Evaporative Emission Regulations for 1978 Model Year Light Duty Vehicles and Trucks

Analysis of Comments

Mobile Source Air Pollution Control
Office of Air and Waste Management
U.S. Environmental Protection Agency

United States Environmental Protection Agency

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Introduction

The Notice of Proposed Rulemaking for Evaporative Emission Regulations was published on January 13, 1976. Fifteen motor vehicle manufacturers, one environmental organization, the research subsidiary of a petroleum company, the State of California, a manufacturers' association, and an equipment manufacturer, responded to the request for comments. The respondents are listed in Table 1.

The responses were, in general, directed toward the areas of concern identified in the Notice.

The consensus of the respondents was that the proposed change in the test procedure is desirable; a six gram per test standard is attainable; and implementation in 1978, while difficult, is possible. Some manufacturers urged postponement until 1979.

Most of the respondents argued that a two gram per test standard is unattainable, or at least not attainable by 1979 - esspecially if vehicle background hydrocarbon emissions are included in the measurement.

The analysis of comments resulted in no major changes to the test procedure.

The analysis of comments consists of the following items:

1. A brief statement of each issue;

2. A description of each respondent's position regarding the issue;

3. A discussion and analysis of the issue; and

4. Recommendations.

This analysis of comments deals only with the 1978 procedure and standards. The comments regarding the 1979 and later 2 g/test standard are discussed in a separate package.

Table 1

List of Respondents

1. American Motors Corporation (AMC)
2. Automotive Environmental Systems, Inc. (AESi)
3. British Leyland
4. California Air Resource Board (CARB)
5. Chrysler Corporation (Chrysler)
6. Exxon Research and Engineering Co. (Exxon)*
7. Fiat
8. Ford Motor Company (Ford)
9. General Motors Corporation (GM)
10. Honda Motor Co. (Honda)
11. International Harvester (IH)
12. Mercedes Benz
13. Motor Vehicle Manufacturers Association (MVMA)
14. Natural Resource Defense Council (NRDC)
15. Nissan Motor Co. (Nissan)
16. Renault, Inc.
17. Toyo Kogyo, Co.
18. Toyota Motor Sales, U.S.A., Inc. (Toyota)
19. Volkswagen
20. Volvo

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* Although Exxon Research and Engineering Co. responded on behalf of its corporation, it should be noted that Exxon Research and Engineering was a contractor to EPA to explore evaporative emission control technology. The subsequent discussions differentiate between the contract study results and Exxon's corporate response to the NPRM.

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(6 g Standard)

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Issue - "Feasibility and Lead Time Requirements of a 6 g/test Standard"

An evaporative emission standard of 6 g/test is proposed for the 1978 model year vehicles. This section deals with the technical feasibility and time requirements for meeting this regulation.

A. Summary of Comments

AMC - "Carburetors for both our six cylinder and eight engines will require venting changes to meet a 6 g/test standard. Lead time requirements for incorporating these carburetor changes are approximately 40 weeks after satisfactory systems have been defined by our various Engineering groups. At this time, we are confronted with a very tight schedule if we are to meet SHED requirements for 1978 across our entire product line. Any unexpected problems could seriously jeopardize our certification schedule and our ultimate production schedule."

British Leyland - "In our present development situation we are not in a position to comment on the proposed 6 gram test standard and it will be a little time yet before we shall have completed tests which will enable us to make meaningful comment."

Chrysler - "In order to meet or approach the proposed evaporative emission standard of 6 g/test, it has been estimated that at least the following design changes would be required to Chrysler's present and planned engine offerings:

a. Vent carburetor bowl to the charcoal canister

b. Add two-way vent (mechanical or solenoid operation) to carburetor."

Exxon - "We think that the proposed standard of 6 grams per SHED test for the 1978 model year is a reasonable standard."

Fiat - "The Fiat certification process lasts, on the basis of our experience of the previous certifications, from the presentation of Part I application to the obtaining of the certificate of conformity, about ten months. Fiat suggests that the 6 g/test standard be postponed to the 1979 model year."

Ford - Ford has successfully developed evaporative emission control systems that would allow emission data vehicles to meet a 6 g/test standard, and there appears to be sufficient lead time to produce these components for the 1978 model year. The systems have been designed to function for 50,000 miles of operation without deterioration. However, no durability testing has yet been conducted, and due to the short time remaining, cannot be conducted prior to the start of 1978 certification. Consequently, Ford recommends that the proposed regulations for a 6 g/test standard for 1978 be revised to delete deterioration factors.

