total test result. The first step is to determine the full-SHED diurnal test estimate from the above component tests. The results of component test #1 (Diurnal Losses from the Fuel Tank) are added to the results of component test #4 (Carburetor Hot-Soak Emissions). This total should be less than the results of component test #2 (Storage System Working Capacity). If the summation of #1 and #4 is greater than #2 then the difference will be used in the full-SHED diurnal test estimate. Normally, however, the summation of #1 and #4 will be considerably less than #2. In this instance, #1 is to be multiplied by 0.7 percent and the result will be used in estimating the full-SHED diurnal test. GM claims that empirical analysis of its data indicates that activated carbon is only 99.3 percent effective in adsorbing HC; hence, 0.7 percent will escape. To this result is added the carburetor cold-soak losses and the cold hose permeation. The total represents GM's estimate of the diurnal portion of the full-SHED test.

An estimation of the hot-soak portion of the full-SHED test is obtained by adding the carburetor hot-soak emissions (component test #4) plus the hot-soak hose permeation (i.e., 2.5 X cold hose permeation). The summation of the full-SHED diurnal test estimate and the full-SHED hot-soak test estimate will give the final test result which, after compensating for a deterioration factor (d.f.) would be compared to the standard.

GM tested 2 vehicles (a heavy-duty pick-up and a C-7 series tractor) in a total of 5 configurations. GM tested each vehicle in an uncontrolled configuration and with a California control system installed. Additionally, the pick-up was tested with an activated charcoal ring in the air cleaner. Each configuration was tested by the full-SHED test and by GM's component test. GM claims that the results of its testing (shown in Table 1) indicate good correlation between its component test procedure and the full-SHED test procedure.

The Agency also received comments on the proposed method of vehicle classification and selection. GM stated that it fully supports the HDG selection criteria developed by MVMA and

Table 1

Full-SHED Test vs. GM's Component Test

	Diurnal (g/test) (background included)	Hot-Soak (gpt) (background included)	Total (g/test)
Pickup Uncontrolled:			
Component Test	36.25	9.93	46.18
Full-SHED Test	36.10	10.67	46.77
Pickup w/ 1979 System:			
Component Test	.52	1.39	1.91
Full-SHED Test	.52	1.27	1.79
Pickup w/ 1979 System plus charcoal in Air Cleaner:			
Component Test	.53	.96	1.48
Full-SHED Test	.53	.93	1.46
C-7 Tractor Uncontrolled:			
Component Test	50.18	15.68	65.86
Full-SHED Test	48.55	25.49	74.04
C-7 Tractor w/ 1980 System:			
Component Test	1.23	2.75	3.98
Full-SHED Test	1.58	4.80	6.38

submitted to EPA on July 10, 1978. That emission-data vehicle selection scheme is as follows:

1. Identify each basic type of carburetor design (e.g., 1V, 2V, 4V).

2. Combine each carburetor with the highest sales volume engine.

3. Match the above combinations with the highest sales volume configuration for each basic chassis type using the following selection criteria.

a. Select only two-axle vehicles.

b. If the chassis type is offered both as a complete (with body) and incomplete (chassis or chassis with cab) vehicle, select a completed version. If a complete vehicle is not offered, the chassis shall be tested in the incomplete configuration.

c. Select only gasoline-powered chassis types having an annual sales volume greater than 1000 units.

4. Select the highest sales volume fuel tank configuration for each of the above carburetor/engine/chassis combinations.

5. If sales of an optional, larger capacity fuel system exceeds 10 percent in the specific chassis selected in step 3, a duplicate vehicle incorporating that option may be tested.

If the MVMA selection procedure is not adopted then GM stated that only one additional emission-data vehicle should be selected per evaporative family instead of two as proposed. This selection would either be an expected highest emitter or a highest sales volume model. If the first selection for a family was on a sale volume basis, then the additional selection would be an expected highest emitter and vice-versa. GM also suggested that the range of the family determinant of carburetor fuel bowl volume be expanded from the proposed 10 cc's to 25 cc's. GM claimed that the proposed range is too small to allow the combination of any two carburetors into the same family.

GM and Ford commented that the vehicle classification system should be changed to allow "worst-case" vehicle testing. For example, one criterion of the proposal's evaporative emission family definition is that all vehicles within the same family must have the same fuel tank capacity (within 20 gallons, or within 25 percent, whichever is greater). GM stated that this could lead to unnecessary certification expense. GM claimed that if two vehicles were alike in all respects except fuel tank capacity, they would still be placed in separate families under the proposed classification scheme. GM claimed that there would be no need to test both the vehicles since testing of the "worst-case" (greater fuel tank capacity) vehicle would also determine compliance for the other vehicle. However, since the two vehicles would be in separate families each would need to be tested due to EPA's proposed classification system.

Another general area of comment concerned the "dieselization" of the heavy-duty vehicle market. GM, Ford and IH commented that the advantages of the diesel engine over the gasoline-fueled engine have caused and will continue to cause the decline of gasoline-fueled engines in heavy-duty vehicles. GM commented that as dieselization of the heavy-duty vehicle market increases, the cost burden for evaporative certification will become disproportionately higher and could force 100 percent dieselization. GM included two magazine articles which describe increased dieselization. However, GM did not make any specific predictions as to when and how much dieselization of the heavy-duty vehicle classes it expects.

Ford's comments on dieselization were more substantive than GM's. Ford's discussion on dieselization included Classes IV-VIII (14,001 lbs. and above GVW) only. The manufacturer stated that in 1973 gasoline-fueled engines accounted for 62 percent of new, Class IV-VIII sales. By 1979 that percentage had fallen to 41 percent. Ford projected that by 1984 the percent of gasoline-fueled engines in new, Class IV-VIII heavy-duty vehicles will be between 16 and 25 percent. Ford stated that since the number of new, gasoline-fueled, heavy-duty vehicles over 14,000 lbs. GVW will decline substantially, the proposed regulation for these classes of HDGs is an unnecessary cost burden. Ford claimed, therefore, that Class IV and above HDGs should be exempt from any evaporative emission regulation.

IH suggested that EPA split HDGs at the 16,000 lb. GVW point. The 212,382 units per year below 16,000 lbs. GVW could be certified by the LDT test procedure while the 156,419 non-California units above 16,000 lbs. GVW could be certified by a component test procedure. IH claims that HDGs above 16,000 GVW will decline substantially due to dieselization which is accelerated by government regulation of the HDG industry.

GM claimed that the proposed certification procedure would cause the manufacturers to test, by an order of magnitude, more HDGs relative to the market than they currently test for LDVs or LDTs. GM stated that this disproportionate burden should be corrected.

GM, Chrysler and MVMA commented that EPA should include an exception for low sales volume models in the final regulations. GM proposed that all HDG evaporative family-system combinations which are less than 3 percent of total HDG production be certified by "design analysis," provided that all such family-systems combined total less than 10 percent of the manufacturer's total sales of HDGs. Chrysler suggested that all models with sales of 300 or less be exempt. MVMA agreed with GM that evaporative emission family-system combinations whose projected sales volume was below a certain percent (MVMA did not propose a percent level) should be certified by "engineering evaluations."

Ford and IH stated that they each introduce new, heavy-duty vehicle models in September of each year but don't introduce new, heavy-duty engine models until December or January. They claimed that it would be an excessive burden to have to develop and certify their vehicles for both introduction periods. Ford recommended that this evaporative emission regulation be applicable to engine Job #1 dates so as to coincide with exhaust emission requirements. MVMA stated that this model introduction offset is needed to use up engine stock effectively.

GM and MVMA requested special certification procedures for certain special situations. They commented that Special Equipment Option (SEO) orders are very small volumes and should be handled by special procedures. SEOs are custom-built vehicles where the engine/fuel tank combinations are not a normal part of the production line. Additionally, GM and MVMA requested exemptions for those vehicles where the ultimate fuel system is destined to be liquid propane gas even though such vehicles leave the manufacturer's plant as gasoline-fueled vehicles. The commenters claim it is unnecessary to have to charge the customer for an evaporative control system that will never be used.

IH requested that if these HDG evaporative emission regulations cause HDG engine compliance testing to be required, then such engine compliance testing should be done by either Subpart D or Subpart H at the manufacturer's option. IH claimed that it would have carried over its engines' certifications into 1984 as it has been doing. If IH is required to recertify its engine families according to Subpart H they would not pass because they were originally certified under Subpart D. Thus, IH would have to develop its engine line to comply for the 1983 model year and again for 1984 when the transient test for heavy-duty engines becomes effective; an excessive and untenable burden.

Discussion and Analysis of Comments

Introduction

In general, the commenters did not believe that the proposed certification procedure was best. They stated that the cost of that proposed procedure was excessive in relation to the benefits to be gained. They recommended that EPA adopt either a component test procedure developed by an Industry/EPA work group or an "engineering evaluation" type of certification procedure (or in some instances a mixture of the two). They claimed these alternative certification programs would be much less expensive yet would still assure EPA of good control of HDG evaporative emissions. The commenters also had specific suggestions to improve the proposed certification procedure. EPA has incorporated many of these suggestions into its recommended certification program.

This discussion will first describe and analyze five different certification scenarios. They are: 1) the proposal scenario (ie., the certification procedure described in the Notice of Proposed Rulemaking (NPRM) that was published April 30, 1980), 2) a California-type engineering evaluation, 3) a component/mini-SHED procedure, 4) a revised proposal scenario and, 5) an abbreviated certification procedure. Theoretically, the best certification procedure is the one that gives the highest benefit-to-cost ratio. However, it is often difficult, if not impossible, to accurately assess the cost of all the different aspects of a program. For example, an accurate cost assessment of research and development efforts under each scenario would be very laborious. Furthermore, estimating benefits can be very difficult. The benefits of the Proposal scenario can be estimated with a fair amount of confidence since there is considerable experience from light-duty vehicle evaporative emission control using a similar certification scenario. But there is very limited data on the emission levels from a component/mini-SHED certification procedure. Emission levels might be accurately estimated if large testing programs were undertaken but such testing programs would probably cost more than they are worth. Some aspects of this issue simply do not readily lend themselves to economic interpretation. Examples include the question of manufacturers' equity and the need for a testing program that yields a discreet, emissions number for use in long-term, nationwide, air quality planning.

The following discussion and analysis will use quantitative benefit and cost analysis when possible. However, qualitative analysis must also be used to arrive at the recommendation. The discussion will be divided into four major parts. The first section will discribe each of the five alternative certification scenarios. The next section will present the advantages and disadvantages of each alternative.

The third section will compare and contrast the alternatives while the final section will present the conclusions and recommendations for the final evaporative emission certification procedure.

Certification Procedures Considered

The Proposal Certification Procedure. The description of this first alternative was presented above under the section titled "Summary of Issue." The reader is referred back to that section for a review of the certification procedure that was proposed.

A California-Type Engineering Evaluation. Currently, the state of California's Air Resources Board (CARB) requires that all HDGs be equipped with evaporative emission control systems (EECS). Under the CARB regulation manufactures submit schematic drawings of the different EECSs that they plan to put on their HDGs. The manufacturers also describe their different HDGs in regards to parameters expected to affect evaporative emissions. For example, they submit information on the different fuel tank capacities and combinations they expect to sell with their HDGs. The manufacturers then discuss why the EECSs they have designed should control HDG evaporative emissions to a level equivalent to that of light-duty. (2.0 g/test is the current light-duty standard.)

One way they can show equivalency is if the EECS is currently being used on LDTs. If the control system is essentially the same as one already on LDTs, then CARB will accept it as long as the manufacturer accounts for any major differences between the LDTs and the HDGs. For example, the HDG may be virtually the same as the LDT in regards to parameters that affect evaporative emissions except for the total fuel tank capacity. In this case, the manufacturer might either show that the charcoal canisters used in the LDT EECS have sufficient working capacity to handle the extra emissions from the larger fuel tank(s) or he might present a logical arguement showing that he has increased the canister(s) working capacity enough to handle the extra emissions.

Under CARB's HDG evaporative program, manufacturers are not required to do any testing of the EECSs. However, some manufacturers do limited testing in order to show that their systems are controlling to a level equivalent to light-duty. For instance, Ford used a component test in an attempt to show that their EECSs were providing adequate control of HDG evaporative emissions. Ford placed the fuel tank(s) and its evaporative control system (ie., canister(s), tubing and valves) in a light-duty SHED. Heating blankets were placed under the fuel tank(s) to heat the fuel from 60°F to 84°F over a 1-hour period and emissions were calculated. This represented the diurnal part of the full-SHED test. Next, the carburetor was placed in the light-duty SHED along with its evaporative emisson control system. The fuel in the carburetor fuel bowl was heated to simulate the temperature profile that would occur during the hot-soak portion of the full-SHED test and the emissions were calculated after one hour. Finally, the results from the two component tests (plus a background factor) were summed to obtain the total test results. Ford claimed that this component test correlated well with the full-SHED test and that since the results of this component test were quite low (from .7783 grams to 1.098 grams), Ford concluded that the control systems were doing an excellent job.

After the manufacturers submit their schematics, discussions, arguements and/or test data, CARB reviews it and certifies the control systems. This "engineering evaluation" is intended to encourage the manufacturer to design HDG EECSs to control evaporative emissions to a level of about 2.0 grams per SHED test. Actual confirmatory SHED testing by CARB is not allowed. The "engineering evaluation" procedure considered in this discussion of alternate certification procedures will be this CARB procedure.

Component/Mini-SHED Procedure. All of the commenters (except Chrysler) stated that the final certification procedure should have at its core a component/mini-SHED test procedure. The basic concept of a component/mini-SHED test procedure is that rather than test an entire vehicle with its associated evaporative emission control system in a full-sized HDG SHED, the different subsystems of the control system would be tested individually with their associated vehicle parts. For example, the subsystem used to control emissions from the fuel tank(s) might be tested by itself. The fuel tank(s) and the control sub-system are attached to a frame and placed in a SHED where the diurnal test is run. These component tests would be done in a light-duty SHED or even in a smaller, less expensive SHED (mini-SHED). Any vehicle's emission level could be determined by the summation of the test results for that vehicle's components.

As described in the "Summary of Comments" of this issue, GM has developed a component/mini-SHED test procedure. To summarize that procedure, GM suggests dividing the full-SHED test procedure into seven component tests which are as follows: 1) diurnal losses from the fuel tank(s), 2) storage system working capacity, 3) regeneration of the storage system, 4) carburetor hot-soak emissions, 5) carburetor cold-soak emissions, 6) running losses, and 7) hose permeation.

Instead of testing an emission-data vehicle as a whole, only the above component tests would be run. After determining that the storage system working capacity and regeneration are adequate, the diurnal losses, carburetor hot-soak losses, carburetor cold-soak losses, and hose permeation are summed.

This result would then be compared to the standard (which is based on the full-SHED test) to determine compliance. (Running losses should only rarely occur and are checked by design analysis and pressure checks.)

Ford has also developed a component/mini-SHED procedure. Ford developed it in early 1978 for the purpose of complying with CARB's HDG evaporative emission regulation. It is simpler than GM's and consists of only two parts: the diurnal test for fuel tank(s) loses and the hot-soak test for carburetor losses.

The vehicle classification (into families and systems) and emission-data vehicle selection procedures would remain the same as they were under the proposal certification procedure. GM commented that only one additional emission-data vehicle per evaporative emission family should be tested (instead of two) and GM and Ford both suggested that the definition of a family should be changed to allow the testing of "worst case" vehicles only. The EPA staff believes that since there is a lack of data correlating a component/mini-SHED test procedure to the full-SHED test procedure, the increased certification testing resulting from retention of the proposed family-system definitions will be somewhat compensatory. Therefore, the vehicle classification and selection procedures for this alternative certification procedure will be the same as the Proposal. However, the advantages and disadvantages of an alternative vehicle classification and selection scheme will be discussed in the next section.

<u>The Revised Proposal Certification Procedure</u>. In an effort to reduce the certification burden, the staff has reconsidered the proposed certification program. The staff believes that the following revised certification program would substantially reduce the time and cost of HDG evaporative emission certification while retaining most, if not all, of the air quality benefits of the originally proposed program. This revision has evolved from written comments, oral comments at the public hearings, conversations with the California Air Resources Board (CARB) and conversations with manufacturers. It is a combination of the proposed certification plan, the California-type engineering evaluation and the component/mini-SHED testing concept.

The staff believes that Class VII (26,001-33,000 lbs. Gross Vehicle Weight (GVW)) HDGs and Class VIII (33,001 lbs. and above GVW) HDGs should be exempt from evaporative emission testing. These two classes of HDGs would still require evaporative emission control systems but certification would be based on an engineering evaluation procedure similar to CARB's. As discussed in Chapter III of the "Regulatory Support Document" for this rulemaking (see the docket), these two classes of HDGs represent a small portion of new HDGs sold each year. In 1979, there were only about 19,000 Class VII HDGs sold. In 1989, EPA projects that new Class VII vehicles will be virtually all diesel-powered. Since this regulation will be implemented in 1985, there will be four model years (1985, 1986, 1987, and 1988) that Class VII HDGs will still be sold. EPA expects that the total number of new, Class VII, heavy-duty gasoline-fueled vehicles sold during model years 1985-1988 inclusive will be approximately 10,800. This represents less than 1 percent of all HDGs sold during this period.

EPA projects that there will be virtually no new sales of Class VIII HDGs for model years 1984 and beyond. Thus, exempting this class of HDGs from certification testing requirements should have no impact on air quality.

Since sales of new Class VIII HDGs are expected to be nonexistent in 1985 and sales of new Class VII HDGs should virtually disappear by 1989, the certification of the evaporative emission control systems for the few new Class VII and VIII HDGs that are produced should be as inexpensive as possible. The engineering evaluation procedure would assure the Agency that these vehicles have control systems that are comparable to the ones found on Class VI (19,501-26,000 lbs. GVW) HDGs. If the maximum carburetor fuel bowl capacity and/or maximum fuel tank(s) capacity offered by a manufacturer (HDGs only) is only offered on a Class VII or VIII HDG, then the manufacturer would have to insure that the vapor storage device(s) has sufficient working capacity to store the evaporative emissions. The manufacturers would submit schematics of components and designs showing that the control systems for their Class VII and VIII HDGs are as effective as those on their Class VI and lighter HDGs.

The revised certification procedure for Class VI and lighter HDGs is a combination of the proposed full-SHED procedure and the component/mini-SHED procedure. This revised certification program would test an entire vehicle according to the full-SHED procedure but the vehicle tested would be a "worst case" vehicle. "Worst case" components would be selected, installed on a "worst case" vehicle, and tested. Less than "worst case" vehicle components would not need to be tested thus saving development and certification effort.

Under this revised certification program a manufacturer's product line would be divided into evaporative emission families and then those familes would be subdivided into evaporative emission control systems. Family differentiation would be very simple. All vehicles which have the same method of fuel/air metering (i.e., fuel injection vs. carburetion) and have the same carburetor fuel bowl volume (within a 10 cc range if applicable) would be an evaporative emission family. These evaporative family criteria are the same as those in the proposal except that the proposal included total fuel tank capacity (within a 20 gallon range or 25 percent, whichever is greater) as a family determinant. As will be discussed later, total fuel tank capacity is still considered in this revised certification program.

To be classed in the same evaporative emission control system, vehicles would have to be identical with respect to the method of vapor storage, the method of carburetor sealing, the method of air cleaner sealing, the vapor storage working capacity (within 20 grams), the number of storage devices, the method of purging stored vapors, the specifications of the purge system, the method of venting the carburetor during both engine off and engine operation, and the liquid fuel hose material. This classification scheme for evaporative emission control systems is essentially the same as the proposed scheme except more detailed and comprehensive. The objective of this classification scheme is to include all parameters which may be expected to significantly affect evaporative emission control.

Once a manufacturer's product line had been divided into evaporative emission family-system combinations, the manufacturer would select a "worst case" vehicle for emission-data testing from each family-system combination. The criteria for selecting a "worst case" fall into two categories: 1) criteria that are model-dependent and 2) criteria that are not model-dependent. A criterion would be defined as model-dependent if, in selecting the "worst case" situation for that criterion, the only vehicles considered are those of a particular model or models rather than all of the vehicles in the entire family-system combination. This definition will become clearer in the discussion and examples that follow.

The first criterion for the selection of a worst case emission-date vehicle is total fuel tank capacity. This criterion is not model dependent, that is, the manufacturer would consider all vehicles (and options for those vehicles) of the entire family-system combination and then select that fuel tank or fuel tank combination which has the largest total capacity. The next criterion, length of nonmetal fuel hose, is also not model-dependent. The manufacturer would consider all vehicles of the family-system combination and choose the maximum length of nonmetal fuel hose. Only fuel hose that carries liquid fuel would be considered since the permeation rate of fuel vapors through fuel hose is considered negligible.

The final criterion which is not model-dependent is the maximum exposure of the nonmetal fuel hose to heat from the exhaust system and other sources. The manufacturer would review the fuel hose routing on all of the models of the family-system combination. He would then select that routing which exposes the fuel hose to the greatest amount of heat. Although the manufacturer would use his engineering judgment to decide which routing is "worst case," he would still submit to

EPA the fuel hose routing diagrams for all of the different vehicles within the familysystem combination showing heat sources as well as the fuel hose routing. The Agency would reserve the option of selecting a different fuel hose routing if it considers such routing to be exposed to more heat than the routing selected by the manufacturer.

In summary, the manufacturer would consider all vehicles of each evaporative emission family-evaporative emission control system which he wishes to market. He would determine the maximum fuel tank capacity, the maximum length of nonmetal fuel hose and the fuel hose routing which exposes the fuel hose to the most heat. These three criteria would be incorporated onto the emission-data vehicle once it is built. The following discussion explains the selection of the emission-data vehicles.

After having selected the above criteria which are not model-dependent, the manufacturer would next select the "worst case" model on which to install those selections. First, the manufacturer would list all models of the evaporative family-system onto which the previously selected largest maximum fuel tank or fuel tank combination can be installed. Models to be considered are not limited to only those models where the manufacturer would normally offer the previously selected largest fuel tank or fuel tank combination. Any model that can reasonably be expected to accomodate the selected fuel tank or fuel tank combination shall be listed. Reasonableness includes consideration of safety and testing facility limitations. Furthermore, in considering whether or not a fuel tank(s) can be installed on a model (for the purposes of this regulation) the fuel tank(s) proximity to exhaust system heat must be approximately maintained.

From this list of models the manufacturer would select that model having the highest Gross Vehicle Weight Rating (GVWR) up to 26,000 lbs. This will be the model of the emission-data vehicle build. If more than one model fits the above conditions, then the selection of the model of emission-data vehicle would be based on first, the proximity of the fuel tank(s) to exhaust system heat and secondly, the engine compartment size, (i.e., the model with the smallest engine compartment would be considered "worst case").

After the "worst case" model had been selected, the manufacturer would install the previously selected "worst case" fuel tank(s) on a vehicle of that model. He would also install the previously selected "worst case" length of fuel hosing in accordance with the previously selected route that exposed the fuel hosing to the most heat. The resulting vehicle would be the emission-data vehicle for that evaporative family-system.

Once the emission-data vehicle had been selected and built, it would be tested according to the proposed full-SHED test procedure (except for changes discussed in this document under the issue entitled "Test Procedure"). Thus, although the test procedure and standard would not change substantially, this revised vehicle classification and selection procedure would substantially reduce the burden of certification by establishing fewer evaporative family-systems and, thereby, would require less developmental and certification testing effort. This reduction of the certification burden will be discussed in detail in the next section.

After the manufacturer had tested its product line it would submit the test data to EPA. EPA would then review the data. The rest of the certification procedure would parallel the light-duty procedure in that EPA could immediately issue a certificate, or could request additional data or could do confirmatory testing. Each manufacturer would have to establish a deterioration factor (d.f.) as proposed in the NPRM. Each manufacturer would be free to develop its own test procedure for deterioration (which would be submitted with its Part I application) but that test procedure would have to include an evaluation of the effects of vibration, the vapor load-purge cycling of the vapor control system, and the aging effects of heat and ozone.

Abbreviated Certification. This certification procedure is the simplest of the five alternatives considered. Abbreviated Certification would establish a 3.0/4.0 g/test standard and the test procedure discussed earlier under the Proposal and Revised Proposal certification alternatives. (For a detailed description of this test procedure, see the issue titled "Test Procedure" in this document.) Also, the evaporative emission family-control system vehicle classification scheme discussed under the Revised Proposal alternative would be used for this alternative. The difference is that manufacturers would not need to submit any test data or engineering evaluation to show that their evaporative emission control system met the standard. Instead, manufacturers would be required to submit a written statement that their HDGs would meet the appropriate standard if tested in the case of Class IIB through VI HDGs and that their control systems are designed to meet a 4.0 g/test standard for Class VII and VIII HDGs. Although EPA would retain the option to deny certification and/or to do confirmatory testing, we would not expect to actually do any since we are confident that the manufacturers can easily meet the 3.0/4.0 g/test standard. Given that: 1) the standards are not as stringent as proposed, 2) the technology is straightforward and 3) there exists a great amount of directly applicable experience from LDT evaporative emission control, we believe that the manufacturers will be able to install their systems on HDGs and be fairly confident of meeting the standards. Furthermore, while the manufacturers would still be required to develop their own procedures for determining d.f.s and such procedures would still need to account for the effects of vibration, ozone, heat and vapor load-purge cycling, they would not be required to submit the d.f. test procedures or the established d.f.s but would themselves apply the d.f.s to their test data. Their statements of compliance would include the d.f. calculation. Negative d.f.s would not be allowed.

Advantages and Disadvantages of the Alternatives

In order to compare the different certification alternatives, the level of emission control will be expressed in terms of a full-SHED test even though the California-type Engineering Evaluation and the component/mini-SHED procedures do not incorporate that test procedure. The estimated level of control from these two procedures will be expressed in terms of a full-SHED test.

Also, the cost estimates included in this analysis were based on an implementation date of the start of the 1984 model year. Since those estimates were made the implementation date has been changed to the start of the 1985 model year. However, since these cost estimates do not change significantly with the one-year delay in implementation, EPA has not recalculated them.

Since the standard in this Final Rule is a split standard (3.0 g/test for HDGs with GVWs 14,000 lbs. and below and 4.0 g/test for HDGs with GVWs greater than 14,000 lbs), we have calculated a single number based on the expected future sales split between these two groups of HDGs. Our projected sales split indicates that 53.3 percent of future HDG sales will be vehicles with GVWs less than 14,000 lbs. which leaves 46.7 percent greater than 14,000 lbs. GVW. By applying these percentages to the appropriate part of the split standard we arrive at a single, combined sales-weighted standard of 3.47 g/test. This number will be used through out this discussion to estimate certification control levels.

The Proposal Certification Procedure. Of the five certification alternatives considered, the procedure proposed in the NPRM would control HDG evaporative emissions by the greatest degree. This procedure would control new HDG evaporative emissions to a level below the standard of 3.0/4.0 grams per full-SHED test (g/test). Manufacturers must account for test-to-test, lab-to-lab, and production variability. They must provide a margin for the deterioration factor (df) and for their own protection. For model year 1981, light-duty trucks (LDTs) had to meet a 2.0 g/test evaporative emission standard. A review of the 1981 LDT certification data shows that the actual average emission level was 1.19 g/test. This is 40.5 percent below the standard. We will assume that the average certification value for HDGs will also be 40.5 percent below the actual standard. Thus, the application of the above LDT ratio (1.19 g/test:2.0 g/test) to the HDG standard yields a control level of 2.06 g/test for new vehicles. This level of control will be compared to the control levels of the other certification procedures as part of the process of selecting the best certification procedure.

Not only is the level of control the greatest for the proposal certification procedure, but the confidence in this level of control is highest too. In controlling a relatively minor mobile source of hydrocarbons such as HDG evaporative emissions, the in-use level of emissions must be estimated from the certification level because little in-use testing is done. In-use emission levels are used in projections of future air quality. These projections can be on a local or regional scale and are important for planning future control strategies. By studying these projections of future air quality, planners determine which pollution sources, if any, should be controlled and to what level. For light-duty vehicles (LDVs), evaporative emission factor programs and extensive in-use testing are used to obtain reliable in-use emission levels. But since HDG evaporative emissions are fairly small, the expense for an in-use testing program will likely be prohibitive. Thus, in-use emission levels will have to be estimated from certification data. The proposal procedure with its associated full-SHED test procedure will give hard numbers from which in-use emission levels can be estimated. Furthermore, since this certification procedure requires the greatest number of emission-data vehicles to be tested, the confidence in the emission levels thus obtained is greater than the other certification alternatives.

Another advantage of this certification procedure is that the full-SHED test procedure is well known. This test procedure has been used for evaporative certification of LDVs for many years. All four HDG manufacturers and EPA are very familiar with it. In implementing this test procedure for HDG evaporative emission certification, a minimum of effort would be needed to initiate the manufacturers and EPA as to how to run the test, how to interpret the data and what kind of problems to expect. The component/mini-SHED and the engineering evaluation certification procedures would require substantially more learning and debugging effort to put in place.

Another advantage of the Proposal certification procedure is its objectivity which is important in a certification program for two reasons. First, EPA must, for obvious reasons, treat all manufacturers equally. Therefore, a certification procedure should have minimal subjectivity since therein lies the potential for inequity. Two EPA reviewers could analyze the same application and make different determinations on subjective portions. (Due to the large number of different vehicles involved and due to the fact that future vehicle configurations and technology are difficult to predict, some measure of subjectivity is usually necessary to maintain flexibility.) The second reason that objectivity is important is that EPA has been attempting to move towards manufacturer self-certification. This will reduce required government effort, give manufacturers better control of their certification programs, and make certification more cost effective. In a self-certification program, subjectivity must be kept to a minimum not only to ensure manufacturer equity but also to assure EPA that control of emissions is not being compromised by manufacturer interpretation.

The vehicle classification and selection criteria for the five certification procedures considered are about the same with repect to objectivity. The criteria for vehicle classification are quite specific. The criteria for emission-data vehicle selection do involve analysis and judgment on EPA's part. For example, under the proposal procedure, EPA would have the option of selecting up to two additional emission-data vehicles from each evaporative emission family after one emission-data vehicle per family-system had been selected. The proposal intentionally leaves open the method that EPA would use to select these two additional emission data vehicles. EPA might choose one or both on the basis of highest expected sales or on the basis of highest expected emissions. All of the certification procedures are potentially subjective in this regard. Vehicle selection will be addressed further under the Revised Proposal certification procedure.

Beyond vehicle classification and selection, the test procedure segment of a certification procedure will have varying degrees of objectivity. The full-SHED test procedure is well defined and yields a discrete number which can be directly compared to a standard. While some test-to-test variability still exists it is small due to the experience gained from years of attempting to reduce such variability.

The major disadvantage of the Proposal certification procedure is cost. Of the five alternative procedures considered, it is the most costly. The manufacturers included cost estimates for the proposal procedure in their final, written comments. These estimates are presented and discussed as "Issue F: Cost" in the "Summary and Analysis of Comments" to this rulemaking (in this document). The cost of this HDG evaporative emission rulemaking can be divided as follows: 1) testing facility and equipment costs, 2) research and development costs, 3) certification costs, and 4) control hardware costs. We have assumed that the control hardware costs will be about the same for all four certification alternatives, and therefore, need not be addressed for the purpose of comparing these alternatives. As shown in the "Summary and Analysis of Comments," the manufacturers' estimated total cost for testing facilities and equipment, research and development and certification under the proposal procedure is about $25M.

Another disadvantage to the Proposal certification procedure is that it would require the greatest amount of leadtime of the four alternatives. As discussed under the issue entitled "Leadtime" (in this document), GM and Ford project that 34 and 30 months, respectively, would be required from the date of publication for implementation. This time would be needed to build new facilities, to install test equipment, and to do development and certification testing.

The background or nonfuel emissions problem is worst with the proposal certification alternatives. This problem is discussed in detail under the issue entitled "Technical Feasibility" (in this document). To briefly summarize that discussion, new vehicles emit evaporative emissions from sources such as new paint, sound deadeners, lubricants, and tires. The level of evaporative emissions from these sources decreases rapidly over time and, after about two months, stabilizes. Manufacturers are allowed to age emission-data vehicles both naturally and artificially (i.e., by baking or driving the vehicle) to stabilize background emissions before testing. Furthermore, manufacturers are allowed to omit these sources of background emissions if they can. The LDV, LDT and HDG evaporative emission standards account for the stabilized level of background evaporative emissions. The biggest problem is that Selective Enforcement Audits (SEAs), which attempt to test production vehicles, become very cumbersome because of these background emissions. It is impractical to select a vehicle for an SEA and then have to wait a month or two for the background emissions to stabilize before testing that vehicle. The manner in which the California-type engineering evaluation or the component/mini-SHED certification procedures could alleviate this problem will be discussed below.

<u>The California-Type Engineering Evaluation</u>

The greatest advantage of this certification procedure over the other procedures is its cost. This procedure is the least expensive of the four alternatives considered. While the other procedures would require the manufacturers to build new facilities and/or purchase testing equipment, this procedure would only require that the manufacturers show by engineering evaluation that its evaporative emission control systems will control emissions to a level equivalent to LDTs. The other procedures would require some development effort with its associated testing expense. This procedure would allow the manufacturer to simply install its LDT control systems on its HDGs as long as it accounts for any major differences between the vehicle classes. The major expense (besides the hardware costs) of this certification procedure would be the man-hours involved in drawing up schematics of control systems and components and in presenting evaluations that attempt to show control systems to be adequate.

Estimates of the cost of an "engineering evaluation" certification procedure are difficult because of the lack of experience with such a procedure and because the expenses involved are difficult to quantify. For example, there may well be a substantial amount of paperwork involved but the number of hours is very difficult to determine. Although conceivably the manufacturers would not have to do any testing under this certification procedure, it is probable that some component testing would be done to generate test data in support of the engineering evaluations. If we assume that the two smaller HDG manufacturers (Chrysler and IH) purchase one mini-SHED each (with associated analysing and recording instruments) and the two larger manufacturers (GM and Ford) purchase two mini-SHEDs apiece, then total equipment costs for this certification procedure would be 6 x $30,000 = $180,000.

This certification procedure would cause somewhat more paperwork than the other procedures and there will probably be some limited amount of development testing that the manufacturers will do. We will assume these costs total about $320,000 thereby bringing the total cost of this certification procedure (excluding hardware) to about $0.5M.

Another advantage to this procedure is that leadtime is minimal. There is no question that the manufacturers could install evaporative emission control systems on their 1984 HDGs. The manufacturers have indicated as much.

This California-type engineering evaluation would reduce the incomplete vehicle problem greatly. The primary manufacturer would certify only those vehicles which he actually produces. The secondary manufacturer would submit its own engineering evaluation to EPA showing that the additions or modifications it made to the original vehicle do not cause that vehicle to emit evaporative emissions at levels higher than LDTs. For example, if the secondary manufacturer adds fuel tanks to an incomplete vehicle, then it would attempt to show, through an engineering evaluation, that the charcoal canister(s) have sufficient capacity to handle the evaporative emissions from those fuel tanks. Since no testing is required and the primary manufacturer would still supply a complete control system, the burden on the secondary manufacturer would be limited to the paperwork needed for the engineering evaluation.

The background emissions problem disappears under this certification procedure. Since there is no testing required, actual emissions (background or otherwise) are never measured and, therefore, do not pose a problem. However, SEAs and NCPs are not possible under this certification procedure since actual test numbers are required for such programs.

A major disadvantage to this certification procedure is that the level of control would probably be the worst of the five alternatives considered. California has required evaporative emission controls on HDGs since 1978. The actual emission levels (in terms of a full-SHED test) of these vehicles was previously unknown because the California procedure does not require the manufacturer to test vehicles nor does it allow CARB to test vehicles for compliance. In their final written comments to this proposed rulemaking several manufacturers submitted data from full-SHED tests of HDGs with certified California evaporative emission control systems. From these test results we have estimated what the level of evaporative emissions from HDGs would be under a California-type engineering evaluation certification procedure.

Ford undertook the most ambitious testing program. It ran a total of 126 full-SHED tests which were split among four trucks. Each truck was tested under various prep cycles, inertia weights and dynamometer horsepower settings. Only those valid tests where the prep cycle was the proposed heavy-duty driving cycle and the control system was the California system were included in the following average because it is our intent to evaluate only the level of emissions from California control systems when tested by the proposed, full-SHED test procedure. The average emission level of the 47 tests which meet the above criteria is 3.35 g/test.

GM tested two HDGs with California control systems. Since GM does not have a heavy-duty chassis dynamometer, it used a road-route for the preconditioning and driving cycle parts of the test. GM patterned the road-route after the heavy-duty driving schedule in order to simulate as close as possible the proposed test procedure. The results of the full-SHED testing of the two trucks averaged 4.09 g/test. GM SHED tested two HDGs in early 1978 but those results (close to the above average but somewhat higher) cannot be included here because: 1) the vehicles employed old technology, 2) the driving cycle used is not known, and 3) the dynamometer limitations prevented testing of realistic horsepowers.

IH tested three HDGs for evaporative emissions and submitted the results in its final comments. IH used a SHED for testing, however, since IH did not have a heavy-duty chassis dynamometer it used a road-route of 8.6 miles with stop, starts, accels, decels and cruises. The use of such a road-route makes the test data somewhat questionable since load factors and purge rates are not the same as if the vehicle were driven over the heavy-duty driving cycle. Two of the three HDGs incorporate 1980 California evaporative emission control systems. The other HDG had a 1979 California control system but this system was modified into a 1980 system by the addition of a charcoal ring in the air cleaner. IH added new tank gaskets and screws to two of the vehicles. Tests were conducted before and after this modification. Since the tests without the new gaskets and screws best represent the California control system, only those tests are included here. IH's average emission level was 4.84 g/test.

The average of the emission levels of Ford's California control system (3.35 g/test), GM's California control system (4.09 g/test), and IH's California control system (4.84 g/test) equals 4.09 g/test. This is 2.03 g/test (or 99 percent) higher than the projected emission level (2.06 g/test) under the proposal certification procedure.

Another disadvantage of the California-type engineering evaluation as a certification alternative is the large amount of subjectivity involved. It would be difficult for EPA to develop objective guidelines for assessing the manufacturer's engineering evaluations. As the California experience has shown, each manufacturer would probably have its own method of evaluating the adequacy of its own control systems. EPA would have to assess each manufacturer's submittal differently. EPA reviewers would have different levels of expertise in different areas and they might analyse different kinds of data (e.g., statistically treated data, raw data, narrative data) in different ways. The chances that one manufacturer might get a less critical review than another or that an inferior control system might slip by EPA while a better one might be rejected exist.

A third disadvantage of this certification alternative is that air quality planners would have less accurate numbers to work with when considering in-use HDG evaporative emission levels. Since the likelihood of in-use testing programs for HDG evaporative emissions is small, in-use emission levels will have to be estimated from certification emission levels. If there is no required testing for certification, then certification emission levels would often be only estimates. Thus, the confidence in the HDG evaporative numbers used for future air quality projections would be reduced.

A final disadvantage to the California-type engineering evaluation certification alternative is that the possibility of HDG evaporative SEAs is reduced because full-SHED testing is not used under this option.

A Component/Mini-SHED Certification Procedure

This alternative, as well as the next (i.e., the Revised Proposal procedure), is a compromise between that alternative which costs the least and supplies the least benefits (the California-type Engineering Evaluation) and that alternative which costs the most and supplies the most benefits (the Proposal procedure). The cost of the component/mini-SHED certification alternative is moderate. Manufacturers will have to purchase mini-SHEDs and they will have to allocate or build facility space for testing. The amount of research and development effort required under this alternative would, most likely, be somewhat less than under the Proposal alternative. However, the testing effort would probably be more since the manufacturer would have to do perhaps three or four component/mini-SHED tests to simulate one full-SHED test. Thus, if we assume the reduction in research and development effort would be offset by the increase in man-hours required to do testing (both development and certification), and if we assume the control system hardware cost is about the same as the proposal alternative, then the main difference in cost between the component/mini-SHED alternative and the Proposal alternative would be the cost of testing facilities and equipment.

Of the $25M (not including hardware) estimated for the Proposal certification procedure approximately $9M was estimated for certification, research and development. Therefore, $9M will be estimated for these efforts under the component/mini-SHED alternative as well. We will assume that GM and Ford will purchase 3 mini-SHEDs each and Chrysler and IH will buy 2 each. Thus, if each mini-SHED (and associated analyzing equipment) costs $30K, then the total cost would be $300K. GM claims it needs 2 new computers ($150K), a canister equilibrator ($63K), and various miscellaneous equipment ($20K) for an additional equipment cost of $233K. If we allow $50K apiece in additional equipment costs for Ford, Chrysler and IH, total equipment costs would equal $683K.

The space needed to install equipment and to store vehicles and vehicle parts must also be included in the cost of this alternative. If we allow 100 ft2 to park two vehicles, 500 ft2 to install four mini-SHEDs, 500ft2 for storage and 500 ft2 for maneuvering, then total space cost for GM and Ford would be about $375K each (@$150/ft2). For Chrysler and IH we will assume 2000 ft2 each for a cost of $300K each. Thus, the total cost for space is estimated to be $1.35M. When equipment costs, facility space costs, certification testing costs and development costs are summed, the resultant total cost (excluding hardware) for this component/mini-SHED certification alternative is estimated to be $11M.

Another advantage of the component/mini-SHED certification alternative is that the problem of background or nonfuel emissions from full-SHED testing would be lessened considerably. Background emission sources include tires, vehicle paint, lubricants, sound deadeners and sealers. Most such sources would never enter the mini-SHED. If the whole engine was placed in the mini-SHED there might be some nonfuel HC emissions from lubricants or paint but these sources could easily be minimized or eliminated. Likewise, if the fuel tank(s) have been painted some nonfuel HC emissions might be emitted but baking or eliminating the paint would reduce or eliminate these emissions.

SEAs become a definite possibility under this alternative only if an industry-wide component/mini-SHED test procedure is developed. Since it seems highly unlikely that EPA would be willing to expend the time or resources to develop a good component/ mini-SHED test procedure that correlates well with the full-SHED procedure and is repeatable, SEAs under this alternative are improbable. If SEAs are not a part of the final rule, then, of course, NCPs would not be either.

Finally, the incomplete vehicle problem would be significantly moderated under this component/mini-SHED certification alternative. EPA would establish evaporative emission family-system parameters for which the primary manufacturers would set limits. If the secondary manufacturer stayed within these limits when making modifications or additions to a vehicle, then the certificate of conformity would remain valid. If the secondary manufacturers wished to exceed the limits of one or more of the parameters it would test that parameter(s) in a mini-SHED or have a primary manufacturer do such testing. This would be an inexpensive and quick thing to do. The burden placed on the primary manufacturer would be reduced in comparison to the proposal procedure because the risk involved (concerning customer satisfaction) if the limits were not extensive enough would be substantially less.

The biggest disadvantage of the component/mini-SHED certification alternative is that the actual level of evaporative emissions would not be known as accurately as with the full-SHED procedure. Both GM and Ford claimed that their component/miniSHED test procedures correlated very well with the full-SHED test procedure. However, a deficiency of data, crucial inconsistencies in the manufacturers' data, and concerns with the procedures themselves cast doubt on these claims of full-SHED test equality.

As discussed earlier, Ford's component test procedure consists of two parts: 1) diurnal vapor loss and 2) hot-soak vapor loss. Ford claimed that the summation of these two tests plus the addition of a background emissions correction factor gave a total test result which was almost identical to the results of the full-SHED test of a 1978 LDT with the same fuel system. The component test result was 1.38 grams and the full-SHED test result was 1.46 grams. This appears to be fairly good correlation. However, later test results do not uphold this correlation.

Ford developed this component test procedure to support the engineering evaluation of its HDG evaporative emission control systems for California certification. In its application for certification of its 1980 model year California HDG evaporative control systems, Ford included its component test results for a system designed to control a vehicle with dual 75-gallon fuel tanks and a 2V carburetor with a bowl volume of 134 cc. The average of the three tests submitted was 1.098 grams. If we include Ford's estimation of stabilized, HDG background emissions of .50 grams then the total test result equals 1.60 grams.

For their final written comments to this rulemaking, Ford tested a vehicle with a 2V carburetor and dual 75-gallon fuel tanks according to the full-SHED test procedure. While we are not sure that the carburetor and fuel tanks are exactly the same as the ones tested earlier by the component procedure, the differences between the fuel system tested for 1980 model year California certification and the fuel system tested for this rulemaking are probably minimal. Additionally, this vehicle was equipped with Ford's California evaporative emission control system. However, the evaporative emissions from the full-SHED test procedure averaged 116 percent higher (3.46 g/test: 1.60 g/test) than the component test results. This is not good correlation between the two test procedures.

Also for 1980 California HDG certification Ford tested a fuel system consisting of a 4V carburetor with a fuel bowl volume of 224 cc and dual 75-gallon fuel tanks. When the .50 gram background emission correction factor is added to the component test average, the total test result is 1.28 g/test. In its final written comments to this rulemaking, Ford included full-SHED test results of a small (6,250 lbs. 7,000 lbs. inertia weight) truck with a 4V carburetor, dual (19.5 and 19.0 gallons) fuel tanks, and Ford's California control system. This vehicle's fuel system should generate significantly less evaporative emissions than the fuel system tested for 1980 California certification because this vehicle's total fuel tank capacity is only 26 percent of the total fuel tank capacity of the fuel system tested for California. Yet, the full-SHED test results averaged 122 percent (2.84 : 1.28 g/test) higher than the component test results.

The above test procedure comparisons raise serious doubts about claims that the Ford component test gives results that closely parallel results from the full-SHED test. Other obvious flaws in the Ford component test procedure include: 1) no provision to evaluate the purging system, 2) no provision to check storage capacities of vapor storage containers after they have been loaded due to a hot soak, and 3) no provision to check carburetor cold-soak losses or fuel tank hot-soak losses. Ford's procedure would need much development before it would be an acceptable test for certification.

The component test procedure developed by GM is significantly more sophisticated and, therefore, more expensive than Fords. GM, like Ford, claimed that its component test procedure gave evaporative emission loss numbers very close to numbers generated by the full-SHED test procedure. GM tested two HDGs by its component test procedure and then tested them by the full-SHED test procedure. It should be noted that since GM did not have a heavy-duty chassis dynamometer, it drove the test vehicles over a road-route for preconditioning and hot-soak warmup. GM did a total of 5 pairs of tests comparing the component test to the full-SHED test. Three pairs were done on vehicles with evaporative emission control system and two pairs were done on the same vehicles but in an uncontrolled configuration. Since we are evaluating the two test procedures in light of the fact that they would be used to test controlled vehicles only, we will consider only those three pairs of tests which used controlled vehicles.

The first problem with using GM's data is that GM was not consistent in its manipulation of the intermediate test results to arrive at a total test result. In two of the three pairs of tests, GM compared the component test results to the full-SHED test results and included the background emissions in the fullSHED results. In the third pair of tests, GM subtracted the background emissions from the full-SHED test total and then compared that to the component test results which included background emissions. GM gave no reason why background emissions were not included in the full-SHED test results. GM's figure for the full-SHED test was 3.88 g/test while its figure for the component test was 3.98 g/test. This appears to be good correlation. However, when the background emissions are added to the full-SHED result to be consistent with the other two pairs of tests, it becomes 6.38 g/test which is 60 percent higher than the component test result. We can determine no reason why background emissions were not included. Therefore, all three of the full-SHED test results will include background emissions as do all three of the component test results.

The next problem with comparing GM's component test results to its full-SHED results is the measurement of background emissions. GM claims that "background emissions" are in large part due to gasoline permeation through the fuel lines. This source of HC emissions should properly be termed as "evaporative" emissions instead of "background" emissions because it is an obvious part of the fuel system. The reason that GM refers to fuel line permeation as a non-fuel or "background" emission source is unknown. GM's component test measures this permeation and then identifies the result as "background" emissions. However, there is substantial data which shows that paint, sealers, lubricants, tires and other non-fuel components of automobiles and trucks give off HC emissions. These sources are properly termed "background" emissions.

In its final written comments Ford presented true background emission data on a HDG. Ford removed the entire fuel system, including the fuel lines, from the vehicle before testing. This vehicle was in an incomplete configuration when tested. That is, it was a chassis with engine and cab but no bed or payload area. It would be likely that a payload area with its significant amount of painted surface area would result in somewhat higher background emissions than Ford's results. The average of three tests showed diurnal background emissions to be 0.09 g/test and hot-soak background emissions to be 0.37 g/test for a total test result of 0.46 g/test.

In a joint testing program, EPA and Ford removed the entire fuel system from a new 1977 HDG (and replaced it with a propane fuel system). After 70 days, background emissions had dropped to about 0.6 g/test. Furthermore, GM submitted data in its final written comments which showed that three LDVs emitted an average of 0.30 g/test of background emissions during the hot-soak portion of the full-SHED test. These vehicles had their fuel lines removed before testing so that none of the HC emissions came from fuel line permeation. When we remember that cold-soak (diurnal) background emissions would add to the .30 g/test and that the LDVs are smaller than HDGS, GM's results agree with Ford's as to the significance of true, non-fuel emissions.

Since GM's full-SHED test for background emissions (in its final written comments) includes true, non-fuel sources such as paint, lubricants, tires sealers and sound deadeners in addition to fuel line permeation, the component test for background emissions should include these non-fuel sources as well. Therefore, we have added 0.5 g/test to each of GM's component test "background" emissions results to account for the fact that GM's component test does not measure true, non-fuel sources of evaporative HC while the full-SHED test does.