If durability verification is required for evaporative systems, Ford would like to be permitted to do this by appropriate design verification tests. These would be done in lieu of 50,000 durability vehicle tests. If these tests showed deterioration of any systems, those particular systems would then be subject to 50,000 mile vehicle durability tests for the determination of a deterioration factor.

GM - A 6 g/test evaporative emission standard is technically feasible. If this were the only new regulation being promulgated for the 1978 model year, GM might not consider it particularly burdensome. However, the (exhaust) emission standards for the 1978 model year are yet unknown, fuel economy standards begin in 1978 and there are proposed new light duty and heavy duty truck standards for the 1978 model year. The combination of these factors, along with other emission regulations, becomes overwhelming.

"As for the lead-time factor, our normal tooling release date will have passed by the time these regulations are promulgated. Although possible, compression of this lead-time would create additional expense and complication in the introduction of our 1978 models."

There also has not been enough experience with the SHED procedure to establish measurement precision. Postponement of the regulations for one year would provide experience with the procedure on California vehicles. This would also minimize the risk involved in introducing the new hardware by applying it to a limited number of vehicles. GM strongly recommends that the regulation be postponed until the 1979 model year.

IH - Preliminary investigations indicate that the present California heavy duty evaporative system with revisions may be capable of meeting the 6 g/test 1978 standard. Estimated changes required to meet this standard are canister location and additional vents and hoses.

Nissan - "It will be possible for us to install additional controls to satisfy the 6 g/test requirement in time for 1978 model year production. Baseline emission data indicates that the electronic fuel injection vehicle will meet the standard with no modification to the present vehicle. However, additional controls are needed to some carbureted vehicles to meet the 6 g/test standard. For these vehicles, the results from our experimental work tell us that it will be possible to comply with the proposed 6 g/test standard, applying a carburetor external vent connected with the canister."

Toyo Kogyo - "We believe it would be difficult to comply with the EPA proposed standard of 6 g/test for 1978, and would recommend it be implemented for the 1979 model year due to the following reasons:

A. Although we have purchased SHED equipment, we would require more time to establish the measuring techniques that would enable us to make accurate evaluations, because we consider that the test result variations we have experienced are due to the measuring method.

B. Due to the time consuming measurement procedures, a considerably longer period of time would be required for us to develop appropriate control systems. We consider the standard would require a considerable degree of modification to the current evaporative emission control systems, including reviewing basic factors such as fuel system design, control of ambient temperature around the carburetor, and various kinds of sealings. Furthermore, the EPA proposal would have a far-reaching effect on the reliability, product acceptability, and productivity of the total systems which we will have to confirm."

Toyota - "As a result of our recent efforts, our new evaporative emission control system has progressed to such a level that we may be able to satisfy the proposed California and EPA evaporative standard of 6 g/test in 1978. It is desirable that the evaporative regulations based on the SHED method be implemented at the same time that the exhaust emission standards are revised in order to make the certification work efficient and to save certification costs and testing time."

Volkswagen - "The time for development and certification is 2.5 years after the law has been issued."

B. Discussion

The comments received generally indicate that a 6.0 g/test standard is technically feasible and that, although the schedule will be rather tight, it can be implemented for the 1978 model year. Three manufacturers (Fiat, GM, and Toyo Kogyo) recommend that the standard be postponed until the 1979 model year, but do not say that the 1978 compliance date can't be met. Only Volkswagon, with the lead time estimate of 2.5 years from issue of the regulation, indicates that they cannot meet the 1978 date. Volkswagon gives no breakdown of the tasks included in the 2.5 years lead-time requirement.

Ford states that there is not enough remaining time to conduct durability testing before the start of 1978 certification, and recommends deletion of deterioration factors for 1978. While some of Ford's 1977 durability vehicles started mileage accumulation in September 1975, others did not start until March, 1976. If the 1978 models follow a similar schedule, there are several months remaining before mileage accumulation would begin on the durability vehicles. So time is available for durability testing.

Ford also said that, if durability testing were required, it would like to do this by design verification tests rather than 50,000 mile vehicle tests. It is EPA's judgment that it is very difficult to incorporate in a laboratory test, all the conditions that will occur in 50,000 miles of vehicle operation. It is essentially impossible to predict all the conditions to which an emission control system will be exposed in day-to-day vehicle operation. Since the emission control systems which will be used for meeting the SHED test requirement are of new (or at least modified) design, vehicle durability data is essential. (See "Durability and Evaporative System Deterioration" issue for additional detailed discussion).