The first vehicle GM tested was a 1979 heavy-duty pickup truck with a 350 in3 engine, 4 bbl carburetor and dual, 20 gallon fuel tanks. GM tested this vehicle with its 1979 California evaporative control system installed and again, with that control system plus a carbon element in the air cleaner. The results of the two pairs of tests (component test procedure vs. full-SHED test procedure) are as follows:

Heavy-Duty Pickup with 1979 California Control System

	Diurnal (g/test) (background not included)	Hot-soak (g/test) (background not included)	Background (g/test)	Total (g/test)
Component Test	.31	.86	1.24	2.41
Full-SHED test	.34	.67	.78	1.79
Component Test Difference from Full-SHED test	-9%	+28%	+59%	+35%

Heavy-Duty Pickup with 1979 Control System Plus Carbon in Air Cleaner

	Diurnal (g/test) (background not included)	Hot-soak (g/test) (background not included)	Background (g/test)	Total (g/test)
Component Test	.31	.43	1.24	1.98
Full-SHED Test	.35	.33	.78	1.46
Component Test Difference from Full-SHED Test	-11%	+30%	+59%	+36%

The above results show that GM's component test procedure underestimated the diurnal portion of the full-SHED test and overestimated the hot-soak and background portions of the full-SHED test. The total test results show a difference of more than 35 percent. Certainly these differences are significant and the only conclusion that can be drawn is that GM's component test procedure gives different results than the full-SHED procedure. If further testing showed that the percent difference for each part of the test procedure stayed about the same for many different vehicles and configurations, then GM's component test procedure would be usable since full-SHED test results could be obtained from the component test results by using correction factors. However, the results from the other vehicle that GM tested show that the relative differences between the two test procedures are unpredictable.

The second vehicle GM tested was a C-7 series tractor unit with a 427 in3 engine, 4 bbl. carburetor, and dual, 50 gallon fuel tanks. The results of this testing are shown below:

C-7 Series Tractor

	Diurnal (g/test) (background not included)	Hot-soak (g/test) (background not included)	Background (g/test)	Total (g/test)
Component Test	.88	1.83	1.77	4.48
Full-SHED Test	.72	3.16	2.50	6.38
Component Test Difference from Full-SHED Test	+22%	-42%	-29%	-30%

These results are completely opposite from the pickup results. Where the pickup averaged 10 percent lower on the diurnal portion of the test, the C-7 tractor is 22 percent higher. Where the pickup averaged 29 percent higher on the component test hot-soak, the C-7 tractor is 42 percent lower. The background and total test results were likewise opposite for the two vehicles. We conclude that the GM component test procedure will not predict full-SHED test results closer than perhaps ± 30-40 percent.

Besides the above test results, there are other, qualitative, observations and questions that cast serious doubt on GM's component test procedure. Listed below are four problem areas that could cause significant differences in test results between GM's component test and the full-SHED test. These problem areas would have to be investigated further before a component/mini-SHED test procedure would be acceptable.

Carbon Canister Equilibration GM suggests that carbon canisters be equilibrated by flowing vapor into them at 4 scfh for ten minutes and their purging at 50 scfh for twenty minutes. GM does not present any evidence that the above flow rates are typical of HD vehicles. The risk is that, although the canisters may be equilibrated, they still could be essentially "green". This question should be explored and resolved.

Fuel Line Permeation GM states that vapor permeation through fuel lines is a principal source of "background" emissions. (It should be noted that EPA considers this source to be part of the fuel system and, therefore, it is not "background".) GM suggests that the hose be filled 75 percent full of fuel and weighed for several days to determine the permeation rate (grams/ft/hr). The diurnal test result would be the effective length of tubing for the vehicle times the permeation rate. The hot-soak test result would be the effective length times the permeation rate times 2.5. The "2.5 factor" is supposed to account for the increased temperature experienced by the fuel lines during the hot-soak. It is a "rule of thumb" factor for which GM provides no data but claims "has been developed from experience." GM admits "hot bench tests (on fuel lines) are relatively meaningless comparisons as every hose experiences different temperatures depending on its location in any specific vehicle. Temperatures can even vary significantly from end-to-end of one hose." Thus, GM's "2.5 factor" for calculating hot-soak fuel line permeation from coldsoak hose permeation should be investigated further to determine the significance of temperature variation effects. Then, the temperature of the fuel lines on each vehicle tested should be measured and the correct hose permeation rate applied. It is important to determine if the "2.5" factor is accurate.

GM's suggestion to fill the hoses 75 percent full is unsupported and needs investigation. The significance of hose permeation is clear when one considers that GM determined that .74 g/test to 1.27 g/test is due to this fuel system emissions source.

Carburetor Hot-Soak Emissions. GM suggests that the carburetor be mounted, with its mounting gasket, on an aluminum block. The air cleaner and charcoal canister are also mounted in their respective positions to the carburetor. An electric heat source is applied to the aluminum block which heats the carburetor fuel bowl. This heating is supposed to follow the heating pattern on an actual vehicle.

The first problem that should be investigated further is that of the convection currents which are set up due to the hot engine block in the vehicle's engine compartment during a full-SHED test vs. the hot aluminum block in GM's component test. These air currents could be very different and could influence the amount of vapor escaping through the air cleaner, carburetor linkages, and carbon canister.

Another problem is that of the appropriate heating cycle. Different vehicles will have different carburetor bowl heating curves. Should one general curve be used or should each evaporative family have its own?

A third problem concerns the background or non-fuel emissions from the hot engine compartment. These emissions are not measured in GM's component test. While it may be argued that they should not be counted anyway, the standard would have to be adjusted accordingly.

A fourth problem is the probability that there are some evaporative emissions from the fuel tanks during the hot-soak test. The proximity of the fuel tank(s) to the exhaust system may cause the tank(s) to absorb exhaust heat to the point where the pressure of the vapor in the tank will be significantly raised and evaporative emissions may occur.

<u>Diurnal Losses from Fuel Tank</u>. The GM component/mini-SHED procedure has no provision for the entrapment of heat around the fuel tanks due to the payload/body platform. If a fuel tank is so located as to be essentially surrounded (at least the upper parts) by the vehicle's body, then heat from the heating blankets can get trapped. This build-up of heat would cause the vapor in the fuel tank to exert more pressure than if the fuel tank is completely exposed to air circulation as it is in GM's component test.

It is clear from the above discussion that actual emission levels from HDGs would not be accurately known under a component/ mini-SHED certification scenario unless a substantial program to develop a reliable procedure was undertaken. Air quality planners' confidence in the HDG evaporative certification numbers to use for in-use emission factors would be low. We will use the results of GM's component tests to estimate the certification emission levels for the component/mini-SHED certification alternative. Although we don't have much confidence in GM's numbers as they relate to the full-SHED test, they are the only numbers we have. Assuming that manufacturers would take advantage of the flexibility available in meeting the standard using this procedure, we expect average emissions to be higher than with a full-SHED test. Based upon the data presented above, we estimate that the difference could easily reach 40 percent. Thus, since the emission level under the Proposal alternative was estimated to be 2.06 g/test, the certification emission level under the component/ mini-SHED procedure is estimated to be 1.4 times 2.06 g/test or 2.88 g/test. While this appears to be below the sales-weighted standard of 3.47 g/test it should be remembered that 2.88 g/test would be an average at certification and, due to variability, it is probable that some vehicles would test above the standard.

The component/mini-SHED certification alternative would be quite subjective since the different manufacturers would most probably develop their own component test procedures. This leads to problems of manufacturers equity and makes difficult the implementation of manufacturer self-certification. EPA could develop its own component test procedure but lack of resources makes this possibility remote.

<u>The Revised Proposal Certification Procedure</u>

The major advantage to this certification alternative is cost savings over the Proposal alternative. Because it is anticipated that the amount of testing will be greatly reduced, only one heavy-duty SHED should be needed per manufacturer. For example, in its final written comments GM submitted its estimate of its certification fleet. GM estimated that under the proposed vehicle classification and selection scheme 29 emission-data vehicles would be tested for certification.

These 29 vehicles have only four different carburetors among them. Thus, if the emission control systems were the same for all vehicles with the same carburetor, only four emission-data vehicles would need to be built and tested. Even if we assume two different emission control systems per family, then only eight emission-data vehicles result. This still represents more than a 70 percent reduction in the number of emission-data vehicles. Thus, GM and Ford, who both claimed to need three heavy-duty SHEDs under the Proposal should need only one under this Revised Proposal alternative. We have determined that a heavy-duty SHED will cost about $100K. Support equipment such as heating blankets, emissions analyzers, temperature achievers, etc. will add another $41K to the cost. Thus, the industry total is expected to be 4 times $141K or $564K.

All of the four HDG manufacturers claimed they would need at least one new heavy-duty chassis dynamometer. Ford claimed it would need a total of three dynos (it has one already). GM claimed it would need two dynos and IH and Chrysler each claimed they would need one dyno apiece. Since this Revised Proposal certification alternative will greatly reduce the number of evaporative family-system combinations and consequently reduce certification, research and development testing, the number of dynos required by each manufacturer will be reduced. We had assumed that each manufacturer will purchase one dyno. However, conversations with a dynamometer manufacturer indicate that no new heavy-duty chassis dynos need be purchased. The test procedure has been changed so that light-duty dynos that have been converted to heavy-duty dynos by adding inertia weights can be used for vehicle pre-conditioning and warm-up. The dyno manufacturer has indicated that a light-duty dyno can be upgraded to handle 13,500 lbs. inertia weight for about $25,000. Upgrading to this inertia weight will handle all Class VI and below HDGs at the new testing weight of 50 percent of GVW (see the "Test Procedure" issue in this document). Thus, if we allow one retrofit kit apiece for GM, Ford, IH, and Chrysler, then a total of four kits would be needed. At $25K apiece, this comes to $100K for dynos. Thus, total industry equipment costs would be $664K.

Facility space costs would be substantially reduced because of the reduction in the number of vehicles that need to be built, soaked, and tested. GM claimed it would need 26,000 ft2 in new facility space. Our cost analysis indicates that not only is 26,000 ft^2 excessive for this revised proposed alternative but it is a substantial overestimate for the originally proposed alternative. We estimate that GM should only require 4000 ft^2 of facility space. We also estimate that Ford would need 4000 ft^2 while Chrysler and IH would each need 3000 ft^2. This industry total of 14,000 ft^2 times a building rental cost of $15/$ft^2$-yr for 8 years gives an industry total of $1.7M.

The only manufacturers to delineate certification testing costs was GM. It claimed that $1.1M would be needed to build the 29 emission-data vehicles required under the Proposal certification alternative. This number of emission-data vehicles should be reduced by at least two-thirds as a result of the changes under this Revised Proposal certification alternative. Thus, certification costs for GM should only be about $350K. Allowing this same amount for Ford and half this amount for IH and Chrysler would bring total industry certification costs to $1.05 M.

Research and development costs are difficult to estimate but should be quite small because the technology required is well known. Under the Proposal and component/mini-SHED certification alternatives we estimated $2M each for Ford and GM and $1M each for IH and Chrysler which should be considered liberal estimates. Under this Revised Proposal alternative, R&D costs should be considerably less because of the reduction in the number of evaporative family-system combinations which would be tested for certification. In the Costs chapter of the "Regulatory Support Document" we estimate that R&D will be $2.0M for the industry.

Since control system hardware costs are assumed to be equal under all of the certification alternatives, they do not need to be estimated when comparing the differences in cost among the alternatives. The total industry cost for equipment, facility space, certification testing, and R&D under this alternative is estimated to be $5.4M. The assumption that control system hardware costs will be the same under all of the five alternatives will be discussed further in the next section where exceptions will be noted.

Another advantage of this alternative is that the level of control would be known with a large degree of confidence. The full-SHED test procedure will yield hard numbers which air quality planners can use in estimating in-use emission factors for air quality projections. We will assume that the average certification emission level would be the same as that under the Proposal certification procedure (i.e., 2.06 g/test). This Revised Proposal alternative does not require as much certification testing as the Proposal alternative because there will not be as many family-system combinations. Therefore, one might expect the average emission level to be closer to the standard due to the reduced safety margin for variability that the manufacturers have to include in their certification emission levels. However, the Revised Proposal vehicle classification and selection criteria will result in evaporative control systems which are somewhat overdesigned. Manufacturers would install their worst case control systems on some less than worst case vehicles so that they do not create additional evaporative family-system combinations which would have to be certified. Such overdesigned control systems will tend to control certification emissions to a level below that which would occur under the Proposal alternative. Although we cannot quantify these effects, we do known they are relatively small and work in opposite directions. We will assume that the increase in the average certification emission level due to less testing would be offset by the decrease in the average certification emission level due to overdesigned evaporative control systems on some vehicles. Thus, the emission level at certification is estimated to be 2.06 g/test for this alternative.

Another advantage to this alternative is that leadtime is significantly reduced from that required under the Proposal certification procedure. GM and Ford both claimed that the major reason for extensive leadtime was the need to install additional SHEDs and dynos. They claimed that lack of testing equipment would severely slow down their R&D programs. Under this Revised Proposal procedure the manufacturers would already have the one SHED they need and the upgrading of light-duty dynos to handle HDGs should take at most 6 months. Furthermore, the amount of R&D would be substantially reduced due to the reduction in evaporative emission family-system combinations.

Other advantages of this Revised Proposal certification alternative include: it is an objective procedure to ensure manufacturers' equity, it would allow easy implementation of manufacturer self-certification, and the test procedure is well known from light-duty experience.

A disadvantage of this alternative is that the problems of incomplete vehicles, background emissions, SEAs and NCPs are virtually the same as under the Proposal certification procedure. For a general idea of these problems the reader is referred back to the discussion of these disadvantages of the Proposal alternative.

Another disadvantage to this Revised Proposal alternative is that some HDGs would have evaporative emission control systems that are overdesigned and, therefore, more expensive than the minimal control system which would allow that vehicle to just meet the standard. However, these extra hardware costs are expected to be quite small and are offset by the decreased cost of certification, research, and development testing. This will be discussed further in the next section.

Abbreviated Certification. A major advantage of this certification alternative is the great flexibility which it would impart to the manufacturers. The manufacturers would be free to test as few or as many vehicles as they deemed necessary to assure themselves that their HDG product lines would meet the 3.0/4.0 g/test standard. Each manufacturer could group its HDGs in any manner it chooses for development purposes. For example, a manufacturer might group together all of his lighter-weight HDGs which are merely extensions of its already controlled LDTs. The only difference affecting evaporative emissions might be that HDGs have larger fuel tank capacities. The manufacturer might only need to test the "worst case" of these HDGs to assure itself that the other HDGs in the group would also meet the standard.

Furthermore, the manufacturers would be free to use any testing methods they want. In its comments to this rulemaking GM claimed that its component test procedure correlated well with the full-SHED test. Under this certification alternative GM could use its component test procedure to develop its HDG evaporative emission control systems. The manufacturers could use full-SHED testing, component testing, engineering evaluation and/or no testing in any mixture and amounts they deem necessary in order to assure themselves that their HDGs would meet the standard. The flexibility provided by this certification alternative would allow the manufacturers to meet the 3.0/4.0 g/test standard in the most cost effective manner since all the decisions on needs for development and testing expenses would be theirs.

Another advantage of this certification alternative is that it would be the second least expensive of the five alternative considered. Only the California-Type Engineering Evaluation would be less expensive. Estimating the cost of this Abbreviated Certification alternative is difficult because it cannot be known how much testing each manufacturer will consider necessary to assure itself of compliance. The cost of this alternative will be somewhat less than the $5.4M (excluding hardware) previously estimated for the Revised Proposal alternative. Both alternatives include a 3.0/4.0 grams per full-SHED test standard, but this Abbreviated Certification alternative does not require any testing. Therefore, we will use the Revised Proposal cost estimates as a starting point for estimating the costs of this Abbreviated Certification alternative.

Under the Revised Proposal, we estimated that the manufacturers would purchase 4 light-duty dynamometer retrofit kits at a cost of $25K each. The amount of testing required under this alternative should be less than under the Revised Proposal, however it is not clear how much. Therefore, we will allow the same number under this alternative. The same is true for SHEDs and supporting test equipment. Thus, we have estimated that total industry test equipment expenditures for this alternative will be the same as for the revised proposal alternative, that is, $664K. This is on the high side because this alternative will allow the manufacturers to allocate their resources more efficiently than the revised proposal alternative to achieve the same result.

The next area of costs to consider is that of new facility space. Under the revised proposal alternative we estimated that total industry costs for the facility space required by this regulation would be $1.7M. This abbreviated alternative would most likely allow some reduction in that amount because the manufacturers would be free to use whatever testing method they choose. Since the manufacturers claimed that a component/mini-SHED test would give results comparable to the full-SHED test, it is to be expected that much of the testing will be done with this type of procedure. However, each manufacturer will probably need at least some space for a full-SHED test site and for parking vehicles. We have left the amount of space the same under this alternative as under the revised proposal alternative. Thus, the cost for facility space under this abbreviated certification alternative is $1.7M.

Certification testing costs were estimated to be $1.05M under the Revised Proposal alternative. Since the manufacturers would only be required to submit a statement that their vehicles would meet the 3.0/4.0 g/test standard if tested, no certification testing would need to be done. However, we presume that the manufacturers would do final testing on their product lines before submitting their statements of compliance. This cost has been estimated in the "Costs" chapter of the "Regulatory Support Document." The total industry cost for this "development testing" is projected to be $800K. This is about $205K less than the cost for certification testing under the revised proposal alternative because some family-systems will meet the standard so easily that little or no final testing will be considered necessary. R&D testing would still be necessary to assure each manufacturer that his product line would meet the 3.0/4.0 g/test standard. We will assume that the amount estimated for R&D under the Revised Proposal alternative would also be required under this alternative. Thus, R&D costs are estimated to be $2.0M for the industry.

The total industry cost for this Abbreviated Certification alternative (excluding hardware) is estimated by summing the estimates for new equipment, facility space, certification testing and R&D. The sum of these estimates is $5.2M. This compares to an estimate of $5.4M for the revised proposal alternative with the reduction due to less certification testing cost.

The level of control which would result from this alternative is difficult to estimate since there is a lack of experience with this type of certification procedure. We have assumed that the manufacturers would do about the same amount of testing under this alternative as they would under the Revised Proposal alternative. If the amount and type of R&D testing is the same for both alternatives then the level of control would be expected to be about the same. However, the manufacturers would be free to use component/mini-SHED testing, bench testing or no testing as they deem necessary. The use of these testing methods (as compared to full-SHED testing) will tend to increase the level of emissions to somewhere above that for the Revised Proposal alternative. Since we do not have a firm estimate of the level of control for this Abbreviated Certification alternative, we will express the expected level of control as a range instead of a single number. The upper bound of the range has been chosen as the midpoint between the level of control expected with the Revised Proposal alternative (2.06 g/test) and the sales-weighted standard (3.47 g/test). This midpoint is 2.77 g/test. The lower bound has been chosen as the Revised Proposal level of control (2.06 g/test).

As discussed previously, another important factor to consider in selecting a certification procedure is its objectivity. In general, objectivity is necessary to assure that manufacturers are treated equally and to make certification as routine as possible. Manufacturers' equity would not be a concern during certification since all manufacturers would be assured certification if they submit the required statement of compliance (and any other information which EPA may request), and act in good faith. However, manufacturer's equity should be considered for the case of later enforcement options. This alternative is objective in that respect because all manufacturers will be subject to the full-SHED test procedure for later enforcement and that test procedure has been developed over a number of years for repeatability and for minimization of subjectivity. Therefore, this certification alternative will be considered as one of the more objective ones.

Another advantage of this alternative is that it would allow plenty of leadtime for the manufacturers to design and develop their evaporative emission control systems before the implementation date of the regulation. Required leadtime would be substantially reduced from the Proposal alternative because manufacturers would need to do little if any facility modification before launching their R&D programs. As discussed in the issue titled "Leadtime" (in this document), the leadtime between publication of the final regulation and the date of implementation should be more than adequate for the manufacturers to develop their control systems.

The biggest disadvantage with this alternative is that the level of control, although estimated to be fair (2.77 g/test) to excellent (2.06 g/test), would not be known with much confidence. It is conceivable that a manufacturer(s) could decide to reduce its effort during development of its control systems from that level of effort needed to assure that all of its HDGs meet the standard. However, EPA believes that the risk of noncompliance is small given that the standard can easily be met, and that EPA retains the right to do confirmatory testing.

This Abbreviated Certification alternative would clearly depend on the manufacturers' honesty and integrity. Our basic approach to this alternative is one of relying on the manufacturers to exert a good faith effort. EPA retains authority to do confirmatory and/or in-use testing for compliance, but we do not have plans at this time to exercise that authority on a routine basis.

The problem of background emissions would be substantially reduced under this alternative. Under the Proposal alternative manufacturers would have to age their emission-data vehicles to stabilize background emissions before certification testing. Under this Abbreviated Certification alternative there would be no certification testing, and therefore, no problem. For R&D purposes, manufacturers can use any testing method(s) they choose. Since the manufacturers claimed that a component/mini-SHED test gives results which closely correlate with the full-SHED test procedure and background emissions are not a problem when a component/mini-SHED test procedure is used, background emissions during R&D work should be a minimal problem.

If SEA testing of HDGs ever occurred, then the problem discussed under the Proposal alternative would also exist under this alternative because the SEA would test vehicles by the full-SHED method.

The incomplete vehicle problem is little changed under this alternative as compared to the Proposal alternative. This Abbreviated Certification procedure retains the SHED test procedure and, therefore, if secondary manufacturers were required to show compliance because of modifications and/or additions, then the method (full-SHED testing) of proving compliance would be very burdensome for those secondary manufacturers. The reader is referred to the issue title "Incomplete Vehicles" for our analysis of and recommendation for this problem.

Comparison of the Alternatives

This section will compare the five certification alternatives. Table 2 summarizes the advantages and disadvantages of the five alternatives. It is obvious that the Proposal certification alternative can be withdrawn from further consideration. The Revised Proposal alternative is as good as or better than the Proposal alternative in all but one of the categories. While that one exception (i.e., the confidence in the level of control at certification for application to in-use emissions estimations) is important, the

Table 2

Comparison of the Five Certification Alternatives

	Proposal	Engineering Evaluation	Component/ Mini-SHED	Revised Proposal	Abbreviated Certification
Level of Control at Certification (gpt)	best (2.06)	worst (4.09)	fair (2.88)	best (2.06)	fair (2.06-2.77)
Confidence in Level of Control (in-use emissions estimates)	best	worst	poor	good	fair
Cost Excluding Hard ware ($M)	worst (25)	best (0.5)	fair (11)	good (5.4)	good (5.2)
Objectivity (mfr. equity and self-cert.)	best	worst	poor	best	good
Leadtime	worst	best	fair	fair	good
Incomplete Vehicle Problem	worst	best	good	poor	poor
Background Emissions, SEA and NCPs Problem	worst	poor	best	poor	poor

difference between the Proposal and Revised Proposal in this category is not very great and the superiority of the Revised Proposal in other categories more than compensates for the deficiency in this one category.

Table 2 also shows that the Revised Proposal procedure is as good as or better than the component/mini-SHED procedure in all but two categories. Both of these two categories are relatively unimportant compared to the other categories. The need for and desirability of SEAs and NCPs for evaporative emission control of HDGs is minimal. While background emissions would be less of a problem under the component/mini-SHED alternative, we have determined that this problem is not a large one and it has workable solutions. The discussion on background emissions found in the issue "Technological Feasibility" presents analyses and solutions to the problem.

The incomplete vehicle problem could be considerably diminished under the component/mini-SHED certification alternative. But since the Revised Proposal offers so many more advantages, it is one problem that we would accept. The analysis and solution of this problem can be found in the issue entitled "Incomplete Vehicles."

Having withdrawn two of the five alternatives from consideration because of the obvious and overwhelming advantages of the Revised Proposal procedure, we are left with the Engineering Evaluation and the Abbreviated Certification alternatives to compare with the Revised Proposal procedure. Since it is clear that the Revised Proposal will control emissions to a lower level than the other two alternatives, the next question is: "Is the extra control worth the extra cost?"

In order to answer that question we have calculated the marginal cost-effectiveness of moving from the Engineering Evaluation alternative to the Revised Proposal alternative. We have also calculated the marginal cost-effectiveness of moving from the Engineering Evaluation alternative to the Abbreviated Certification alternative and of moving from the Abbreviated Certification alternative to the Revised Proposal alternative as will be discussed later. The difference (4.09 g/test to 2.06 g/test) between the control level of the Engineering Evaluation and the Revised Proposal is 2.03 g/test. The cost difference between these alternatives is $4.9M. The marginal cost-effectiveness number will be the increase in cost per gasoline-fueled heavy-duty vehicle as one moves from the Engineering Evaluation to the Revised Proposal divided by the decrease in lifetime HC emissions per HDG (in tons). The methodology for converting g/test to grams per mile (gpm) is given in Chapter IV of the "Regulatory Support Document" to this rulemaking. Using that methodology we have calculated that the difference between the two alternatives under consideration is .179 gpm. Since the typical lifetime for a HDG is 114,000 miles, the difference between the total tons of HC emitted over the lifetime of an HDG for the two alternatives is:

$$(.179 \text{ gpm}) \times (114{,}000 \text{ mi}) \times \left(\frac{1 \text{ lb}}{453.6 \text{ g}}\right) \times \left(\frac{1 \text{ ton}}{2000 \text{ lbs}}\right) = .0255 \text{ tons}$$

The difference in cost between the two alternatives is $4.9M. This cost difference must be discounted to 1984 and then amortized over 5 years production to arrive at a per vehicle cost. Discounting $4.9M for 3 years to 1984 (@ 10 percent) yields $6.5M. Total HDG production for 1984 through 1988 inclusive is estimated to be 1,768,900 (see Chapter III of the "Regulatory Support Document") or an average annual production of 353,780 HDGs. Amortizing $6.5M over 5 years at 353,780 HDGs per year yields a value of $4.85 per vehicle. Dividing the difference in price by the difference in tons of HC emitted per vehicle gives a cost-effectiveness of $216/ton HC.

This marginal cost-effectiveness number is well within the range of other HC control strategies. Table VI-A in Chapter VI of the "Regulatory Support Document" shows various HC control strategies and their cost-effectiveness numbers. It should be emphasized that the number we have calculated above is the marginal cost-effectiveness of going to the Revised Proposal certification alternative from the Engineering Evaluation alternative. In general, the marginal cost-effectiveness of controlling the last several percent of an HC emission source increases geometrically as the one-hundredth percentile is approached. The table of cost-effectiveness in Chapter VI of the "Regulatory Support Document" shows this tendency. The cost-effectiveness of controlling the first 50 percent of an HC source is much lower than the marginal cost effectiveness of controlling the last 10 percent. In light of this fact, a marginal cost-effectiveness of just $216/ton HC at such a high level of control is, indeed, a very good number. Therefore, the extra HC control achieved by the Revised Proposal alternative is well worth the extra expense.

The Revised Proposal alternative is also better than the Engineering Evaluation alternative in the categories of "Confidence in Level of Control" and "Objectivity." These are important considerations in selecting a certification procedure. The Revised Proposal alternative will give hard, full-SHED test emission numbers during certification. These numbers will be relatively easy to use when air quality planners need to project the level of in-use HDG emissions. The Engineering Evaluation will give no emission numbers at all and, over time, the actual emission levels of HDGs would be expected to vary greatly. The Revised Proposal alternative is objective and will assure manufacturers' equity at certification. The Engineering Evaluation alternative would result in many different types of evaluations which could lead to inequitable treatment of one manufacturer's submittal as compared to another's.

Required leadtime is less under the Engineering Evaluation. However, there would be sufficient leadtime to implement the Revised Proposal for the 1984 model year. Since there is enough leadtime for both alternatives, this apparent advantage of the Engineering Evaluation is not an important one.

The problem of incomplete vehicles and the problem of background emissions would disappear with the Engineering Evaluation alternative. However, the advantages of the Revised Proposal alternative would outweigh these disadvantages. We would accept these problems and develop workable solutions to them. Finally, SEAs and NCPs are not possible at all under the Engineering Evaluation while they are possible under the Revised Proposal alternative.

Therefore, we have concluded that the Revised Proposal would be preferable to the Engineering Evaluation. So far the Revised Proposal alternative has been judged superior to the Proposal alternative, the component/mini-SHED alternative and the Engineering Evaluation alternative. This leaves only the Abbreviated Certification alternative to consider.

We have also calculated the marginal cost-effectiveness of going from the Engineering Evaluation to the Abbreviated Certification and of going from Abbreviated Certification to the Revised Proposal. As discussed above, the marginal cost-effectiveness of going from Engineering Evaluation with a control level of 4.09 g/test all the way to the Revised Proposal with a control level of 2.06 g/test is estimated to be $216 per ton HC. The estimated level of control under the Abbreviated Certification alternative (2.77 g/test) lies between these other two alternatives. If we assume that the Abbreviated Certification level of control would be 2.06 g/test, then the marginal cost-effectiveness of going from Engineering Evaluation to Abbreviated Certification is $207 per ton HC. If we assume that the Abbreviated Certification level of control would 2.77 g/test then the marginal cost-effectiveness would be $318 per tone HC. Thus, the cost-effectiveness of moving from the Engineering Evaluation alternative to the Abbreviated Certification alternative is very good regardless of where, within the range assumed, the actual Abbreviated Certification level of control turns out to be.

The marginal cost-effectiveness of going the rest of the way to the Revised Proposal may or may not be good depending on the level of control assumed for the Abbreviated Certification alternative. If we assume a level of control of 2.77 g/test, then the marginal cost-effectiveness of moving from Abbreviated Certification to Revised Proposal is only $25 per ton HC.

However, if we assume an Abbreviated Certification level of control of 2.06 g/test, then the marginal cost-effectiveness becomes infinite becaue costs are increasing but benefits remain the same.

The above calculations show that it is cost effective to move from Engineering Evaluation to Abbreviated Certification. However, whether or not it is cost effective to go the rest of the way to the Revised Proposal depends on the actual level of control obtained under the Abbreviated Certification alternative. We believe, as indicated by our inclusion of substantial R&D effort when estimating the cost of the Abbreviated Certification alternative, that the manufacturers will make a good faith effort to control evaporative emissions. Although we do not normally expect to require the manufacturers to submit their data and/or analyses and we do not routinely expect to do confirmatory testing, we believe that the risk of EPA exercising these options is sufficient to assure compliance with the appropriate standard. For this reason, we conclude that the level of control obtained under the Abbreviated Certification alternative will be closer to the lower end (2.06 g/test) of the range and the cost effectiveness of moving to the Revised Proposal is likely to be very poor. Furthermore, the Abbreviated Certification alternative allows the manufacturers substantial flexibility in the total effort expended as well as the division of that effort over their product lines and the scheduling of that effort. This flexibility increases the probability of maximum efficiency of resources to obtain the same control level. Thus, the cost differential between the Abbreviated Certification alternative and the Revised Proposal alternative is probably greater than our conservative estimate.

For all the above reasons and in order to lessen the burden on this industry to the extent possible we recommend that the Abbreviated Certification alternative be included in the Final Rule.

Recommendation

We recommend that the Abbreviated Certification alternative be adopted as the certification procedure for control of evaporative emissions from HDGs. This procedure should result in control of emissions to a level below the 3.0/4.0 g/test standard at a low cost. It will give the manufacturers a great deal of flexibility in their approaches to the development and testing of their control systems. Most of the emission reduction expected from the original proposal will be obtained at a much lower overall cost.

B. Issue: Incomplete Vehicles

Summary of Issue

The four HDG manufacturers (GM, Ford, Chrysler, and International Harvester) sell many vehicles in an incomplete form. Most of these incomplete vehicles are Class IV and above (greater than 14,000 lbs. GVW) heavy-duty vehicles. These vehicles may be complete except for the payload bed or box or the vehicle may only include an engine and a chassis. The purchaser (secondary manufacturer) of these incomplete vehicles completes them by adding engine compartments, operator enclosures, payload devices and/or fuel tanks and lines.

Secondary manufacturers also modify already complete vehicles by adding extra fuel tanks or changing the location of existing fuel tanks and/or exhaust systems. All of the above manipulations of HDGs by secondary manufacturers could affect the level of evaporative emissions from those vehicles. Herein lies a problem faced by EPA in its attempt to promulgate this HDG evaporative emissions regulation. Although completed vehicles meet the HDG evaporative emission standard because they are tested during the certification process; how can we make sure that vehicles which are later added to or modified by secondary manufacturers also meet the HDG evaporative emission standard?

The most obvious answer would be to require secondary manufacturers who make additions or changes to vehicle parameters that could reasonably be expected to affect the level of evaporative emissions to test those vehicles for compliance. However, there are hundreds of secondary manufacturers many of which are quite small in terms of total assets. The expense of a heavy-duty SHED, its associated analysing bench, and space to put it along with the expense of a heavy-duty dynamometer would probably eat up many years of profit for many of the smaller secondary manufacturers. Thus full-SHED testing by secondary manufacturers would be very burdensome and would force many out of business.

In the NPRM the Agency proposed that the primary manufacturers would determine the limits of a worst case completed vehicle configuration for each incomplete vehicle they wish to market. These limits (in addition to those specified by the exhaust emission certificate) would be those defined by the evaporative emission family-system combination and the evaporative vehicle configuration, i.e., fuel tank volume, carburetor bowl fuel volume, method of vapor storage, vapor storage material, vapor storage working capacity, method of carburetor bowl venting, vapor purging technique, fuel system, maximum GVWR, maximum frontal area, body type, and other features as specified by the Administrator. If an incomplete vehicle was selected to be an emission-data vehicle, then the manufacturer would build up that incomple vehicle in accordance with the worst case limits he has previously determined. The incomplete vehicle would then be covered by the certificate of conformity as long as the secondary manufacturer stayed within the worst case limits. If the secondary manufacturer wanted to make an addition or modification which was worse than the primary manufacturers worst case limits, then the secondary manufacturer would have to test the vehicle and show compliance.

Summary of Comments

A total of eight organizations commented on this issue of incomplete vehicles. Besides the four HDG primary manufacturers (GM, Ford, Chrysler, International Harvester), four trade associations submitted comments. These were the Motor Vehicle Manufacturer Association (MVMA), the National Truck Equipment Association (NTEA), the Truck Body and Equipment Association (TBEA), and the National Automobile Dealers Association (NADA).

The commenters generally claimed that EPA failed to define "worst case" adequately. As discussed above, EPA listed a number of parameters for which the manufacturer would need to determine worst case limits when certifying an incomplete vehicle. GM stated that in some cases the completed vehicle with the largest frontal area may not be the completed vehicle with the highest GVW. If such a chassis/engine combination was picked for emission-data testing, then the resulting emission-data vehicle build would be worse (in regards to evaporative emissions) than any vehicle that would actually be produced. This was considered unfair.

The commenters also claimed that a worst case determination for some of the parameters on EPA's list would be impossible because EPA had failed to define how changes in such parameters affect evaporative emissions. For example, the proposal would require the manufacturer to determine a worst case body type but EPA failed to delineate how a manufacturer could determine which possible body type was worst. The inclusion of the undefined and open-ended worst case parameter of "other features as specified by the Administrator" was claimed to be unreasonably vague. Since commenters considered the proposed scheme for determining worst case vehicles to be unreasonable, impracticable, and not objective, it was claimed to be illegal as shown in Paccar, Inc. vs. NHTSA, 573 F. 2d 632 (9th Cir. 1978); Chrysler vs. Dot, etal, 472 F. 2d 659 (6th Cir. 1972); I.H. etal vs. Ruckelshaus, 486 F. 2d. 375 (D.C. Cir. 1973).

Another major concern with EPA's proposed solution to the incomplete vehicle problem was the claim that even if it were known how to determine the worst case of a parameter, finding the completed vehicle which incorporated that worst case would be impossible. GM stated that "a large portion of these (incomplete) vehicles are ordered through dealerships; for these order, General Motors has no direct knowledge of who the purchaser is, much less of what kind of finished body or cargo enclosure the secondary manufacturer intends to construct." Furthermore, GM claimed that only in a limited number of sales does it have contact with a secondary manufacturer and "even for these orders we frequently have little or no knowledge of the final form, the method of construction, and the materials used on the completed vehicle. Also, "the secondary manufacturer may not know the final form of the vehicle when he contracts with General Motors or its dealer to provide a chassis. It is common practice for such manufacturers to order chassis in speculation of subsequent resale and then finish the vehicle construction on receipt of a final customer order." Thus, GM states that "the blatant unreasonableness of requiring a manufacturer to 'seek and find' worst cases in the market place alone should have prevented this regulation from being proposed..."

Ford, Chrysler and IH agree that due to the unlimited variety of secondary manufacturer modifications and the fact that these modifications are done by hundreds of secondary manufacturers outside the primary manufacturers' knowledge, EPA's proposed scheme is unreasonable and overly burdensome. IH included a Federal Register listing of several hundred bonafide motor vehicle manufacturers. GM and Chrysler stated that even if the above problems were to be resolved, the prevention of sale of an engine/chassis/fuel system combination in any form because a worst case configuration fails the certification test is obviously unjust.

Another problem that the primary manufacturers expressed concern about was that they would lose control of their certification timing. They claimed that once they produced the engine/chassis for an emission-data vehicle they would have to ship it to a secondary manufacturer in order to complete it in its worst case configuration. They claimed that this could take months and they wouldn't have any control over the work. This would delay their certification program so much that they might not be able to finish certification before production was scheduled to begin.

Beyond the practical problems of defining and then discovering a worst case final configuration, the commenters claimed that the proposal would impose vicarious liability on the primary manufacturer. They claimed that secondary manufacturers perform many additions and/or modifications which could influence evaporative emissions. Some of these additions or modifications have not been accounted for in EPA's proposal. For example, relocations or revisions to exhaust systems, the use of paints, sealers and sound deadeners, the installation of permeable plastic fuel tanks, and the particular placement of operator's enclosures in relation to exhaust system components can all affect evaporative emissions but the proposal does not address these items. Thus, the primary manufacturer could certify an incomplete vehicle which is then completed by a secondary manufacturer who stays within the worst case limits set by the primary manufacturer. The completed vehicle would be covered by a certificate of conformity. However, the vehicle could later be found to be in noncompliance because of additions and/or modifications for which there were no worst case limits. The commenters claimed that the proposed regulation would make the primary manufacturer liable even though noncompliance was not their fault.

GM and MVMA claimed that Congress clearly intended that the incomplete vehicle manufacturer should warrant the vehicle it produces and the subsequent manufacturer should warrant the product it produces (i.e., the remainder of the vehicle as completed by it). They cited Section 216(1) of the Clean Air Act which defines "manufacturer" as any person engaged in the manufacturing or assembly of new motor vehicles or new motor vehicle engines. GM cited four cases in which the court found that the Administrator lacks power to impose liability upon a blameless party for the acts of another beyond his control. These cases include: Chrysler Corp., etal vs. EPA, 600 Fed 2d 904 (1979); Amoco Oil Co. vs. EPA, 177 U.S. App. C.C. 123, 543 F. 2d. 270 (1976); Amoco Oil Co. vs. EPA, 163 U.S. App. D.C. 162, 188-180, 504 F. 2d. 722, 748 (1974); and Rex Chaimbelt, Inc. vs Volpe, 486 F. 2d. 757, 762 (7th Cir. 1973). The other primary manufacturers also claimed that the proposal imposed vicarious liability on them and, therefore, it was illegal.

The primary manufacturers were in general agreement on a recommended solution to the incomplete vehicle problem. They stated that EPA should only require that the vehicle meet emission control requirements at the time that it left the primary manufacturers control. Ford stated that incomplete vehicles should be certified in their "incomplete" state. GM suggested that EPA could handle the liability problem in a similar way to how the Agency handled the noise control regulations liability problem.[1] The procedures developed from that case permit the manufacturer to state that the incomplete vehicle complied with applicable EPA noise control regulations at the time it left the manufacturer's control.

GM included labeling language which would be placed on all incomplete vehicles leaving the primary manufacturer's control. GM suggested the following label:

"This vehicle conformed to the U.S. EPA certification regulations applicable to 19__ Model Year New Motor Vehicles at the time it left (insert initial incomplete vehicle manufacturer's name) control, provided it was not equipped with a temporary fuel system.

NOTICE

Any subsequent manufacturer who installs any permanent fuel system or modifies an existing permanent fuel system on this vehicle is required to obtain prior approval from the Environmental Protection Agency."

GM goes on to say that the above label would require EPA to develop a clear testing procedure for certification of incomplete vehicles and to develop a means by which secondary manufacturers could obtain approval for new, permanent fuel systems or modifications of existing systems.

MVMA suggests that "EPA could require the primary manufacturers to certify that an incomplete vehicle is capable of being made to conform to applicable emissions regulations when completed within the manufacturer's fuel system specifications. Such a statement could accurately reflect the extent to which an incomplete vehicle manufacturer can predict compliance of a vehicle whose eventual design and end-use are unknown at the time when the statement is made."

The three trade associations (NTEA, NADA, and TBEA) that represent secondary manufacturers were concerned that the primary manufacturers would not include a wide enough range for the worst case limits. NTEA stated that the primary manufacturer does not know what the worst case limits should be because of insufficient information. These trade associations all commented that most secondary manufacturers do not have the resources to purchase the necessary test equipment to run a full-SHED test. Thus, many secondary manufacturers might be forced out of business thereby leaving the business to "large secondary manufacturers and 'shadetree' mechanics." TBEA stated that primary manufacturers don't offer enough options and modifications for all truck customers and, therefore, a buyer will no longer be able to purchase the truck that really meets his requirements. NADA pointed out that the price of HDGs would be raised due to any testing costs. NADA also suggested that EPA expand "worst case" to include all modifications by secondary manufacturers and require the primary manufacturers to inform the secondary manufacturers of such worst case limits.

Analysis of Comments

The comments received on this complex issue were very useful and have helped to clarify the problems involved. In summary, the primary manufacturers had three main areas of concern. First, they felt that some of the parameters listed in the NPRM were related to evaporative emissions in a vague and ill-defined way so that determining a worst case situation would be very difficult. Second, they felt that the burden of finding all of the modifications and/or additions to incomplete vehicles in order to determine a worst case vehicle was intolerable. Finally, they were concerned about their liability if in-use testing showed a modified vehicle to be in noncompliance. This analysis will address the first two areas in a combined way and then the liability question will be discussed.

Information obtained from the four primary manufacturers (see the docket) indicate that the number of HDGs which leave the factories in an incomplete form is substantial. Ford indicated that 55 percent of their medium-duty gasoline-fueled trucks (8500-11,000 lbs. GVW) are incomplete and 100 percent of their 16,000 lbs. and above GVW vehicles are sold as incomplete. (Ford produces very few HDGs in the 11,000-16,000 lbs GVW range.) Chrysler told us that approximately 10 percent of their 8500-10,000 lbs. GVW HDGs are incomplete and virtually all of their 10,000-14,000 lbs. GVW HDGs are incomplete. (Chrysler doesn't produce HDGs over 14,000 lbs. GVW). IH only produces HDGs over 16,000 lbs. GVW and it indicated that virtually all of such vehicles leave its plants in an incomplete form. GM indicated that about 30 percent of its HDGs below 14,000 lb. GVW and about 80 percent of those above 16,000 lbs. GVW are sold as incomplete vehicles. Incomplete fuel systems and incomplete cargo areas are the major items that are not finished. The total number of incomplete HDGs approaches 50 percent of all HDGs produced. This is considerably more than we had believed when this regulation was proposed.

In addition there are hundreds of secondary manufacturers. The list of bonafide motor vehicle manufacturers that IH submitted has 256 companies on it. This list was published in the Federal Register on June 23, 1980. It contains only those companies that wish to obtain duty-free Canadian articles. Thus, it is likely there are a number of secondary manufacturers which are not on the list because they do not import Canadian articles. Also, there are probably some secondary manufacturers who could be on the list but have chosen not to be or are not aware of the list. Perhaps a more accurate assessment of the number of secondary manufacturers is the membership total of the Truck Body and Equipment Association. TBEA currently has 700 members.

When the large number of incomplete vehicles produced is combined with the fact that there are hundreds of secondary manufacturers, the problems involved in expecting the primary manufacturers to determine the worst case for each evaporative emission parameter listed in the NPRM become obvious. The primary manufacturer would have to contact every customer of incomplete HDGs it has and attempt to determine what additions and/or modifications to each listed parameter the customer plans to make. Some of those customers would be dealers who buy incomplete vehicles without knowing to whom they will ultimately be sold, let alone what kind of modifications and/or additions will eventually be made. These dealers typically buy chassis/cab combinations on the expectation that someone will want to purchase them at some future time. The dealer has no knowledge of who the ultimate purchaser might be or what the final, completed vehicle will be like.

Not only would the primary manufacturers have to investigate in detail each of its customers' vehicle completion plans but for some of the evaporative emission parameters listed in the NPRM a worst case determination would be quite difficult. For example, little is known about the effect of "body type" on evaporative emissions. While different body types undoubtedly trap heat around the fuel tank(s) and line(s) to different degrees thus changing the amount of evaporative emissions, there is no data on the extent that a certain body type might increase emissions over one or more other body types. In the NPRM, we assumed that there were relatively few incomplete vehicles sold and, therefore, the effort to determine which body types were worst case would be minor. However, in light of the fact that there are such a great number of incomplete vehicles sold, most of which are sold without the body, the burden placed on the primary manufacturers would be excessive. Therefore, "body type" is omitted from the final rule.

EPA also included, in the NPRM, an open-ended statement of evaporative emission parameters. This statement was "and other features as specified by the Administrator" and was included so that we could add additional parameters if we discovered the need to do so. Because we believed the number of incomplete vehicles was relatively small, we considered the potential burden of such an open-ended statement to be minimal. However, since the number of incomplete vehicles is substantially greater than we had expected, we agree with the manufacturers who claimed that such an open-ended requirement is unreasonably burdensome and we are recommending that the statement be dropped.

Another parameter included on the list in the NPRM was "fuel system". This term refers to the fuel lines, their routings, the fuel tank, the fuel pump and the carburetor. (The NPRM listing includes fuel tank volume and carburetor bowl fuel volume as separate parameters.) While it is doubtful that secondary manufacturers would modify the fuel tank (unless they are adding extra fuel tank volume), the carburetor or the fuel pump, they do occasionally reroute and modify fuel lines in order to accommodate the body type. The location of a fuel line with respect to heat sources can affect evaporative emissions since fuel lines permeate HC vapors in proportion to temperature exposure. Furthermore, different fuel line materials will permeate HC vapors at different rates. Under the incomplete vehicle requirements in the NPRM the primary manufacturers would have had to determine which modifications to the fuel lines would be worst case. Again, due to the large number of incomplete vehicles, the proliferation of secondary manufacturers, and the lack of hard data on the extent that increased temperatures would increase HC vapor permeation we are recommending that fuel lines be deleted from the incomplete vehicle requirements except that secondary manufacturers will have to use non-metal fuel line material which is at least as impermeable as the material used by the primary manufacturer.

The omission in the final rule of "body type," "fuel lines" and "other features as specified by the Administrator" should substantially decrease the burden on the primary manufacturers. While these parameters affect evaporative emissions to some extent, we believe the effect is not large and that the increase in emissions due to these factors will be small. We are also recommending that the parameters of maximum GVWR and maximum frontal area be dropped from the list. It would be difficult to determine a maximum frontal area because of the custom orders received by secondary manufacturers. Furthermore, this parameter should not have a major impact on evaporative emissions anyway. In regards to maximum GVWR, the primary manufacturer sells a chassis/engine combination with some designated maximum GVWR limit based on the strength of the chassis. This is necessary so that the secondary manufacturer does not complete the vehicle and then recommend a maximum GVWR which is too large for the strength of the chassis. Therefore, the manufacturers should know the proper GVWR of each incomplete vehicle for evaporative emission control system development purposes and that control system should be sufficient (at least in terms of GVWR) for the completed incomplete vehicles. In summary then, we recommend that "body type", "fuel system", "maximum GVWR", "maximum frontal area" and "other features as specified by the Administrator" be deleted from the list of evaporative emission parameters to be considered in the treatment of incomplete vehicles because even their combined effect on evaporative emissions is expected to be minimal and the burden on the primary manufacturers if they were required to find each worst case could be excessive.

The other parameters listed in the NPRM should be retained in the final rule. These parameters are carburetor fuel bowl volume, method of vapor storage, vapor storage material, vapor storage working capacity, method of carburetor bowl venting, and vapor purging technique. (Fuel tank volume will be discussed separately below.) These six parameters of the evaporative emission control system should not and probably would not be modified by secondary manufacturers. When a secondary manufacturer completes an incomplete vehicle by adding the body or adding an operator's enclosure there should be no reason why that secondary manufacturer needs to modify and/or add to these six control system parameters. For example, a secondary manufacturer shouldn't need to switch carburetors, which might change the fuel bowl volume and the method of carburetor bowl venting. The engine that was ordered with the chassis should have the desired carburetor. The vapor purging technique will likely be engine specific also and, therefore, the secondary manufacturer should not need to modify it. Certainly the secondary manufacturer should have no reason to change the method of vapor storage or the vapor storage material. The vapor storage working capacity might need to be modified if the secondary manufacturer added fuel tank capacity above that for which the primary manufacturer had designed the control system. This potential problem will be discussed below under the topic of liability.

These six parameters, in addition to being listed in the NPRM for incomplete vehicle consideration, are evaporative control family-system determinants in the proposed as well as the recommended final vehicle classification scheme. The purpose of both classification schemes is to divide each manufacturer's product line into groups of vehicles which are expected to emit approximately the same amount of HC vapors (family) and have the same control system (system). Since these six parameters are recommended to be evaporative control system determinants, modification by secondary manufacturers would not be permitted without recertification.

This is current Agency policy in the light-duty truck (LDT) area. Some LDTs are sold as incomplete vehicles or are modified by secondary manufacturers. Secondary manufacturers who modify vehicles so as to remove them from inclusion in the engine-system, evaporative emission family and/or evaporative emission control system combination in which the original vehicle was certified may be subject to the proscriptions against tampering or selling uncertified vehicles. We recommend that this policy be retained in this HDG regulation. Thus, the modification of the six parameters discussed above (as well as the other evaporative control system determinants listed in the issue "Certification Procedure") could constitute tampering and would, therefore, be illegal unless the vehicle was recertified. However, secondary manufacturers should not have to recertify because the parameters selected as evaporative family-system determinants should not have to be modified. (The upgrading of hydrocarbon storage devices is an exception as will be discussed below).

The final parameter listed in the NPRM for consideration under the proposed incomplete vehicle requirements is "fuel tank volume." Unlike the other parameters which we have recommended to delete in this final rule because their impacts on evaporative emissions are considered to be minor, fuel tank volume is known to have a major impact on evaporative emissions. In its comments to this rulemaking, GM claimed that every 10 gallon increase in fuel tank volume results in a 0.18 gpt increase in controlled evaporative emissions. In the NPRM we presented data showing only a 0.05 gpt increase in evaporative emissions with a 10 gallon increase in fuel tank volume. Although there is a substantial difference between GM's and our claims, both are significant when it is noted that HDGs can have fuel tank volumes of up to 150 gallons. If a secondary manufacturer added fuel tank capacity to bring the total from 40 gallons to 150 gallons, GM's data would predict a 1.98 gpt increase in controlled emissions while our data would predict a 0.55 gpt increase. Both increases could cause a vehicle to emit above the level of the standard. Another factor to remember is that these increases assume that the working capacity of the HC vapor storage system and the purging system are adequate to handle the increase in uncontrolled HC emissions resulting from the fuel tank volume increase. If the working capacity was not sufficient, breakthrough would occur causing much higher in-use emissions than those predicted above. If the purging system could not adequately purge the storage devices, then those devices would eventually become overloaded causing breakthrough also. It is clear that the problem of increased fuel tank volume should not be dismissed as minor.

Discussions with the primary manufacturers have revealed that a large majority of orders for incomplete vehicles include permanent fuel tanks of a specified volume. Chrysler and IH informed us that all of their incomplete HDGs have permanent fuel tanks installed when they leave the factory. Ford said that only about 10 percent of its over 16,000 lbs. GVWR vehicles (all of which are sold incomplete) do not have permanent fuel tanks. Instead, these vehicles have a small, temporary fuel container used to move the vehicle through the delivery system. GM told us that only about 10 percent of its HDGs less than 14,000 lbs. GVWR are sold with incomplete fuel systems.

Thus, there are relatively few incomplete HDGs that leave the factory with the final fuel tank volume of the completed vehicle unknown. In addition to the few HDGs that leave the factory without permanent fuel tanks there are also some HDGs that will have an extra fuel tank(s) added to the permanent, factory-installed fuel tank(s). This might occur, for example, in the case of a dealer who buys a chassis/engine combination without having a customer for it. When the customer does materialize he might want an additional amount of fuel capacity. We do not know the total number of instances where HDGs have fuel tanks added after they have left the factory but we believe the number to be small. We believe the primary manufacturer can, with relative ease, make a good faith effort to seek and find most of these situations and inform the potential dealers/customer that the evaporative emission control system must be adequate to handle the HC emissions from the vehicle in its completed configuration. Once the dealers/secondary manufacturers become aware of the requirement, we expect that they will inform the primary manufacturers of the total fuel tank volume that they foresee the completed vehicle having. The primary manufacturer will then supply the appropriate evaporative emission control system with the incomplete vehicle. Therefore, we recommend that fuel tank volume be retained as a parameter which must be considered for certification of incomplete vehicles.

It should be noted that "fuel tank volume" is not an evaporative family-system determinant. It was a family determinant in the proposed vehicle classification system, however, we are recommending that it be deleted in the final rule in order that the primary manufacturers can have greater flexibility in grouping their product lines. For example, one manufacturer might choose to have a wide range of fuel tank volumes controlled by a single evaporative emission control system which would imply overdesign for the lesser fuel tank volume vehicles whereas another manufacturer might choose to design separate control systems for each fuel tank volume he sells thereby having no overdesign but having, instead, more family-system combinations to certify.

To summarize, the primary manufacturer will place each incomplete vehicle he wishes to sell into an evaporative emission family-evaporative emission control system combination. The family determinants will be the method of fuel/air metering (i.e., fuel injection vs. carburetion) and the carburetor fuel bowl volume (within a 10 cc range). The control system determinants will be the method of vapor storage, the method of carburetor sealing, the method of air cleaner sealing, the vapor storage working capacity (within 20 grams), the number of storage devices, the method of purging stored vapors, the specifications of the purge system, the method of venting the carburetor during both engine off and engine operation, the liquid fuel hose material, and the configuration of the storage system for fuel tank emissions. Manufacturers must certify that each family-system meets the standards as built, up to a stated maximum fuel tank capacity. For incomplete vehicles, the primary manufacturers can use a typical frontal area in the road load equation for determination of the dynamometer horsepower setting. The large majority of incomplete vehicles will have permanent fuel tanks installed at the factory. These incomplete vehicles can be certified with that fuel tank volume. For incomplete vehicles, the primary manufacturer will include a label which states that the evaporative control system that is supplied with the vehicle was designed to handle a specified maximum fuel tank volume.

Situations where the secondary manufacturer will add fuel tank volume beyond the maximum specified by the primary manufacturers are expected to be few. As discussed above, that portion of all incomplete vehicles which leave the factory without permanent fuel tanks is small and, for the majority of them, the primary manufacturer will supply a control system designed to handle the emissions of the fuel tank(s) when the HDG is completed. Secondary manufacturers who order incomplete HDGs and install fuel tanks should tell the primary manufacturers what amount of fuel tank capacity they plan to install. The primary manufacturers will then supply a control system large enough to handle that fuel tank capacity.

However, there will still be some instances where a secondary manufacturer may want to increase the fuel tank capacity beyond the maximum specified by the primary manufacturer. For example, the secondary manufacturer might not know the ultimate desired fuel tank capacity until after the incomplete vehicle has been purchased. This situation might occur where a secondary manufac turer buys an engine/chassis combination without knowing who the ultimate owner might be. Information available to the Agency does not indicate that these "custom-made, third party" HDGs are common and the few that do occur will most probably require total fuel tank capacities which are within the limit set by the primary manufacturer.

For those few instances where a secondary manufacturer wishes to exceed the primary manufacturer's fuel tank volume, the secondary manufacturer will be required to increase the adsorption capacity of the hydrocarbon storage device(s) according to the following formula:

$$Cap_f = Cap_i \left(\frac{T.\ Vol.}{Max.\ Vol.}\right)$$

Where:

Cap_f = Final amount of fuel tank vapor storage material in the hydrocarbon storage device, grams.

Cap_i = Initial amount of fuel tank vapor storage material in the hydrocarbon storage device as supplied by the primary manufacturer, grams.

T. Vol. = Total fuel tank volume of vehicle when completed, gallons.

Max. Vol. = Maximum fuel tank volume as specified by the primary manufacturer, gallons.

The above equation increases the capacity of the hydrocarbon storage device in proportion to the increase in the fuel tank volume. This is being done because the increase in emissions is essentially proportional to the increase in fuel tank volume. Therefore, we have concluded that the resultant increase in vapor storage material will be sufficient to control the increased vapors from the larger fuel tank.

If the secondary manufacturer needs to add a second canister rather than just change to a larger canister than that supplied by the primary manufacturer, the secondary manufacturer shall hook up the new canister in series after the first one and the first canister must be sealed to eliminate any openings to the atmosphere. Also, the second canister's elevation shall be equal or higher than the first canister's. Any fuel vapor hosing used by the secondary manufacturer must be at least as impermeable to hydrocarbon vapors as that used by the primary manufacturer and the vapor storage material must have the same adsorptive characteristics as that used by the primary manufacturer.

A secondary manufacturer who wishes to add fuel tank capacity beyond the maximum specified by the primary manufacturer will be required to submit a written statement to the Administrator that it has upgraded the hydrocarbon storage device(s) according to the requirements discussed above.

This discussion will now turn to the question of liability. The primary manufacturers were concerned that this regulation, as proposed, would leave them liable for modifications and/or additions to incomplete vehicles which caused those vehicles to be in noncompliance with the standard. This Final Rule will clarify this point. Each incomplete vehicle will be certified as meeting the standards as built, at some GVWR, at some frontal area and with some maximum fuel tank volume. Also, these vehicles will all have evaporative emission control systems designed to contain the HC vapors emitted. If a secondary manufacturer adds fuel tank volume above the primary manufacturer's specified maximum, or changes any other parameters, then potential liability for noncompliance will shift to the secondary manufacturer if the change is the cause of the noncompliance.

The principal arena for questions of liability is the area of in-use emissions. Although, EPA has the option of doing in-use testing of HDGs for evaporative emissions (see the issue "Certification Procedure"), we do not have plans for such testing. However, if EPA does in-use testing, it would normally be limited to situations where a number of HDGs are suspected of evaporative emissions well above the standard. Since the parameters that secondary manufacturers would be able to modify (without recertification) are expected to have a minimal affect on evaporative emissions (e.g., body type, relocation of exhaust, frontal area), the need for a comprehensive in-use testing program would most probably be the fault of a primary manufacturer's inadequate design or component defects and excess emissions would show up in a wide variety of secondary configurations. Should this not prove to be the case, then the Agency would fully investigate to determine appropriate placement of liability. If the primary manufacturers make a good faith effort in designing and producing HDG evaporative emission control systems and if they properly transfer the limitations and assemblage instructions of those systems to the secondary manufacturers, then EPA should have little reason to exercise its option to do in-use evaporative emission testing of HDGs.

Recommendation

We recommend that the primary manufacturer place each of its incomplete vehicles in an evaporative emission family-control system grouping as defined in the issue "Certification Procedure." Each incomplete vehicle will have a label on it specifying the maximum fuel tank volume that the control system was designed for. Secondary manufacturers will be responsible for correct assembly of the evaporative emission control system (if applicable). Secondary manufacturers will be subject to tampering regulations if they modify the control system so as to remove the vehicle from its original, certified family-system combination. If a secondary manufacturer wishes to add fuel tank volume in excess of that specified by the primary manufacturer, then it must submit a written statement to EPA that it has upgraded the hydrocarbon storage device(s) as required.

References

1. Chrysler Corp., etal vs. EPA, 600 Fed. 2d. 904 (1979).

C. Issue: Technical Feasibility

Summary of the Issue

In the NPRM EPA proposed an evaporative emission standard for gasoline-fueled heavy-duty vehicles (HDGs) of 3.0 grams per test (g/test). The preamble to the proposed regulations included EPA's rationale in support of the technical feasibility of the proposed standard. That discussion examined: 1) the level of evaporative emission control for light-duty trucks (LDTs), and 2) the differences between LDTs and HDGs with regards to evaporative emissions. One major difference is that maximum fuel tank capacities are greater for HDGs. While LDTs usually don't have maximum fuel tank capacities exceeding 40 gallons, HDG fuel tank capacities can exceed 100 gallons. A regression analysis of 1979 model year LDT certification data predicted (although there was not a strong correlation) that a 10 gallon increase in fuel tank volume results in a .05 g/test increase in total controlled evaporative emissions. Thus, a 100-gallon fuel tank would have 0.3 g/test higher evaporative emissions than a 40 gallon fuel tank.

Additionally, the preamble cited data gathered by the American Petroleum Institiute (API) as part of a refueling loss study which demonstrated an efficiency of 99.5 percent in controlling evaporative losses. Since both industry and EPA have shown that an uncontrolled, 100-gallon fuel system generates about 50 grams of HC during the diurnal part of the evaorative emissions test, the API result indicates that a 100-gallon fuel tank can be controlled to a level of 0.23 grams (50 grams HC x (100% - 99.55%)).

Another difference between LDTs and HDGs is that nonfuel or "background" evaporative emission levels are expected to be higher for HDGs. Sources of background HC emissions include paint, tires, sealers and sound deadeners. Since HDGs are, on the average, larger than LDTs, the amounts of such background sources of HC are also larger. For example, payload boxes on trucks such as large delivery vans use more paint than the payload area of a pickup truck. EPA tested a new 1977 Ford truck for background emission levels and found that it emitted about 0.6 g/test. Ford tested a LDT and found that it emitted 0.31 g/test. These results indicate that HDGs emit about 0.3 g/test more background emissions than do LDTs and the proposed standard for HDGs accounted for this.

A third difference between LDTs and HDGs that affects evaporative emissions is the volume of the carburetor fuel bowl. The main source of HC emissions during the hot-soak portion of the SHED test is the carburetor fuel bowl. Increasing fuel bowl volume and increasing peak temperatures both contribute to increasing hot-soak losses. With regard to temperature, data submitted to EPA by Ford indicated that higher engine output, as required in the HDG driving schedule as compared to the LDT driving schedule, does not result in higher carburetor gasoline temperatures during the hot-soak test. So LDTs and HDGs see about the same carburetor fuel bowl temperatures. Typically, LDTs have fuel bowl volumes ranging from 70 cc to 150 cc. We believed that HDGs had maximum fuel bowl volumes of 268 cc. One 1979 LDT family also had a carburetor fuel bowl volume of 268 cc. Three of these LDTs with a carburetor fuel bowl volume of 268 cc were tested for evaporative emissions and the best of these three tests was 2.2 g/test. This data demonstrated the feasibility of controlling evaporative emissions from vehicles with carburetor fuel bowl volumes representative of large HDGs to a level below 3.0 g/test.

Using the above worst case situations, EPA determined that a 3.0 g/test standard was technically feasible. A LDT with a large carburetor fuel bowl volume (268 cc) emitted 2.2 g/test. If this vehicle had a total fuel tank capacity of 100 gallons, then it might have emitted an additional 0.3 g/test. Furthermore, if this LDT was physically as large as the bigger HDGs, then it might have emitted an additional 0.3 g/test in background emissions. The summation of the above worst case conditions yields a total of 2.8 g/test. Therefore, the proposed HDG evaporative emission standard not only appeared to be technically feasible but allowed for a safety margin as well.

Summary of Comments

The four primary HDG manufacturers (GM, Ford, Chrysler, and IH) were the only commenters on this issue. In general, the commenters felt that a 3.0 g/test standard could be met for the lower weight classes of HDGs although they differed as to what weight range to use. GM stated that its HDGs of 12,000 lbs. GVW or less could meet the proposed standard. Ford commented that the 3.0 g/test level would be appropriate for its 14,000 lbs. GVW and under HDGs. IH stated that the cut-point should be 16,000 lbs. GVW. IH does not produce any HDGs in the lower weight classes. Chrysler did not discuss what level of control its HDGs could meet. Instead, Chrysler claimed that EPA's rationale and data used to show the 3.0 g/test standard to be technically feasible was inadequate.

GM and Chrysler specifically attacked EPA's technical feasibility rationale as given in the preamble of the NPRM. Both manufacturers claimed EPA's conclusion that HDGs would emit about 0.3 g/test more than LDTs because of increased fuel tank capacities was invalid. GM SHED tested two HDGs: one with a fuel tank capacity of 40 gallons and one with a fuel tank capacity of 100 gallons. The difference between the diurnal portions of the two tests was 1.06 grams of HC. GM concluded, therefore, that a 10-gallon increase in fuel tank capacity would result in a 0.18 gram increase in diurnal test emissions rather than the 0.05 gram increase that EPA had concluded. Chrysler claimed that a report[1] by EPA showed that losses are not directly proportional to the volume of the fuel tank and, therefore, there must be other tank factors besides volume contributing to the diurnal losses. From this Chrysler concluded that EPA's estimate that a 100-gallon fuel tank would emit 0.3 g/test more than a 40-gallon tank was not valid. Furthermore, Chrysler stated that the API refueling study is irrelevant and may have been biased because the API wanted to show that on-board refueling loss control systems would be better than stationary recovery systems.

GM and Chrysler both claimed that EPA's estimate of the difference in background emissions between HDGs and LDTs is invalid. GM tested background levels of two HDGs and found significantly higher background emission rates than EPA's estimate. GM's background data on these two trucks (both 1-1/2 years old and thoroughly cleaned) are as follows:

Vehicle	Diurnal Background (g)	Hot-Soak Background (g)	Total Background (g)
Chevrolet Pickup	.18	.60	.78
GMC Tractor	.86	1.46	2.32

GM went on to estimate that 95 percent of the pickup's and 55 percent of the tractor's background emissions were due to vapor permeation through liquid fuel hoses. GM recommended that an EPA/Industry work group be formed to find a better solution to the background emissions problem.

GM and Chrysler claimed that EPA's estimate of background emissions was based on insufficient data because only one heavy-duty truck was tested. Furthermore, Chrysler stated that there was no indication that the one truck tested was a worst case situation and GM stated that since the truck was a 1977 model, it was not state-of-the-art. Chrysler recommended that background levels be measured and then subtracted from certification test results.

GM, Chrysler and IH questioned the technical feasibility of controlling hot-soak losses from carburetors with large fuel bowl volumes. GM stated that while EPA had claimed that the maximum fuel bowl volume for HDGs was 268 cc, it markets a carburetor with a fuel bowl volume of 400 cc. Thus, EPA has not shown feasibility for this worst case. Chrysler stated that EPA's use of the lowest test result from the three tests of 1979 LDTs with fuel bowls of 268 cc was unfair. The lowest result was 2.2 g/test but the other two tests yielded 2.7 g/test and 4.5 g/test. IH concluded from its HDG evaporative testing program (13 tests) that "four-barrel engines may be more difficult to control than two-barrel engines. This may suggest that the 3 gram standard may be too stringent for a four-barrel engine." IH did not indicate why four-barrel engines may be harder to control but larger fuel bowl volumes may be a contributing factor.

In the preamble to the NPRM, EPA presented certification data which showed that LDTs could be controlled to less than 3.0 g/test. GM stated that while 69 of the 137 LDT evaporative tests for 1979 model year certification had results as low as 2.2 g/test, the remaining 68 vehicles averaged emissions of 3.56 g/test. Thus, GM claimed that rather than proving evaporative emissions could be controlled below 3.0 g/test for LDTs, this data showed that a large percentage of LDTs, using the best available technology in control hardware, failed to meet a 3.0 g/test standard.

GM and Chrysler both claimed that EPA's use of light-duty data and experience to predict HDG evaporative emissions is invalid. Chrysler stated that since the proposed HDG driving cycle and test procedure are different than the light-duty driving cycle and test procedure, LDT test results are not equivalent to future HDG test results and thus cannot be used to predict HDG evaporative emissions. GM cited EPA as stating in 44 Federal Register at page 46298, column 2 (August 7, 1979) that: "Large heavy-duty trucks have characteristics different from those of trucks under 8,500 lbs." This statement referred to evaporative emissions. GM then stated that in spite of the above statement, EPA used LDT test methods and projections of LDT test results to predict HDG evaporative emissions. In GM's opinion there is no technical rationale "which supports EPA's new and inconsistent treatment of (HDGs)."

Since EPA allegedly did not adequately demonstrate the technical feasibility of the proposed standard, Chrysler stated the Agency has not fulfilled its statutory obligation to do so, found in the Clean Air Act, §202(a)(2) and §202(b)(1)(C). GM claimed that EPA failed to live up to its obligation to consider the representativeness of the test data used to develop and justify the standard. GM claimed that this obligation was recently reaffirmed in National Lime Association vs. EPA, D.C. Circuit, No. 78-1385, May 19, 1980.

GM also suggested that background emissions will cause production HDGs to exceed the standard at the time of their introduction into commerce and that the legal implications of this should be addressed by EPA. GM stated that although the preamble indicated that a manufacturer can reduce background emissions for HDG certification testing in similar ways as they are allowed for in light-duty evaporative emission testing, the regulations do not mention this.

Ford did not discuss EPA's technical feasibility rationale. Instead Ford conducted an extensive HDG testing program. Ford tested four HDGs a total of 126 times. This is far more testing than done by either GM (5 tests) or IH (13 tests). Table 1 is Ford's testing summary sheet. Ford also ran a total of three background tests on a HDG. From its testing results Ford concluded the following three points:

1. The current capability of the existing California control system, using the proposed test procedure, is about 3.0-4.0 g/test based on testing of high volume trucks which are relatively lightweight.

2. Because the emission level is a function of the test procedure used, a new development program would be required to modify the existing Ford/California systems to assure compliance with the proposed Federal 3.0 g/test standard. Anticipated areas of need improvements are:

a. Design of new purge control systems

b. Carburetor bowl vent design changes

c. Fuel system vapor integrity improvements

3. Background HC levels on aged HDG vehicles are most probably in the area of 0.5 g/test.

Ford's technical comments describing the effect of different vehicle inertia weights and driving cycles will be discussed in the next section, "Analysis of Comments". In general, Ford did not indicate the proposed 3.0 g/test standard would be infeasible but rather that the control of HDGs to this level would not be possible by 1983 due to leadtime and facility problems.

Analysis of the Comments

In general, the commenters agreed with EPA that a 3.0 g/test standard will be feasible for the lighter HDGs. GM stated "We recommend that a 3 g/test standard be implemented for (HDGs) below 12,000 GVW. We believe that the technology does exist to meet the three gram limit on the smaller HDVs which have background rates more closely related to LDT". Ford stated that based on its test program "The current capability of the existing California control system, using the proposed test procedure, is about 3.0-4.0 g/test based on testing of high volume trucks which are relatively light-weight". The HDGs Ford tested had inertia test weight (IW) settings which ranged from 6250 lbs to 36,000 lbs. Since the final test procedure calls for IW settings equal to 50 percent of GVW, we presume that the HDGs Ford tested were representative of HDGs with GVWs of 12,500 lbs to 72,000 lbs. Ford also stated that it "believes that the present evaporative control systems for LDT could be extended to 8500-14,000 lb GVW vehicles by 1983

Table 1

Ford's Vehicle Test Results Summary

Vehicle Number	Test Numbers	Route	IW & HP Setting	Average Grams/Test
C-700 #402	8 thru 14 (7)	Heavy-Duty	19,250/59.6	2.99
Total Tests	16 thru 18, 20, & 21 (5)	Heavy-Duty	19,250/88.7	3.31
Run = 36	22 thru 25 (4)	Heavy-Duty	36,000/110	4.54
	28	Heavy-Duty Dual	36,000/110	5.30
	32, 33, 36 (3)	Heavy-Duty Dual	19,250/88.7	3.02
C-700 #411	9 thru 14 (6)	Heavy-Duty	19,250/59.6	2.71
Total Tests	17, 18, 20, 21, 22 (5)	Heavy-Duty	19,250/88.7	3.15
Run = 39	24 thru 28 (5)	Heavy-Duty	36,000/110	4.80
	29, 30, (2)	Heavy-Duty Dual	36,000/110	3.23
	35, 36, 39 (3)	Heavy-Duty Dual	19,250/88.7	4.02
F-350 #414	11, 12, 14 (3)	Heavy-Duty	7,000/53.3	2.98
Total Tests	15 & 16 (2)	Heavy-Duty	7,000/24.0	2.65
Run = 28	26 thru 28 (3)	Light-Duty	7,000/23.9	2.12
F-350 #415	6 thru 8 (3)	Heavy-Duty	6,250/22.9	2.74
Total Tests	10, 12 thru 14 (4)	Light-Duty	6,250/23.4	2.21
Run = 23	15 thru 19, 22, 23 (7)	Heavy-Duty	7,000/57.5	3.51

and Ford probably could recalibrate the system to meet the proposed 3 g/test standard with the associated test procedures."

IH tested three HDGs and concluded that "four-barrel engines may be more difficult to control than two-barrel engines. This may suggest that the 3 gram standard may be too stringent for a four-barrel engine." This is the only comment IH gave on what it considers to be a technically feasible level of control. Since IH does not produce HDGs in the lower weight classes (below Class VI), this discussion of technical feasibility for the lower weight HDGs does not apply to it. However, we will refer to IH's comments later in the discussion of the higher weight HDGs.

Chrysler's comments attacked EPA's derivation of the technical feasibility of the proposed 3.0 g/test standard but Chrysler did not indicate what level it believed was feasible. Since all of Chrysler's HDG production is in the lower weight classes (less than 16,000 lbs), the level of the standard for the lower weight HDGs is important to it.

GM and Ford both agree that the 3.0 g/test level of control is technically feasible for the lower weight classes of HDGs. LDTs, which go up to 8,500 lbs., are currently controlled to a level of 1.3 g/test (1981 certification testing average). The differences between LDTs and the lower weight classes of HDGs are relatively minor since typically these HDGs have similar fuel tank capacities (although somewhat larger), similar background emissions and, in most cases, they use carburetors which are also used on LDTs. A 3.0 g/test standard for HDGs would be 50 percent higher than the current LDT standard of 2.0 g/test which will more than compensate for these differences. Chrysler produces many LDTs and therefore, possesses the technical experience in controlling LDT evaporative emissions to the 2.0 g/test level. In light of the above, Chrysler should have no trouble controlling its HDGs, which are all relatively light weight, to the same level that GM and Ford have agreed to, that is, 3.0 g/test.

The above discussion verified that the proposed standard of 3.0 g/test is technically feasible for the lighter weight HDGs. However, the commenters disagreed somewhat as to the exact weight level at which the 3.0 g/test standard would no longer be appropriate. GM commented that the split between "light" HDGs and "heavy" HDGs should be 12,000 lbs GVW while Ford claimed it should be at 14,000 lbs GVW. Chrysler did not comment on this but IH mentioned 16,000 lbs GVW as a good breakpoint.

From Ford's and GM's comments it is clear that the breakpoint should be in the range of 12,000 lbs GVW to 14,000 lbs GVW. GM gave no reason why it had chosen 12,000 lbs GVW. Ford did not give a reason either but its choice of 14,000 lbs

GVW coincides with the breakpoint between heavy-duty Classes III and IV and we assume that is why Ford chose 14,000 lbs GVW. Maximum fuel tank capacities and vehicle sizes (as they relate to background emissions) both gradually get larger with increasing GVW but there is much overlap between HDGs in the narrow weight range of 12,000 to 14,000 lbs. In fact, it is highly unlikely that any discernible difference in these parameters could be detected even if an exhaustive study were undertaken comparing HDGs of 12,000 GVW to those of 14,000 lb GVW. Therefore, we will make the split at 14,000 lbs GVW so as to coincide with the widely accepted HDV class groupings. Thus, all HDGs in Class III and below (less than or equal to 14,000 lb GVW) will be required to meet the standard of 3.0 g/test.

We now turn our attention to those HDGs with GVWs greater than 14,000 lbs GVW but less than or equal to 26,000 lbs GVW (Classes IV-VI) (HDGs with GVWs greater than 26,000 lbs will be certified by engineering evaluation.) These heavier HDGs will be more difficult to control because the three major factors contributing to evaporative emissions reach their respective maximums with increasing GVW. Maximum fuel tank capacity is expected to be around 150 gallons. This amount of fuel is needed on large HDGs where fuel consumption is highest to give such vehicles sufficient range. HDGs carrying the biggest loads require the biggest engines which in turn require carburetors with the maximum fuel bowl volumes. Finally, in many cases, those HDGs with the most painted surface area (and, therefore, the highest background emissions) are the largest HDGs both in terms of physical dimensions and GVW.

Our analysis of the feasibility of a 3.0 g/test standard for these "heavy" HDGs is positive but only marginally so. That analysis is based on extrapolation of light-duty increases in controlled emissions versus increases in fuel tank volume and carburetor fuel bowl volume. The only data on actual HDG evaporative emissions testing we have is that which the commenters supplied.

GM tested one relatively large HDG. The result of this test was 6.38 g/test. This vehicle was equipped with the 1979 California evaporative control system and no attempt was made to improve on that design. Two obvious improvements would be to use a less permeable liquid fuel line and to include activated charcoal in the air cleaner. Both of these control system strategies are standard light-duty technology. According to GM, the liquid fuel lines emitted 1.27 g/test and the addition of a carbon air cleaner might reduce the total test result by another 0.3 g/test. We have no doubt that further improvements could reduce the evaporative emissions from this HDG to below 4.0 g/test. GM states on page 15 of its final, written comments, "We recommend that a 3g/test standard be implemented for GFHDV below 12,000 GVW and a standard of 4 g/test for GFHDV above 12,000 GVW." Later, on page 16, GM states "In all of our previous responses to the EPA, we have always recommended a standard of 4 g/test for GFHDV." therefore, a level of 4.0 g/test is appropriate for GM.

Ford did the most testing by far. It tested HDGs with inertia weight settings of 6,250 lbs to 36,000 lbs. At the test weight requirement of 50 percent of GVW, these vehicles represent a GVW range of 12,500 lbs to 72,000 lbs which encompasses the range of GVWs to which the 4.0 g/test standard will apply (14,001 lbs to 26,000 lbs). Ford tested two, C-700 HDGs at an inertia weight setting of 19,250 lbs (i.e., a GVW of 38,500 lbs). The average result of these 23 tests was 3.02 g/test. This clearly shows the feasibility of the 4.0 g/test standard especially when it is remembered that these HDGs had little, if any, R&D. Ford states in its final comments that "the proposed 3 g/test standard for 1983 cannot be attained using the proposed test procedure because of lead time/facility issues." Thus, Ford indirectly admitted that the 3.0 g/test standard is technically feasible not only for the "light" HDGs but for the "heavy" HDGs as well. Ford also stated that based on its testing program, "the current capability of the existing California control system, using the proposed test procedure, is about 3.0-4.0 g/test ...." It is clear, therefore, that not only is a 4.0 g/test standard appropriate for Ford, it is one that Ford's California control system is meeting already.

IH tested three HDGs, one 2-bbl and two 4-bbl. The 2-bbl was tested as a 25,440 lbs GVW vehicle and clearly would meet a 4.0 g/test standard since the test results were 1.69 g/test and 1.67 g/test after the installation of new tank gaskets and screws. Vehicle #341, a 4-bbl had a lowest test of 4.51 g/test and vehicle #342, another 4-bbl, had a lowest test of 3.30 g/test. IH's only comment on what it thought was a feasible level of control was "We would conclude that four-barrel engines may be more difficult to control than two-barrel engines. This may suggest that the 3 gram standard may be too stringent for a four-barrel engine." We agree with IH and since all of IH's HDGs would be subject to the 4.0 g/test standard, we conclude that the 4.0 g/test level is appropriate for IH also.

Chrysler does not produce any "heavy" HDGs but if it were to begin such production we would presume that it, too, could meet the 4.0 g/test standard since GM, Ford and IH can.

<u>Recommendation</u>

We recommend that the proposed standard of 3.0 g/test be retained for HDGs with GVWs between 8,500 lbs and 14,001 lbs (Classes IIB and III). For HDGs with GVWs greater than 14,000 lbs, we recommend a standard of 4.0 g/test.

References

1. "Heavy-Duty Truck Evaporative Emissions Regulation Development," EPA Technical Support Report for Regulatory Action, John Corcoran, July 1976.

D. Issue: Leadtime

Summary of the Issue

In the NPRM, we determined that 1983 was the earliest feasible model year for implementation of this regulation. This determination was in accordance with sections 202(a) and 202 (b)(1)(C) of the Clean Air Act. The time required to implement this regulation was divided into three categories: 1) time for research and development (R&D) to identify effective control components and systems, 2) time to finalize production designs and produce the necessary drawings, and 3) time to effect tooling changes for production of the new components. We estimated that tooling changes would take 10 months and that the time to finalize production designs and produce the drawings would be 6 months. Thus, a total of 16 months would be needed from the time the control components and systems had been identified to the time of their introduction on the new models. Since we assumed that the HDG model year begins September 1 of each year, the identification of the control components and systems would have to be completed by May 1 of the preceding model year.

The NPRM was published on April 30, 1980 and the Final Rule was projected to be published in December of 1980. The time between Final Rule publication and May 1981 was, therefore, projected to be about 6 months. We estimated that this would be enough time to identify the necessary control components and systems because those components and systems were expected to be virtually the same as the current LDT components and systems. In fact, the majority of HDG carburetors are also used on LDTs and most of the HDGs in the lower weight ranges have fuel tank capacities similar to LDTs. Thus, the R&D for HDGs was expected to be quite limited because the evaporative control systems for most HDGs would be the same or slightly modified versions (e.g., bigger canisters, higher purge rate) of current LDT systems.

The largest HDGs were expected to require most of the R&D work. Vehicles with carburetors not in use on LDTs and with fuel tank capacities in the 100 gallon plus range were expected to need R&D test work. We recognized that some manufacturers might not have a test cell operational by the projected date of Final Rule publication. However, manufacturers had indicated that component tests gave results very close to full-SHED test results. Thus, manufacturers could use alternative test procedures to begin the limited R&D work needed for the large HDGs until their full-SHED facilities were completed. We concluded that all manufacturers would be able to identify the new control components and systems by May 1, 1981 and, therefore, the earliest feasible model year was projected to be 1983.

Summary of the Comments

The four primary manufacturers of HDGs (GM, Ford, Chrysler, IH) were the only commenters on this issue. In general these manufacturers disagreed with us that there is adequate leadtime for 1983 model year implementation. Since each manufacturer's projected timetable is different, we will present their comments and projections separately.

GM presented a detailed leadtime chart which estimates that 35 months would be required after publication of the final rule. GM claimed that a new test facility with required test equipment would be needed. Corporation appropriations would require 4 months. Then, design and construction of the test facility along with procurement and installation of testing equipment was projected for the next 20 months. Finally, system checkout was scheduled to take 5 months making the total leadtime required to complete the new test facilities 29 months.

Concurrent with facility construction would be control component and system development. A total of 29 months is estimated for this development work with no full SHED testing until the fourteenth month after final rule publication. At that time component, background and purge system testing begins and is projected to require 5 months. Next, certification fleet assembly and new control system development testing are scheduled to be completed by the twenty-fifth month at which time durability testing of the new components and systems is scheduled to begin. Durability testing is projected to take 4 months.

After 29 months, the certification facilities and the system development work are projected to be complete. Next, GM estimated three months for certification testing and two months for EPA review. GM's timing chart shows a 1-month delay after EPA's review before the start of production. GM did not provide an explanation for this delay.

GM did not agree with the NPRM that the only change to current carburetors (not already in-use on LDTs) woud be venting to the charcoal canister. GM claimed gasket material and stem and/or rod sealing changes would have to be evaluated. GM also stated that the NPRM's assumption of test facility existence soon after final rule publication is erroneous. GM claimed that EPA has failed to provide an acceptable option for SHED testing by manufacturers who do not have the facilities. Finally, GM stated that a carburetor design that has undergone significant changes for this evaporative emission regulation will be required to undergo more design changes (and corresponding tooling changes) for compliance with the 1984 MY exhaust emission standards.

Ford also presented a leadtime chart, although it did not include much detail. Ford claimed that 1800 development tests and 250 certification tests would be required each model year. From experience, Ford concluded that slightly more than two full-SHED test cells would be required. Since Ford already has one test cell, one or two more would need to be purchased and installed. Ford projected that 17 months would be required for this test cell procurement and installation. This estimate presupposed that EPA would approve worst case testing (e.g., testing a given evaporative system with dual fuel tank application would be sufficient to approve a single tank application with the same evaporative system without testing).

While the additional test cells are being procured, Ford would begin control system development with the one test cell it already has. Ford stated that it anticipated that the design of new purge control systems, carburetor bowl vent design changes and fuel system vapor integrity improvements would be needed. Ford projected that this control system development would take 29 months based on the availability of one cell for the first 17 months.

Ford estimated that certification testing would require an additional 5 months and EPA review would take 1 month. Ford's estimate of leadtime, therefore, was 34 months from the time of the final rule publication.

Ford also commented on an alternative certification plan whereby HDGs greater than 14,000 lbs GVW would be certified by the California method of engineering evaluation and HDGs less than 14,000 lbs would be certified as proposed in the NPRM. Ford claimed this alternative could be implemented for the 1983 MY (assuming Final Rule publication by February 1, 1981) because control system development time would be cut from 29 months to 17 months.

Another concern Ford had was that although its new heavy-duty engines are introduced in January of each model year, its new heavy-duty vehicles are introduced in the preceding September. Ford uses the previous model year's engines in its new vehicles for the four months until the new engines are introduced. Thus, a new vehicle model introduced in September could have a different engine in it by January. Ford's concern is that, strictly speaking, the NPRM would require certification of such a vehicle twice, once in September and again in January.

Finally, Ford stated that it is very much opposed to installing new evaporative control systems which may necessitate engine recalibration, and therefore, certification in 1983 (Ford expects engine certification for 1982 and 1983 to be carryover) only to have to certify its engines again in 1984 due to the new heavy-duty exhaust emission regulations.

Delaying the implementation of this regulation for 1 year to coincide with the implementation of the heavy-duty exhaust emission regulation would allow Ford to carryover its engines through 1983.

Chrysler claimed that it would not be feasible to comply with the proposed regulations by 1983. Chrysler stated that 12 months would be needed to purchase and install a SHED and dynamometer. Assuming publication of the final rule in January, 1981, development work could not begin until January, 1982. The remaining time before production of 1983 MY vehicles was claimed to be insufficient to complete the development of evaporative control systems especially in light of the fact that EPA underestimated the technical effort required.

Additionally, Chrysler stated that evaporative standards for 1983 MY may impact unfavorably upon the gaseous exhaust standards. The 1983 evaporative hardware may cause a recalibration of the 1983 exhaust emission hardware, and then a recalibration of the evaporative emissions hardware may be required with the change in 1984 exhaust emission standards. Evaporative standards for 1983 MY would frustrate any carryover certification from the 1982 MY for engines while the 1984 exhaust emission standards would frustrate evaporative emission carryover from the 1983 MY. Chrysler stated that "EPA should delay the implementation date for at least one year, to the 1984 model year at the earliest. This would allow the industry and EPA to make a better determination of what is indeed feasible, and will largely alleviate current leadtime problems."

IH submitted a leadtime chart with its comments. On the chart, IH projects that procurement of a heavy-duty dynamometer would take 10 months, installation and checkout of the dynamometer woud require another 2 months, necessary R&D would then require 6 months and the resultant carburetor retooling would need 14 months bringing total leadtime to 32 months. If the final rule had been published by January 1, 1981 as IH assumed, then the earliest feasible model year for implementation would have been 1984.

IH, like Ford, was concerned with the problem of its new heavy-duty vehicle model year beginning in September while its new engines are introduced the following January.

The final major area of concern of IH was that currently all of its heavy-duty engines are certified by Subpart H. If a demonstration of compliance for these engines is required in 1983 as a result of the impact of evaporative emission control on exhaust emission control, then IH would have to use Subpart D for such engine certification testing. IH has planned that its engines will be certified through 1983 by the carryover provision. If IH is required to test its engines using Subpart D, then they will fail to meet emission standards. IH requested that EPA allow use of either Subpart D or Subpart H to satisfy any engine test requirements that are necessary as a result of evaporative emission requirements.

Analysis of the Comments

This Final Fule has a number of changes from the NPRM which affect the leadtime issue. We will first describe these changes and discuss their influences on leadtime. Then, we will discuss each of the four HDG manufacturer's leadtime concerns in light of these changes. Finally, we will present our recommendation of the model year in which to implement this regulation.

The first area of significant change affecting leadtime is the procedure by which a manufacturer receives the certificate of conformity. In the NPRM we proposed that each manufacturer's product line would be divided into evaporative emission families based on three criteria; 1) method of fuel/air metering, 2) carburetor fuel bowl volume (within 10cc) and 3) fuel tank volume (within 20 gallons, or within 25 percent, whichever is greater). This Final Rule deletes fuel tank volume as a family determinent. This change will significantly reduce the number of evaporative emission family-systems because each manufacturer will be free to choose the range of fuel tank volumes that each control system is designed to handle. Thus, a manufacturer may find it advantageous to develop one evaporative control system to cover a large range of fuel tank volumes even though the control system may be over-designed for the smaller fuel tank volumes to which it applies. This change is essentially the worst case testing that Ford requested in its comments.

The reduction in the number of family-systems means less research and development work since a manufacturer will only need to concentrate on the worst case vehicles. Those vehicles for which assurance of compliance is easy will not need a whole certification program as they would have under the proposed certification procedure. Instead, they will be included in an evaporative emission family-system which also includes the harder to control worst case vehicles on which the manufacturer will concentrate his R&D efforts. We estimate that Ford and GM will be able to reduce the number of evaporative emission family-systems that they must certify from somewhere in the high 20's to about 6 or 8. Since the time required for R&D is a major portion of total leadtime, this change will have a significant impact on the amount of leadtime needed to implement the final rule.

Another reduction in R&D effort will occur due to the provision that Class VII and VIII HDGs need only be certified by an engineering evaluation. As discussed in the issue "Certification Procedure", we project that virtually all Class

VIII vehicles (GVW greater than 33,000 lbs.) will be powered by diesel engines by 1984. We also estimate that by 1988 the same will be true for Class VII vehicles (GVW between 26,000 and 33,000 lbs.). The few gasoline-powered vehicles in these classes that will be produced do not warrant the cost of a certification test program to ensure that they meet the 4.0 gpt standard applicable to HDGs between 14,001 lbs. and 26,000 lbs. GVW. We are confident that extrapolation of the control technology used on the Class VI HDGs (19,501-26,000 GVW) will be adequate to control the few Class VII and VIII HDGs to a level very close to the 4.0 gpt level. Thus, manufacturers will not have to expend resources and time on these HDGs except to install the evaporative emission control systems on them.

The final change to the proposed certification procedure is that instead of testing all of the evaporative family-system combinations for compliance, then submitting this certification test data to EPA and finally, waiting for EPA to review it and to issue certificates of conformity; manufacturers will only be required to submit a statement that each of its evaporative family-systems meets or is designed to meet the standard. No test data or engineering evaluation or explanation will generally be needed. Elimination of certification testing and subsequent EPA review will save 5 to 6 months according to the comments from GM and Ford.

Another important change to the NPRM that will significantly affect leadtime is the level of the standard. The manufacturers generally agreed that the existing LDT control systems could be used for the lighter weight HDGs to meet a 3.0 gpt standard. However, they had concerns that the heavier HDGs would be more difficult to control to this level because of increased fuel tank volumes and higher background emissions. Therefore, most of their R&D effort was expected to be directed at the larger HDGs meeting a 3.0 gpt standard.

This final rule includes a split standard (as recommended by GM) of 3.0 gpt for HDGs between 8,501 and 14,000 lbs. GVW and 4.0 gpt for HDGs between 14,001 and 26,000 lbs. GVW. Thus, not only have we eliminated the SHED testing for the very large HDGs (Classes VII and VIII) but we have substantially eased the standard for the middle classes of HDGs (IV-VI). This change will decrease the R&D effort even more since the manufacturers indicated that a 4.0 gpt standard would be easy to meet. (The issue "Technical Feasibility" discusses this in more detail.)

To summarize thus far, this Final Rule includes three changes to the NPRM that will reduce the amount of R&D time. First, the number of evaporative family-systems will be reduced substantially allowing the manufacturers to concentrate their R&D efforts on worst case vehicles. Second, very little if any R&D effort will be needed for Classes VII and VIII HDGs. And third, the less stringent standard for Class IV-VI HDGs of 4.0

gpt will be easy to meet with current technology while the manufacturers agree that a 3.0 gpt standard can already be met for the lighter HDGs.

Another change to the NPRM which will influence leadtime is that the test procedure no longer requires the manufacturers to acquire heavy-duty dynamometers. This change is discussed in the issue "Test Procedure." Instead they will be able to upgrade existing light-duty dynamometers by the simple addition of flywheels. By changing the inertia splits to 500 lb. increments and using a 2,000 lb. trim, an existing light-duty dynamometer can be converted to provide up to 13,500 lbs. equivalent vehicle weight (EVW). This, coupled with the change to the NPRM of test weight being 50 percent of GVW instead of 70 percent, allows existing light-duty dynamometers to be used for testing all HDGs through Class VI. Therefore, heavy-duty dynamometers will not be needed since the heaviest HDGs (Classes VII and VIII) will not need to be tested.

Discussions with test equipment manufacturers, as well as the comments of the HDG manufacturers, indicate that the procurement and installation of heavy-duty dynamometers is the longest of the test facility leadtime requirements (except for GM which claimed it needed to construct a new building). The procurement and installation of a heavy-duty dynamometer can take 12 months as IH commented but the upgrading of a light-duty dynamometer requires at the most 6 months, which is also about the time required to install a heavy-duty SHED, the next longest leadtime item. Thus, the time needed to acquire testing capability, providing a new building need not be constructed, will be reduced by 6 months as a result of these test procedure changes.

Before we present an analysis of each manufacturers' leadtime position, we will address the concern of Ford and IH that their new heavy-duty engines are introduced four months after introduction of their new heavy-duty vehicles. Changes in a vehicle from one model year to the next can affect evaporative emissions. For example, the relocation of the exhaust system could influence the amount of heat that is transferred to the fuel tank and/or fuel lines. Also, changes in the shape of the engine compartment or the operators enclosure might change heat distribution thereby affecting evaporative emissions. Changes in an engine could also affect evaporative emissions. For example, a new carburetor would need to be tested to assure vapor integrity or a different engine might need a different set of canister purging specifications.

Thus, it is possible that a manufacturer might have to certify its new HDGs twice in the same model year. This might occur, for example, if a manufacturer introduced a new vehicle model in September for which a new certificate of conformity would be required and then that manufacturer introduced a new engine model for those new vehicles in the following January. If the new engine affected the evaporative family-system combination, then the manufacturer would have to certify the vehicles again. However, since the manufacturer is always responsible for the compliance of any new vehicle and/or engine and the certification procedure for this regulation is very simple (ie., a written statement attesting compliance), the effort involved if a manufacturer did have to certify twice in one year would generally be limited to

sending EPA a second written statement of compliance. Also, since heavy-duty vehicles and engines typically do not change much from year to year, this problem is further reduced. For the above reasons, therefore, this Final Rule requires that each new evaporative emission family-system combination be certified upon its introduction into commerce.

This discussion will now analyze each manufacturer's leadtime position. GM claimed that it would need a total of 35 months from the date of final rule publication to the start of production. The changes in this final rule as they affect R&D and test equipment procurement would allow GM to substantially reduce its leadtime requirements were it not for GM's claim that it needs to construct a new building. In its leadtime chart, GM allows 4 months to process the appropriations request, 6 months to design the facility, two months to acquire quotes and 12 months to construct the facility for a total of 24 months. If GM did need to construct a small building to house its heavy-duty testing cells, it should not require 24 months to build. Such a building would be a conventional one with no complex requirements. GM's allowance of 6 months to design it appears out of proportion. We believe 3 months for design would be more than adequate. Also, GM allowed 4 months to process the appropriations request. We feel confident that with very little extra effort company funds could be appropriated much more quickly especially since this rulemaking has been in the works for at least 3 years now. Allowing 3 months for appropriations seems more realistic. Furthermore, since there is no backlog in the construction industry due to the severe recession that industry is experiencing (at least in the Detroit area), time for construction can probably be reduced by 30 percent (or 3.6 months). To be conservative we will reduce construction time by only 2 months. Thus, the construction of the building should take no longer than 18 months.

Simultaneous with the completion of building construction would be the completion of the installation of the test equipment as GM indicated in its comments. GM then allows 5 months for system checkout. Although GM does not explain why 5 months would be needed to check out test equipment that is, in most cases, common to light-duty evaporative emissions testing and, therefore, very familiar, we presume that because GM envisioned this facility correlating with EPA's, extra care and time would be required. Since the final rule does not allow EPA to confirmatory test or for that matter even require the manufacturer to do any certification testing, it seems reasonable that system checkout for the purpose of establishing repeatability would not require more than 3 months.

In its comments GM shows its R&D work being completed at the same time as the facility system checkout is completed. Since GM claimed that component test procedures give results very close to the full-SHED test, we imply that some of GM's R&D work will occur coincidently with facility construction. The finalization of the evaporative emission control systems can utilize full-SHED testing since such equipment will be available for use for some months before the facility is complete. Because the required R&D effort has been substantially reduced by the changes to the NPRM discussed above, we conclude that the 21 months allowed to complete the facility and perform system checkout is also plenty of time to complete the R&D work. GM then assumed that the next 6 months would be needed for certification testing and EPA review. Since the final rule does not include any such requirement, GM's total leadtime is 21 months even if it constructs a new building.

Ford stated that 29 months would be required for control system development based on the availability of 2 test cells for the first 17 months. The changes in the test procedure as compared to the NPRM should allow Ford to complete its second test cell in 6 months instead of 17 since the upgrading of an existing light-duty dynamometer takes considerably less time than the procurement and installation of a heavy-duty dynamometer. Once the second test cell is ready Ford projected an additional 12 months would be needed to complete the development work. This seems unlikely since this final rule has substantially reduced the required R&D. However, we will assume the full 12 months will be needed. After completing the control system development work Ford estimated 6 months would be needed for certification testing and EPA review. Since no such testing or review is required in this Final Rule, Ford's total leadtime requirement is 18 months.

Chrysler claimed it would need 12 months to purchase and install a SHED and dynamometer. This should now only require 6 months as discussed above. The only additional information Chrysler supplied was that if it had test facilities ready by January 1982, then it would have enough time to complete the necessary R&D and certification testing for the 1984 model year. Thus, we imply that 23 months (i.e., January 1982 - December 1983) would have been sufficient for Chrysler's R&D and certification program under the proposed certification procedure. We can further assume that of this 23 months about

6 months were required for certification testing and EPA review since both GM and Ford indicated as much. Thus, only 17 months would actually be devoted to R&D work. We will assume that this can be further reduced due to the decrease in R&D resulting from changes to the NPRM and to the fact that Chrysler does not produce HDGs with GVWs more than about 14,000 lbs. This latter fact means that Chrysler will not have to deal with some of the problems of the large HDGs but instead can directly apply current LDT technology to all of its HDGs. Reducing the time for R&D by about the same proportion as for IH results in an estimate of 14 months for Chrysler. This added to the 6 months needed to establish a test cell yields a total of 20 months leadtime.

IH claimed that a total of 32 months would be required to implement this regulation. The first 12 months would be needed to procure and install a heavy-duty dynamometer. As we have discussed previously, this can now be reduced to 6 months because of test procedure changes. IH then claimed that 6 months would be needed for R&D work. We will reduce this by 1 month because of the decreased R&D effort required due to less family-systems, no testing of Class VII or VIII HDGs, and the less stringent standard.

Furthermore, IH claimed that 14 months would be needed for tooling once the new designs have been identified by the R&D program. The question of tooling time deserves discussion. The other three manufacturers did not specifically mention tooling as a component of their leadtime estimations. This may be because required changes to carburetors are expected to be non-existent as far as tooling time is concerned or perhaps the manufacturers perceived that while some tooling may be necessary, it would be so minimal that other leadtime items would be the critical ones. Since we have reduced the manufacturers' leadtime estimates, we have investigated tooling time to be sure that it is still not a critical path for any manufacturer.

Evaporative emission control is a very well understood and simple technology. In fact, the majority of HDG carburetors are virtually the same carburetors currently used on LDTs with the difference being that the LDT carburetors are configured to control evaporative emissions. We expect that for HDGs which currently use these basic carburetors, very minimal tooling (e.g., slightly larger bowl vent openings) will be required. These HDG carburetor modifications will almost certainly be made on existing production lines.

Even evaporative control system adaptations for those HDG carburetors which do not have LDT counterparts will not have to start from scratch. California has required evaporative emission control of HDGs since 1978. Because the HDG manufacturers sell their vehicles in California, all HDG carburetors have designs for conversion to the evaporative emission control configuration. These California control systems are already controlling HDG evaporative emissions to a level close to meeting the standards in this Final Rule, especially since we have relaxed the standard for the larger HDGs (Classes IV-VI) to 4.0 gpt. Thus, minimal, if any, tooling will be required.

Staff experience indicates that minor carburetor changes might need as few as six months to implement. A study by Aerospace Corp.[1] indicates that normal tooling time required to set-up an entire production line for a carburetor of known design is about 12 1/2 months. This study estimated that such tooling could be reduced to 11 1/2 months fairly easily. We expect that any carburetor modifications necessitated by this Final Rule will not involve the production of a new carburetor but rather will be minor changes to the existing design of a carburetor. This case is even simpler than the 11 1/2 month case described in the Aerospace report because new production lines will not have to be built. Instead, we foresee minor changes to existing production lines based on extensive experience with evaporative emission control of LDTs and California HDGs. Therefore, we estimate that 10 months is a liberal allowance for any tooling that this Final Rule may necessitate.

IH's estimate of 14 months was based on the proposed standard of 3.0 gpt for all HDGs. This Final Rule contains a standard of 4.0 gpt for HDGs with GVWs greater than 14,000 lbs. All of IH's HDGs are greater than 14,000 lbs. GVW and, therefore, will be subject to the 4.0 gpt standard. The less stringent standard should allow IH to complete any required tooling in 10 months. In any case, IH's required leadtime estimate is 21 months.

The total leadtime estimates for the other manufacturers are also well beyond the 10 months estimated for tooling. Thus, we believe that even if these manufacturers required tooling, there exists adequate leadtime for it.

We have adjusted the manufacturers' estimates of required leadtimes to 21 months for GM, 18 months for Ford, 21 months for IH and 20 months for Chrysler because of changes to the NPRM. Thus, based upon manufacturers'estimates, this regulation can be implemented with the start of the 1985 model year for all manufacturers. Our independent analysis of the required leadtime, which assumes that GM constructs a building and that no manufacturer currently has test equipment, indicates that 6 months would be required for test equipment procurement and installation, 6 months would be needed for R&D (of which 50 percent can occur simultaneously with test equipment installation), and 10 months would be required if any tooling changes are necessary. Thus, the total leadtime is about 19 months. GM's building construction would also fit within this time-frame. Back-calculation of 19 months from September 1984 gives a publication date as late as February 1983. Therefore, we conclude that if this Final Rule is promulgated by February, 1983, then its implementation should be the start of the 1985 model year.

The above analysis shows that implementation of this Final Rule with the start of the 1985 model year will allow adequate leadtime for all manufacturers. In fact, we expect that the 1985 model year implementation date will provide several months of safety margin. This leadtime safety margin will reduce the burden of this regulation even further from the already reduced levels that were accomplished by changes to the level of the standard, the certification procedure and the test procedure. Extra leadtime will allow better planning for greater efficiencies and will stretch out the financial commitment for a better cash flow.

Recommendations

We recommend that the implementation date of this regulation be changed from the proposed date (1983 MY) to the start of the 1985 model year.

References

1. "Assessment of Domestic Automotive Industry Production Leadtime of 1975/1976 Model Year: Volume II - Technical Discussion Final Report," EPA-460/3-74-026-b, December, 1972.

E. Issue: Costs

Summary of Issue

In developing the NPRM (45 F.R. 28922) we estimated the costs of the proposed regulation. These estimations are detailed in Chapter V of the "Regulatory Analysis for the Proposed Evaporative Emission Regulation for Heavy-Duty Vehicles" (in the public docket). In that document we broke down the expected costs to the manufacturers into four main categories: 1) industry R&D costs, 2) industry investment costs, 3) industry certification costs, and 4) control system components costs (hardware).

For the proposal we projected that R&D costs would be minimal since the technology for controlling evaporative emissions is well known. Light-duty vehicle (LDV) and light-duty truck (LDT) evaporative emissions have been controlled for many years and the control of HDG evaporative emissions was expected to closely parallel that of LDVs and LDTs. We estimated that any necessary R&D costs would be fully accounted for by allowing a 100% profit markup from manufacturing cost to retail price equivalent for the hardware.

Industry investment costs included testing equipment such as chassis dynamometers, SHEDs and durability testing equipment in addition to a fair rate of return for the facility space that would need to be allocated to HDG evaporative emission testing. Total industry investment costs were estimated to be $5.20M (discounted at 10 percent to 1983). When this total cost was amortized over the number of new HDGs expected to be produced from 1983 through 1987 inclusive, the per vehicle price increase due to industry investment costs was calculated to be $2.91.

The proposal would have required each manufacturer to test its HDGs and submit the data to EPA in order to receive a certificate of conformity. This "certification testing" was expected to be a major cost and was, therefore, estimated as a major cost category. Components of certification testing costs were expected to include personnel costs for control system installation, triplicate testing and durability testing. Also the cost of using the HDG during certification was included. These costs were estimated to be $2.37M for the five year period of 1983 MY through 1987 MY. Amortized over the projected HDG production during these five years this total cost was calculated to be equal to $1.33 per HDG.

The fourth and largest area of cost was that estimated for the control system hardware. We estimated the typical control system would consist of two charcoal canisters ($8.00 each), extra hoses and tubing ($1.00), a carburetor fuel bowl vent

($5.00), carburetor shaft seals ($1.00), a charcoal bed in the air cleaner ($5.00), purge air intake from air cleaner ($.50), a threaded fuel cap ($.50) and a liquid-vapor separator/roll-over value ($1.00). These costs total $30 per HDG.

Summation of the per vehicle costs for industry R&D, industry investment, industry certification and control system components yields an estimated "sticker price" increase of $34.20 per HDG.

Summary of Comments

Cost comments were received from all four of the primary manufacturers (GM, Ford, Chrysler and IH). Comments were also received from two trade associations: the Truck Body and Equipment Association (TBEA) and the National Automobile Dealers Association (NADA). The primary manufacturers' comments were general in nature with little detail in support of their final numbers. This discussion will summarize each manufacturer's comments separately and then turn to the trade associations' comments.

GM categorized its expected costs into three areas: 1) facilities and test equipment, 2) construction of data vehicles, and 3) hardware costs. Its estimate for facilities totalled $5.1M. The main component ($3.9M) of this cost was the 26,000 ft^2 that GM estimated it would need for 2 test sites and 10 soak spaces. GM also included $0.5M for site work and $0.7M as a contingency fund. GM provided no further details. For test equipment, GM estimated a total of $1.4M would be needed. The major items included: two dynamometers (at $375K each), two computers (at $75K each), a canister equilibrator (at $63K), two SHEDs (at $50K each) and a vehicle scale (at $35K). Other equipment included two emission benches, two balances, calibration weights, a driver's aid, a power washer, six fuel carts, two vehicle movers and miscellaneous parts and equipment. Again, no discussion or other details were provided. GM's estimate for facilities and test equipment, therefore, totalled $6.5M.

GM's second area of cost estimates was the construction of data vehicles. GM estimated that the proposed regulation would cause its HDG product line to be divided into 11 evaporative emission families. GM then estimated that EPA would require it to build and test three certification vehicles for seven of these families and two certification vehicles for the other four. Thus, the number of certification builds was estimated at 29. GM also estimated that it would cost between $20K and $60K to build each vehicle and run the certification tests. GM's total estimated certification fleet cost was $1.27M of which $0.164M was estimated to be recoverable due to salvage so that GM's final estimate for the construction of data vehicles equaled $1.11M.

The last area of costs estimated by GM was that of required hardware. GM stated that for HDGs "which are designed and manufactured by our GMC Truck and Coach Division (generally in the above 12,000 GVW range) we would require new designs and hardware necessary to comply with the NPRM procedure and a 4 g/t standard ...the estimated hardware costs in 1980 dollars are listed below."

Vehicles with Engine	Estimated Cost to Consumers
Single tank 292-L6 and 350-V8	$250.00
Dual tank 366-V8 and 427-V8	$300.00

GM did not provide any details as to why these costs are estimated so high while its 1980 MY prices for California HDG evaporative emission control systems were priced at $122.66 for single tank trucks and $161.40 for dual tank trucks.

Ford's comments were also very general. Ford claimed that the proposal would cause it to incur investment expenditures (including facility, tooling, launch and engineering costs) of $12M (1980 dollars). This total consists primarily of test facility requirements of $7M and engineering development costs (including development testing). Ford did not reveal what portion of the $12M total was represented by engineering development costs nor did it describe the new facilities/testing equipment that it claimed it would need.

Ford also stated that its projected cost ($12M) translated into a first-year retail price equivalent (RPE) cost increase of $60 per HDG vehicle (1980 dollars). Ford claimed that if HDGs with GVWs greater than 14,000 lbs were exempted from the regulation then the RPE increase would be reduced to $40 per HDG vehicle. Apparently this estimated reduction results from an investment savings of $7M which would not have to be spent on new facilities although Ford's comments are not clear on this point.

The only direct mention of hardware costs in Ford's comments was a general statement that the total investment cost of $14M included some tooling. Tooling can be a major portion of hardware costs. Ford's estimate of a $60 RPE increase must include hardware costs since Ford compares that RPE increase directly to the RPE increase of $34 that we estimated for the proposal.

Chrysler's comments on expected costs were divided into two areas: 1) hardware, and 2) facility costs. Chrysler stated that the proposed regulation would require a trap door air cleaner with dual snorkel, a second air pump (with brackets and diverter value) for purging, three 5-port canisters, a sulfonated plastic gas tank and the tank vent system with tubing. Chrysler did not give an estimated cost for each of these components but rather gave a total cost of approximately $150 (retail) for a HDG with a 45 gallon fuel tank while for a HDG with a 36 gallon tank these hardware costs were estimated to be $110. This is the extent of Chrysler's hardware cost comments.

Chrysler listed a number of items and their estimated costs under the general category of "Facility Costs". The most expensive of these items was the square footage estimated for fueling, soaking vehicles and general storage. Chrysler did not state how much area was involved but did estimate the cost to be $0.93M. Chrysler also stated it would need a SHED (at $180,000), a 200 hp dynamometer (at $110,000), "analytical facilities and test equipment" (at $85,000) and contingency funds of $130,000. Thus, Chrysler's total facility cost estimate was $1.435M.

IH's comments were the least detailed of the four primary manufacturers. IH presented the following cost chart (1980 dollars):

Engines	Two-Barrel Engines	Four-Barrel
Capital & Product Costs	$53	$119
Engineering &Warranty	$27	$ 27
Total	$80	$146

IH then stated, "The substantial increase in the cost of the four-barrel configuration is due to the complexity of the <u>governed</u> - dual float bowl four-barrel carburetor and its associated tooling, plus low volume over which costs can be spread." This concluded IH's comments on costs.

The comments from the two trade associations (TBEA and NADA) were basically the same. They claimed that secondary manufacturers could not afford to test HDGs according to the proposed full-SHED test procedure. Therefore, any Final Rule eventually promulgated must not require testing by secondary manufacturers.

<u>Analysis of Comments</u>

The cost estimates submitted by the four primary manufacturers were, for the most part, of a very general nature which restricted their usefulness for this rulemaking. Many of the estimates lacked sufficient detail to allow a substantive analysis. For example, when a manufacturer merely states that hardware costs will be $250 per vehicle or that investment costs will total \$12M without including a breakdown of such gross figures, there is little information for us to use in our determination of the appropriateness of the estimate. These broad estimates are further diminished in value when they differ from our's and/or independent sources by large amounts (5-10 times) such as some of the manufacturers' estimates do. For these reasons, and because the Final Rule includes changes to the proposal which were specifically developed to reduce costs, the manufacturers' cost estimates were not as helpful as they might have been.

The following discussion will examine each manufacturer's cost estimates and will point out areas where those estimates differ significantly from ours. Furthermore, the impact of the changes to the proposal on the cost estimates will be examined. This presentation will attempt to clarify the comments and highlight those comments that were useful in developing the Economic Impact chapter of the "Regulatory Support Document." That chapter presents a detailed analysis of the expected costs of this Final Rule. The "Regulatory Support Document" can be found in the public docket (#OMSAPC-79-1) for this rulemaking.

GM claimed it would need an additional 26,000 ft^2 of facility space because of the proposed regulation. This space included 10 soak spaces and 2 test sites. If we assume a typical soak space/test site is 14' wide by 40' long, then the twelve such spaces claimed as necessary would sum to only 6,700 ft^2. If the facility was laid out such that there was two rows of six sites with 40' between the rows for maneuvering the HDGs, the total space required is only 10,000 ft^2. Even with an allowance for fueling and storage areas GM's total facility space requirement under the proposed regulation should not have been more than 13,000 ft^2. Thus, GM appears to have overestimated the building cost by at least a factor of two (\$2.5M).

The changes to the proposal included in the Final Rule significantly affect the amount of facility space needed by GM. Under the proposal GM estimated that it would be required to certify 29 family-system combinations. Under the Final Rule we have estimated that GM will have only 8 family-system combinations because of the provision for "worst case" control system development and the redefinition of "evaporative emission family." This reduction in the number of family-systems will substantially reduce the size of the testing facility because the number of vehicle control systems to be developed will be reduced by about 70 percent. Thus, GM's estimate of 26,000 ft^2 (\$5.1M) is out of proportion to the requirements of the Final Rule.

GM estimated that new test equipment would cost \$1.4M. In its estimates GM assumed it would need two test sites. Due to changes incorporated in the Final Rule, we estimate GM will need only one test site. Also, changes in the test procedure will allow upgrading of existing light-duty dynamometers at a cost of $25K instead of requiring the purchase of new heavy-duty dynamometers at a cost (GM's estimate) of $375K each. GM's estimate for new test equipment is thus reduced by at least 2/3's.

GM also estimated that certification vehicle builds would cost $1.11M per year under the proposed regulation. This estimate included 29 family-systems at an average cost of $38.3K per vehicle. The already mentioned changes to the definition of "evaporative emission family" is expected to reduce GM's family-systems to 8. Additionally, the Final Rule does not require any certification testing at all. This provision will further reduce these costs since GM will not have to build final development vehicles for those control systems where there is a considerable safety margin of control.

The final area of GM's cost comments concerned the hardware needed for the control systems. GM estimated that hardware costs for HDGs above 12,000 lbs. GVW with a single fuel tank would be $250.00 per HDG ($300.00 for vehicles with dual fuel tanks). The only support for these numbers was a statement that 1980 MY prices for California HDG evaporative control systems were $122.66 (single tank) and $161.40 (dual tank) and that the control system required by this regulation would be "more sophisticated and, therefore, possibly more costly than the 1980 MY system (California)."

First, it appears somewhat contradictory to state that the new control systems will "possibly" be more costly and then to estimate the new cost at double that of the old system. Second, our estimates of hardware costs, which include liberal profit markups and were developed by Exxon,[1] totalled $38.25. Third, Ford estimated that the first-year retail price equivalent (RPE) cost increase for the proposed regulation would be about $60 per HDG which includes $12M for investment requirements. The cost of just the control system hardware would be substantially less than the total of $60 per HDG. Ford, also stated that if HDGs with GVWs greater than 14,000 lbs. were exempted from this rulemaking, then the RPE increase would only be $40 per HDG since controlling the heavier HDGs is more costly. This Final Rule contains a split standard where HDGs with GVWs greater than 14,000 lbs. are subject to a 4.0 gpt standard instead of the proposed 3.0 gpt standard. The split standard was developed so that the heavier HDGs would not require substantially more R&D effort than the lighter HDGs. This will decrease the overall RPE increase for HDGs. Ford's hardware cost estimate, therefore, agrees quite well with ours while GM's hardware costs appear to be considerably overestimated.

Ford's cost comments were, like GM's, too general to be of use to the degree we would have expected. As discussed above, Ford stated that the RPE increase under the proposed rule would be about $60 per HDG. However, Ford did not separate this figure into hardware vs. investment costs and did not itemize required hardware at all. Ford did state that investment costs were expected to be $12M and included test facility requirements of $7M with tooling, launch and engineering expenditures making up the rest. Ford did not give any detail as to how the above investment expenses were broken down. We have concluded that Ford would not need to spend more on facilities than GM and GM's required facility expense under the proposed regulation would not have exceeded $3M. Thus, even without those changes to the proposal which significantly reduce the required facility and test equipment expenses, we have determined that Ford's facility estimate is about 233 percent larger than our estimate. Ford's required facility, like GM's, is substantially reduced due to the changes in the vehicle classification scheme, changes in the certification procedure and changes in the test procedure. Without a detailed breakdown of its estimate, it is hard to know what Ford's new facility could have included that would have cost $7M. Ford's estimate of tooling, launch and engineering expenditures suffer from the same lack of detail.

Chrysler's hardware cost comments were the most detailed of the four manufacturers. Chrysler listed five items which it claimed would be needed to control evaporative emissions from a HDG with a 45 gallon tank. Chrysler did not give individual price estimates for each item but rather gave only a total price for all five of $150.00. Apparently the difference between our cost estimate for hardware and Chrysler's is that Chrysler claimed the proposed regulation would require it to equip HDGs with a second air pump for purging and a sulfonated plastic gas tank. The other items listed are common to our list and we will assume that their prices are approximately the same.

Chrysler does not discuss the need for a second air pump except to state that it is needed "for purging the evaporative emission system." Our analysis indicates that a second air pump will not be necessary. Ford did extensive testing of HDGs to determine the technical feasibility of the proposed standard. The results of Ford's testing showed that the HDG control system could be adequately purged over the proposed driving cycle with existing equipment. In fact, Ford's California HDG evaporative emission control systems actually met this standard in many cases. Also, IH did some testing and did not indicate a need for an extra air pump to increase purging. We believe that once Chrysler begins to test its HDGs it will agree that the HDG driving cycle provides adequate purging opportunity without the addition of an extra air pump.

Chrysler's claim that it would need a "sulfonated plastic gas tank" as a result of this regulation is not discussed at all in Chrysler's comments. We have no idea why this regulation would necessitate the use of a sulfonated plastic gas tank. Perhaps Chrysler is already using plastic gas tanks and this regulation would require the sulfonation of these tanks to reduce HC vapor permeability. However, sulfonation would be a minimal expense.

Chrysler's facility costs estimates are approximately the same as ours. However, due to changes to the proposal Chrysler will not need a $110K dynamometer. Instead, a $25K retrofit kit will be needed. Also, Chrysler estimated that a new SHED with associated analytical facilities and test eqipment would cost $265K. Our estimate which is based on discussions with SHED manufacturers, is $141K.

Finally, IH's cost estimations were too general to be of much use in evaluating the costs of the final rulemaking. It should be noted, however, that because we have changed the level of the standard that IH must comply with from 3.0 gpt to 4.0 gpt (IH does not produce any HDGs with GVWs less than 14,001 lbs.), the extra complexity of controlling the governed-dual float bowl four-barrel carburetor which IH claimed would add a substantial cost to the RPE increase will be significantly diminished. In fact, IH is very close to meeting the 4.0 gpt standard now with its California HDG evaporative emission control systems as shown by its testing effort for this rulemaking. A discussion of IH's testing effort can be found in "Issue C: Technical Feasibility" which is a part of this document.

The above discussion has shown that the manufacturer's cost comments were limited and of a general nature which restricted their usefulness in the estimation of the cost of this Final Rule. Our analysis of the economic impact of this Final Rule can be found in Chapter V of the <u>Regulatory Support Document</u> (in the docket).

References

1. "Investigation and Assessment of Light-Duty Vehicle Evaporative Emission Sources and Control," P.J. Clarke, Exxon Research and Engineering Company, EPA Report No. EPA-460/3-76-014, June 1976.

F. Issue: Test Procedure

Summary of the Issue

The proposal for control of HDG evaporative emissions which was published on April 30, 1980 included a testing procedure (Subpart M). Test procedures are needed to assure EPA that manufacturers are attaining the required level of control as well as to identify the in-use levels of control for air quality modeling and planning. The test procedure, as proposed, is similar to that used for light-duty vehicles and light-duty trucks. However, changes to the light-duty test procedure have been made where necessary to accomodate the differences between light-duty and heavy-duty vehicles.

The test procedure requires that a HDG be placed in an airtight enclosure (Seal Housing for Evaporative Determination (SHED)) and its evaporative emissions measured. The test procedure can be divided into four major parts: 1) preconditioning, 2) diurnal, 3) driving cycle, and 4) hot soak. The purpose of the first part, preconditioning, is to stabilize and appropriately load the carbon canisters in preparation for the rest of the test procedure. Virgin-activated charcoal will adsorb more HC vapors than will activated charcoal which has been through many cycles of HC vapor adsorbtion/desorbtion. Therefore, the test procedure requires that charcoal canisters undergo a number of HC vapor adsorbtion/desorbtion cycles so they will simulate the canisters on in-use vehicles. Also, this preconditioning phase will load the canisters so that the canisters enter the next part of the test procedure with some HC vapors in them as they would under real world conditions.

The second part of the test procedure attempts to simulate the effect of a summer day on evaporative emissions. As the heat of the day increases so does the temperature of the fuel in the tanks. The resultant expansion of air in the fuel tanks causes HC vapors to be forced out of the tank. These vapors must be trapped and disposed of properly rather than being emitted to the atmosphere. In the test procedure the fuel tanks are filled to 40 percent of capacity with chilled (less than 60°F) fuel. The HDG is then pushed into the SHED and the enclosure is sealed. Heat is then applied to the fuel tanks so as to raise the fuel temperature from 60° F to 84° F over a 1-hour period. The HC vapors that escape the control system during this hour are measured (in grams) and constitute the result of this diurnal part of the test.

The vehicle is then either pushed or driven to the dynamometer where it is operated over the driving cycle given in Appendix I(d). This serves two major functions. First, the engine and engine compartment are heated in preparation for the hot-soak part of the test procedure. Second, this engine operation will purge the carbon canisters of HC vapors thereby making room for more HC vapors generated during the next part of the test.

The final part of the test procedure is called the hot soak. After operating the vehicle over the driving cycle, it is again placed into the SHED. The SHED doors are sealed and the concentration of HC in it is monitored for one hour. The heat from the engine block and engine compartment will raise the temperature of the vapor space of the carburetor fuel bowl. The resultant expanding vapor will seek to escape through leaks in the induction system (e.g., throttle shaft, accelerator linkage, air cleaner). An evaporative control system will attempt to route these vapors to a carbon canister. The HC vapors which escape the control system are measured after one hour, and the result, is added to the result of the diurnal to arrive at the total test result which is expressed in grams HC per test (gpt).

Summary of the Comments

GM, Ford, Chrysler, and MVMA were the only commenters on this issue. The comments received can be divided into major and minor categories. Major comments are those which require discussion and analysis in some depth. Minor comments are those which are simple to resolve and require very little analysis. Minor comments include grammatical errors, typographical errors, and obvious omissions. These minor comments are treated separately as an appendix to this issue. This section will briefly summarize the major comments. Further explanation and detail will be included in the next section, Analysis of the Comments.

GM, Ford, and MVMA commented that the proposed formula for determining the dynamometer loading is incorrect. GM claimed that many HDGs have the same physical body shells as LDTs and, therefore, must have the same coefficient of aerodynamic drag. However, this coefficient is .50 for light-duty vans and .58 for light-duty pickup trucks while it would be .67 for all HDGs under the proposed test procedure. Thus, the dynamometer loading would be higher than it should be for HDGs with van or pickup body styles. Furthermore, GM claims that the HDG dynamometer tire friction factor is too small and also questions why a "coastdown" procedure is not allowed.

Ford presented coastdown data from a C-700 vehicle which showed that the proposed dynamometer loading formula results in a 36 percent higher dynamometer load than actual road load requirements would dictate. Ford also presented an alternative method for determining the dynamometer setting but cautioned that more data was needed to verify the experimentally derived formulas.

All four commenters stated that the proposed test weight of 70 percent GVW is too much. They pointed to a study conducted by Olson Laboratories, Inc.,[1] an FEA document,[2] and a letter dated November 6, 1975, from former EPA Director of Technology Mr. John DeKany to Mr. Duffing of MVMA [Appendix 1] as evidence that the typical HDG does not weigh 70 percent of GVW. GM also stated that, at first glance, a document by the FHA[3] appears to support the 70 percent of GVW vehicle test weight requirement. GM then listed four reasons why this document is not representative of HDGs and concluded that it should not be used in the determination of the proper test weight.

GM, MVMA, and Chrysler claimed that the proposed requirement that HDGs be run over the driving cycle with hood closed is unreasonable. They stated that the light-duty evaporative test procedure calls for testing with the hood open in order to prevent overheating. Since HDG testing presents a more serious cooling problem, EPA should allow the hood to be open and should allow the manufacturers to employ cooling fan capacities greater than 10,000 CFM (§86.1235-84). They claimed that closing the hood for HDG testing would cause unrealistic and excessively high levels of evaporative emissions to be formed.

Another major area of comment was the driving cycle. GM stated that both the HD engine cycle and the proposed HD chassis cycle are derived from the CAPE-21 data base. Since the engine cycle is 107 seconds longer than the chassis cycle, it is not possible to claim that both cycles are representative. GM, Ford, and Chrysler were concerned that the shorter cycle would allow less purge time and thus make control more difficult. GM requested that consistency between the two test procedures be established and that the record be kept open on this issue until MVMA completes its study of EPA's derivation of the cycles from the CAPE-21 data. Chrysler agreed that EPA should wait for the MVMA study to be completed and also claimed that the chassis cycle was unrepresentative of its HDG product line because Chrysler HDGs are all in the lower weight classes while the CAPE-21 data included many HDGs in the upper weight class.

GM and Chrysler disagreed with EPA's proposed 24° F fuel temperature rise for the diurnal part of the test. GM cited two documents[4,5] as evidence that 24° F was too high. GM concluded from the EPA document that a typical daily temperature excursion was 20° F, not 24° F, and that the average fuel tank is filled to 59 percent capacity instead of the 40 percent capacity proposed. GM stated that the time/temperature document does not support the NPRM test procedure either because the daily temperatures were above normal and the vehicles studied were passenger cars. GM recommends a 15° F fuel temperature rise with a 60 percent fuel fill.

Chrysler stated that the 24° F fuel temperature rise is unrepresentative of its HDGs because EPA based the 24° F rise on HDGs with saddle tanks (i.e., those fuel tanks which would be directly exposed to the sun's rays) and Chrysler does not use such fuel tanks on its trucks. Also, Chrysler claimed that the driving cycle was based on a delivery type of schedule yet the diurnal heat build assumes a commuter type of schedule. Chrysler objected to this inconsistency. Chrysler recommended a 15° F fuel temperature rise and presented a heat flow calculation to substantiate it.

Analysis of the Comments

Test Weight

We agree with the commenters that 70 percent of GVW is not the average weight of a typically loaded HDG. However, at the time this test procedure was developed, it was not the intent of the Agency to address the "average" HDG. Instead, we wanted to ensure that the majority of HDGs would comply with the standard. We believe that an adjustment to the proposed test weight is appropriate because of reasons in addition to the manufacturers' comments. We will begin this discussion with a brief analysis of the manufacturers' comments and then turn to the above mentioned reasons.

The letter from Mr. DeKany of EPA to Mr. Duffing of MVMA (Appendix I), which all four commenters cited as evidence against the 70 percent factor, gives a "mean-weighted payload" of about 500 lbs. for trucks in the 6,000 to 9,000 lbs. GVW range. If we assume that a HDG with a GVW of 8,600 lbs. has a curb weight of 4,092 as stated by GM, then it might be considered that the test weight should be 4,092 plus 500 lbs. or 53 percent of GVW. However, the "mean-weighted payload" figure is an average of all trucks whether loaded or not.

The DeKany letter also gives a number called the "mean-loaded payload." This number is an average for only those trucks which had a payload and is thus more pertinent to a strategy of controlling the majority HDGs rather than just the "average" HDG. The "mean-loaded payload" for the 8,600 lb. GVW truck discussed above is estimated to be about 780 lbs. from the DeKany letter. The test weight for this truck would be 4,092 lbs. (GM's curb weight estimation) plus 780 lbs. (the "mean-loaded payload") for a total of 4,872 lbs. or 57 percent of GVW.

The above calculations assume that the curb weight of trucks have significantly been reduced (as GM claimed) since the time that the data on which the DeKany letter is based was collected (1973). If the curb weights given in the DeKany letter were used in conjunction with the "mean-weighted payload" (500 lbs), then the test weight for a HDG with a GVW of 8,000 lbs. would be 6,600 lbs. (6,100 lbs. curb weight plus 500 lbs mean-weighted payload") or 83 percent of GVW. For a HDG with a GVW of 9,000 lbs. the same calculation yields a test weight of 80 percent of GVW. While we have no reason to doubt GM's claim of reduced curb weights relative to GVW, the DeKany letter alone would certainly not support lowering of the proposed test weight.

The data used in the DeKany letter was 1973 FHA weigh station survey data. This same source (but a different year's data (1977)) is later attacked by GM as nonrepresentative. GM claimed it is not truly representative since only interstate highway vehicles are in the sample size and the curb weights are in excess of late MY (1980) vehicles. Both points are well taken and apply to the DeKany letter as well as the 1977 FHA data. Due to the push for greater fuel economy, curb weights have indeed dropped substantially and GM's estimates seem reasonable. Also, we agree that local as well as interstate traffic should be considered in setting the test weight requirement. The FHA data only includes interstate traffic, but when combined with GM's curb weight estimates, it indicates that the test weight should be in the range of 50 to 60 percent of GVW.

A better source for determining the test weight is the Federal Energy Administration (FEA) study because it includes both local and intercity traffic. When the average vehicle loads of this study are combined with GM's curb weight values for the appropriate GVW classes, the test weights are calculated to be about 50 percent of GVW for all HDGs less than 26,000 lbs. GVW. (HDGs having GVWs greater than 26,000 lbs. will not be tested but will be subject to an engineering evaluation instead.)

The data sources also indicate that the loaded vehicle weight as a percent of GVW varies with GVW. For maximum real world simulation some relatively small increment of GVW would need to be selected and a different percentage applied to each GVW increment to derive the test weight. This would be a sizeable task and the resultant improvement in the test procedure would be minimal because a 10 or 20 percent increase or decrease in test weight is not going to affect the purge rate or engine compartment temperature in a major way. We conclude that the proposed method of using one percentage for all GVWs will be appropriate for all sizes of HDGs.

After reviewing that data available, we have determined that while the proposed test weight of 70 percent of GVW would be most appropriate if a "worst case" strategy of control were pursued, a test weight of 50 percent of GVW is more appropriate if an "average case" strategy is pursued. On the other hand, because of the limited role that the test weight plays in the test procedure, it is not likely that the difference between these two choices will substantially affect test results. Therefore, since we wish to reduce the burden of this regulation to the extent possible and since we do not believe the change in test weight will significantly affect air quality, we recommend that the test weight be changed to 50 percent of GVW.

Dynamometer Load Formula

GM and Ford commented in some detail on this topic. While the main thrust of their comments were the same (i.e., EPA's proposed dynamometer load formula produces horsepower settings that are too high), they attack the issue from different viewpoints.

GM claimed that EPA's frontal area coefficient of .67 is incorrect. GM stated that the formula for LDTs uses a frontal area coefficient of .50 for vans and .58 for pickup trucks. Since some HDGs in the lower weight classes have pickup or van body styles, it stands to reason that these vehicles should have frontal area coefficients the same as for LDTs. However, under the HDG test procedure, the .67 frontal area coefficient would have to be used, thus resulting in a higher dynamometer horsepower setting than if the LDT coefficient had been used.

We agree with GM that the .67 frontal area coefficient is not accurate for all HDGs. It is too high for the smaller HDGs and it is too low for the large HDGs. GM suggested that EPA propose multiple factors to cover each body shape found in the heavy-duty truck category. We have determined that the cost (e.g., testing, person-hours, etc.) to develop such a set of factors is greater than the relatively small benefit that would be gained. A different situation exists for LDTs in that two main body shapes (van and pickup) account for the large majority of LDTs sold. This situation does not occur with HDGs. HDG's body shapes include buses, tractor/trailer combinations, pickups, large delivery vans, garbage trucks, small vans, and stake-body trucks to name a few. EPA would need to expend a significant amount of resources to determine the proper frontal area coefficient for all HDG body types. The proposed coefficient of .67 was intended to be an average which we believe to be representative of all HDGs.

While we agree that the .67 coefficient is high for some HDGs, the purpose of the coefficient must be considered in determining if it is <u>too</u> high. In LDT certification, the frontal area coefficient is used to determine the dynamometer horsepower setting. This is also true for HDGs. However, there is a major difference between the two classes in the purpose of running the vehicle on the dynamometer. In LDT certification, the truck is run on the dynamometer and exhaust emissions are sampled. Almost as a by-product, the vehicle's engine compartment is warmed and the carbon canisters are purged in preparation for the hot soak part of the evaporative emission test. The affect of different dynamometer horsepower settings is much greater on exhaust emissions than on evaporative emissions. As will be discussed below, a relatively large difference in horsepower settings produces a small difference in total evaporative emissions. It is understandable that LDT frontal area coefficients should be relatively more accurate because they are used in exhaust emission testing as well as the warm-up cycle for evaporative emissions.

We believe that retaining the .67 frontal area coefficient, while being slightly more stringent for some of the lower weight HDGs, will not result in any unrepresentative dynamometer horsepower settings. Some settings may be higher than the "average" truck for that body shape category but still will not approach the "worst case" situation. In this sense, the .67 coefficient is lenient. We also point out that the dynamometer horsepower settings for HDGs as determined by this test procedure are already being lowered as a result of the change in the test weight formula. We proposed the test weight to be 70 percent of GVW. As discussed in the previous section, we now recommend that the test weight in this Final Rule be 50 percent of GVW. This results in a lowering of the horsepower setting of about 10 percent.

Ford did not specifically assail the .67 frontal area coefficient. Instead, Ford conducted a coastdown testing program with a C-700 HDG (27,500 lbs. GVW) to determine the actual track road load. This vehicle was selected for testing because it exhibited the most difficulty in meeting the maximum speed requirements of the driving cycle proposed by EPA. With the vehicle loaded to 70 percent of its GVW, Ford's coastdown testing yielded a dynamometer setting of 55 hp. The EPA formula would result in a dynamometer setting of 75 hp. Thus, Ford's coastdown testing of one HDG resulted in a dynamometer setting 27 percent lower than that derived from EPA's dynamometer load formula.

Ford then presented an alternate method for determining the dynamometer setting. However, Ford cautioned that this alternate calculation uses experimentally-derived formulas which are based on the data from only one vehicle. Ford stated that further data on a variety of vehicles must be obtained to verify the method.

While a 27 percent difference in dynamometer horsepower setting may seem to be substantial, Ford's test data indicates that it probably doesn't make much difference in evaporative emissions testing. Ford tested two C-700 HDGs for evaporative emissions using the proposed test procedure. The tests pertinent to this discussion were those in which the test weight of the vehicles were held constant at 19,250 lbs. (70 have the most trouble since such vehicles would be in WOT more frequently than th lighter HDGs. Chrysler, which only produces the lighter HDGs, should have no trouble adequately purging the carbon canisters using this driving cycle.

Chrysler's other concern was that since it produces only the lighter HDGs, the driving cycle might be unrepresentative. It is true that the driving cycle is derived from a data base which includes operational characteristics from light-, medium-, and heavy-weight HDGs. However, we do not believe it is reasonable to expect a different driving cycle for each manufacturer depending on its particular product mix. The Agency simply does not have the resources to undertake such a task. We believe the driving cycle is representative of the HDG class.

GM claimed that since this driving cycle has a duration of 1,060 seconds and the exhaust emission cycle (engine transient test) has a duration of 1,167 seconds, one or the other must be unrepresentative.

Both cycles are representative. The technique used to generate all of the cycles was a random number generator with appropriate filters and is known as the "Monte Carlo" technique. The mean trip time as determined from the CAPE-21 data base was approximately 18-20 minutes. In generating driving cycles from the CAPE-21 data base it was desirable to keep the time near 18-20 minutes. However, it would be unusual to have each cycle exactly the same length of time due to the randomness of the "Monte Carlo" technique. In fact, because the cycle would need to be forced to terminate, it would not be randomly generated thus reducing the objectivity of the "Monte Carlo" technique. The 1,060 seconds duration of the HDG evaporative emission cycle equals 17.67 minutes. The diesel engine transient test cycle is 1,199 seconds (i.e., 19.98 minutes), and the gasoline engine transient test cycle is 1,167 seconds (i.e., 19.45 minutes). While none of the three cycles mentioned above are exactly the same duration, they are all about 18-20 minutes long. They are all within the "window" that was established for representative cycles. It should also be repeated that Ford has already shown, through its HDG evaporative emission testing program, that the driving cycle does allow adequate time for purging. We assume that this is why GM was concerned with the discrepancy between the duration of the exhaust cycle and this evaporative cycle.

The representativeness of the CAPE-21 data base and the appropriateness of the "Monte Carlo" technique were both analysed in detail during the Final Rulemaking for the 1984 heavy-duty engine exhaust regulations. The reader is referred to the "Summary and Analysis of Comments" for that rulemaking (in Public Docket #OMSAPC-78-4) for further information on the development of the cycles.

Fuel Temperature Rise

Both Chrysler and GM claimed that a 15°F fuel temperature rise would be more appropriate for HDGs than the proposed 24°F fuel temperature rise. Chysler claimed that the driving cycle was based on a delivery type of schedule yet the diurnal heat build assumes a commuter type of schedule. Also, Chysler presented a heat flow calculation which showed that given the same ambient temperature and fuel tank configuration, the fuel temperature in a large tank will increase more slowly than that in a small tank. GM claimed that the two documents[4,5] we had used to substantiate the 24°F fuel temperature rise instead supported a 15°F fuel temperature rise.

The CAPE-21 data base included HDGs of many occupational uses. The resultant driving cycle is representative of the class of HDGs. We would agree that the majority of HDGs instrumented for the CAPE-21 study were in some sort of delivery mode. However, we do not agree with Chrysler that the heat build assumes a commuter type of schedule. Since Chrysler did not expand on its comment, it is not clear what it means by a "commuter type of schedule." The 24°F heat build assumes only that the vehicle is outside for the entire day. This is certainly true for the great majority of HDGs.

While we agree with Chrysler's general calculation, there are some specific factors which it did not take into account. First, there are many HDGs in the lighter weight categories which have fuel tank capacities similar to light-duty trucks and undergo the 24°F fuel temperature rise of the light-duty test procedure. Fifty-three percent of all HDGs have GVWs of 14,000 lbs. or less. This means that while there are some HDGs with fuel tank capacities of 100 or even 150 gallons, many HDGs have fuel tanks in the 20 to 40 gallon range, which is similar to LDTs. Second, for the most part HDGs with the large fuel tank capacities have these fuel tanks located where they are exposed directly to the sun. The fuel in these "saddle-type" tanks would thus be expected to increase in temperature more quickly than the fuel in tanks which are located underneath the vehicle and thus shaded.

Finally, Chrysler did not consider the fact that during a daily ambient heating cycle the fuel temperature of the smaller tank will cease to rise long before that of the larger tank. This occurs because the ambient temperature rises until it reaches a maximum and then decreases to its minimum. Chrysler's calculation assumes a constant heating rate. The fuel temperature of the smaller tank will lag behind the ambient temperature and will continue to rise until the ambient temperature has begun its descent and equals the fuel temperature of the smaller tank. From the point where the ambient temperature and the fuel temperature of the smaller tank are equal (i.e., maximum small tank fuel temperature) to the point where the ambient temperature and the fuel temperature of the larger tank are equal (i.e., maximum large tank fuel temperature) the difference between the fuel temperatures of the two tanks will shrink. Thus, the difference between the fuel temperatures of the two tanks that one might observe at the maximum ambient temperature can be expected to decrease throughout mid-afternoon.

GM claimed that the two documents[4,5] indicated that the fuel temperature rise during a typical day equals about 75 percent of the ambient temperature rise and that the typical summertime ambient temperature rise is from 64°F to 84°F. Thus, GM recommends the test procedure fuel temperature rise should be 75 percent of 20°F which equals 15°F. We agree with both of these findings, however, we do not agree with the recommendation because we are concerned with the control of evaporative emissions in most situations rather than just 50 percent of them. The days when higher than average ambient temperature diurnals occur are generally the same days when the amount of sunlight is most and wind is least. These factors aggrevate the air pollution problem and, therefore, the release of HC vapors should be doubly guarded against. We believe that this test procedure should attempt to assure control of evaporative emissions during these critical periods as well as during the average periods.

The typical summertime ambient temperature diurnal to which GM referred is exceeded many times. In fact, a 32°F ambient diurnal is not at all uncommon as Figure 1 indicates. A test procedure fuel temperature rise of 75 percent of such a 32°F ambient diurnal would yield 24°F. This is the fuel temperature rise of the proposed test procedure and we recommend its retention in the Final Rule.

Canister Preconditioning

GM claimed that the proposed canister preconditioning requirements were excessive. We had proposed that "green" or "virgin" activated carbon in the evaporative control system be exposed to 100 adsorb/purge vapor cycles before the full-SHED test would be run. Adsorb/purge vapor cycles are necessary to stabilize the carbon's working capacity. The 100 cycles proposed was estimated to be a sufficient number to assure stabilization. Ninety of the 100 cycles could be done with a bench-type procedure while the last ten cycles had to be done while the carbon device was attached to the HDG in its production configuration.

GM submitted data showing that equilibrium was reached after approximately 20 adsorb/purge cycles. We have, therefore, changed this Final Rule accordingly. The official test procedure requires only 20 bench-type adsorb/purge vapor cycles plus ten cycles with the carbon device attached to the

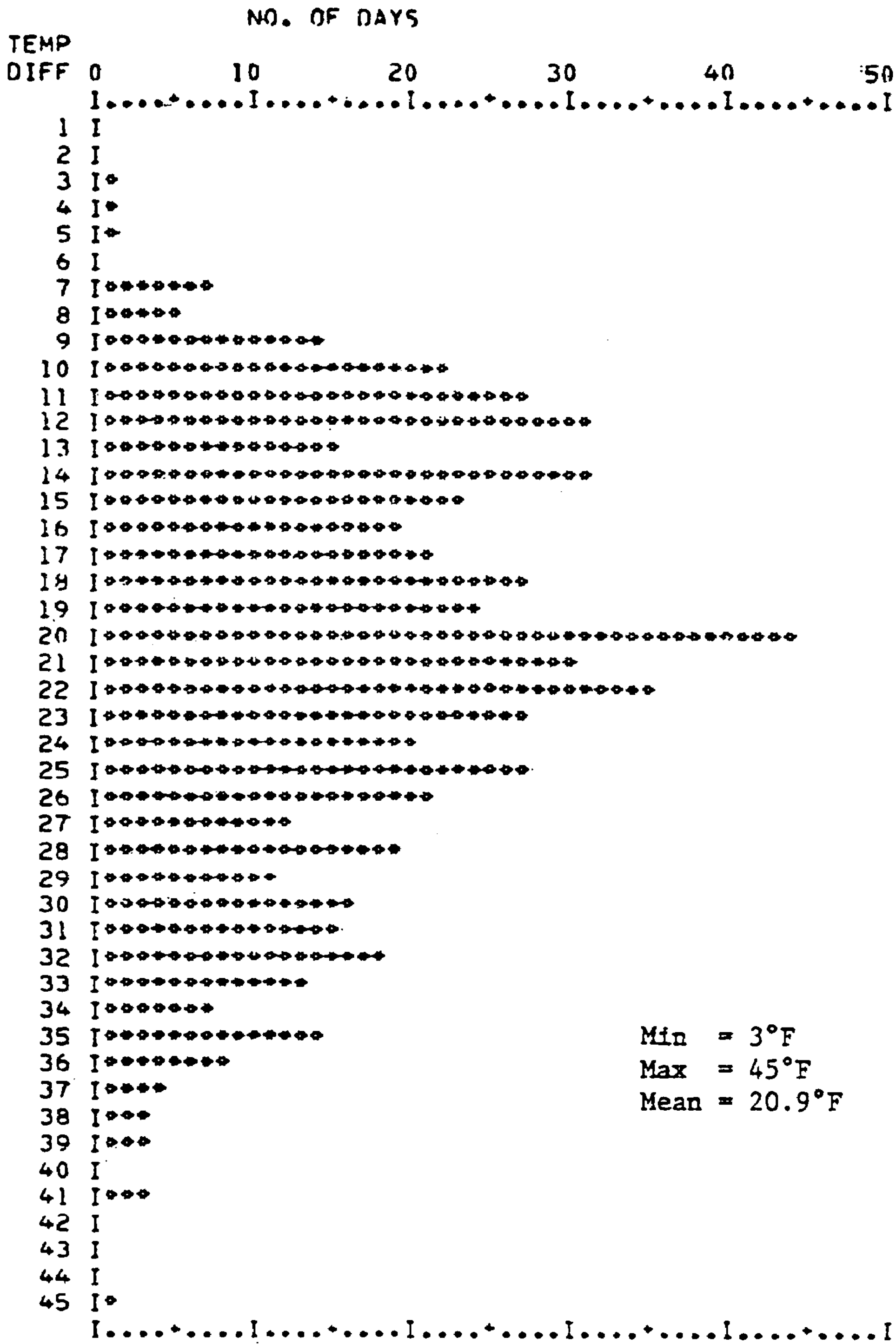

Figure 1 Composite Distribution of Differential Daily Temperatures – 5 Cities (July & August)

Source: "Typical Vehicle Diurnal" U.S. EPA, October, 1976

HDG. However, it should be noted that this aspect of the test procedure is, in actuality, left to each individual manufacturer's discretion. Each manufacturer is free to use any testing method it chooses to assure compliance with the standard and the only testing EPA might do would be on in-use vehicles. Such vehicles will have canisters which are aged and stabilized. The canister preconditioning aspect of this official test procedure will thus not be necessary when and if EPA ever does test HDGs for evaporative emissions.

Hood Open vs. Closed

MVMA, Chrysler and GM claimed that since the light-duty test procedure requires the vehicle's hood be open during operation over the driving cycle, this HDG test procedure should at least leave that option up to the manufacturer. The proposed HDG test procedure required that the vehicle's hood remain closed. The commenters claimed that this was not equitable with the light-duty procedure.

We acknowledge the fact that this HDG test procedure is different than the light-duty test procedure. We do not, however, find anything inequitable in this. HDGs' hoods are certainly closed when they are in-use and leaving the hood closed during the driving cycle therefore better simulates the real world. The practive of opening the hood for light-duty vehicles was established many years ago to aid cooling since the fans available were inadequate. We have doubled the maximum fan size (from 5300 cfm to 10,600 cfm) for this HDG rulemaking. We believe these bigger fan capacities will adequately cool the HDGs as they are driven over the cycle. If, however, the manufacturer can show that during field operation the vehicle receives additional cooling, and that such additional cooling is needed to provide a representative test, the fan capacity may be increased or additional fans used.

None of the commenters mentioned the increased maximum fan capacity (as compared to light-duty). In a sense, this increased maximum fan capacity is intended to offset the reduction in cooling due to the requirement that the hood be closed. None of the commenters claimed that 10,600 cfm would not be enough to provide adequate cooling. In fact, Ford has demonstrated the technical feasibility of the test procedure and standard for a 27,500 lbs. GVW vehicle. We do not believe that this test procedure must be identical to the light-duty test procedure and, therefore, recommend that the hood-closed requirement be retained in the Final Rule.

References

1. "The Composition, Function and Travel Patterns of Medium Duty Trucks," MVMA #L17510-C1.21.

2. "Trucking Activity and Fuel Consumption - 1973, 1980, 1985, and 1990," FEA/D-76-390, July 1976.

3. "1977 Federal Highway Administration In-Use Truck Weight Data."

4. "Typical Vehicle Diurnal," Emission Control Technology Division of the Office of Mobile Source Air Pollution Control, EPA Evap 76-3, October 1976.

5. "Time-Temperature Histories of Specified Fuel Systems, Volume I," Coordinating Research Council, Inc. (APE-5-68, October 1969.

APPENDIX I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR MICHIGAN 48105

November 6, 1975

OFFICE OF
AIR AND WATER PROGRAMS

Mr. Lewis E. Duffing
Staff Engineer
Motor Vehicle Manufacturers Assoc.
320 New Center Building
Detroit, Michigan 48202

Dear Mr. Duffing:

This is a response to your request for information on light duty truck loading contained in your letter of October 17, (attached) EPA conducted an analysis of 1973 truck weigh station survey data available from the U.S. Dept. of Transportation, Federal Highway Administration and thereby arrived at the figure of 500 lbs. average combined passenger and cargo loading for light duty trucks. The table below summarizes the data used in deriving this value.

TABLE-TRUCK WEIGHTS AND PAYLOADS (lbs)

GVW	Mean Curb weight	Mean loaded payload	Mean weighted payload
6000	4695	905	518
7000	5280	770	470
8000	6100	734	456
9000	6671	809	534

The mean weighted payload value was derived by multiplying the mean loaded payload by the percent of trucks observed to be loaded and then adding the 300 pound value currently associated with passenger and fuel loading for personal transportation vehicles. The value so determined stays relatively constant over the GVW range under consideration for the revised light duty truck class and therefore the approximate value of 500 lbs. was chosen as representative.

Sincerely yours,

John P. DeKany, Director
Emission Control Technology Division

cc: C. Gray
C. Rossow