GM's greatest concern with meeting the 6.0 g standard in 1978 appears to be the number of other regulations which may be implemented in that same year. However, some of the regulations which GM listed will not be implemented with the 1978 models. The heavy duty truck standards are being proposed for the 1979 model year. As of this analysis Congress is also considering amendments to the Clean Air Act which might provide relief in either implementation dates and/or emission standards for Light Duty Vehicles.

In regards to GM's comment on measurement precision, the most recent data available to us are results of the EPA-MVMA SHED cross-check study. This program consisted of multiple SHED tests on two vehicles at the facilities of AMC, Chrysler, EPA, Ford, and GM. The standard deviation of the means between facilities was 15% for one vehicle and 7% for the other. This is no greater than typical variation in exhaust emission tests between facilities.

C. Recommendation

The 6.0 g/test standard is technically feasible and there is sufficient lead time to implement it for the 1978 model year. Therefore, the 6.0 g/test standard should be promulgated for the 1978 model year.

Issue - "Cost of a 6 g/test Standard"

In the Environmental and Economic Impact Statement associated with the "Proposed Evaporative Emission Regulations," the sales weighted increase in vehicle retail price required to meet a 6 g/test standard was estimated at $7.30. The following comments were received regarding the costs involved in meeting a 6 g/test evaporative standard.

A. Summary of Comments

Chrysler - For the 1978 model year, the retail price increase per light duty vehicle is estimated at $6.00 over the 1977 models (1976 economics).

Ford - Ford's current estimate of control system costs to meet a 6 g/test standard for 1978 is a retail price equivalent of $15.00 per vehicle.

GM - It is estimated that the cost to the consumer for hardware necessary to comply with the proposed 6 grams of hydrocarbon evaporative emission test (SHED) will be in the area of $1 to $4 per car over the current 1976 models.

Nissan - Retail cost increase from 1977 model is estimated as follows:

A. Carburetor vehicle (per vehicle)

Carburetor external vent (with solenoid valve)	$4.20
Canister size up	$1.80
Total	$6.00

B. Electronic fuel injection vehicle: No cost increase.
Assumption: Current price level
1 U.S. dollar = 304 Yen

Toyota - The price per vehicle increase to meet a 6 g/test standard on the 1978 model vehicle is expected to be approximately $13.

IH - IH estimates the system cost to the customer at $32.00 per vehicle (in 1976 dollars).

B. Discussion

The range in vehicle price increase estimates supplied by the manufacturers was greater than anticipated, especially among the three largest U.S. automakers. GM estimated a range of $1 to

$4 and Ford estimated a cost of $15. Apparently the proposed control systems to be used by these manufacturers may be quite different, although the range in the evaporative emission levels of the 1976 model vehicles from these two manufacturers is not substantially different. The reasons for the substantially higher Ford estimate could not be ascertained. However, this suggests either a low cost effectiveness for the Ford system or that the Ford system was targeted for lower emission standards.

Exxon Research and Engineering has recently conducted a test program for EPA which investigated the cost of vehicle modifications to reduce evaporative emissions.(1) As part of this program, the evaporative control systems of six production passenger cars were modified using several different types of modifications in order to demonstrate lower emission levels. At some point in the modification program, all vehicles reached an evaporative emission level below 6 g/test. A sales weighted average of the estimated increase in vehicle retail price for these modifications was about $2. Although this cost estimate is based on limited data, it is in agreement with the cost estimate of $1 to $4 which was supplied by General Motors. Thus, it would appear this estimate of the cost of a system for compliance with a 6 g/test standard seems reasonable.

Based on the cost estimate received from the manufacturers, the sales weighted vehicle retail price increase required to meet a 6 g/test standard (assuming $2.50 for GM vehicles) is $7.40. The sales data were obtained from "Automotive News" for the 1974 model vehicles as listed in the "Environmental and Economic Impact Statement" for this regulation. This sales weighted price increase of $7.40 is in agreement with the price increase estimate of $7.30 which was contained in the "Environmental and Economic Impact Statement". The $7.40 estimate is higher than the $2 estimate made by Exxon primarily due to the high $15 cost given by Ford. For estimating the economic impact of a 6 g/test standard it would seem most appropriate to use the manufacturer's sales weighted average of $7.40. However, it is concluded that compliance with a 6 g/test standard is possible for a $3/vehicle average cost increase.

C. Recommendation

Some recent data indicate that the required increase in sales weighted vehicle retail price may be as low as $2.00. It is recommended that a cost increase of $7.30 be retained for cost-effective and economic impact considerations because it agrees with the sales weighted average of the manufacturer's estimates.

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(1) Clarke, P.J., "Investigation and Assessment of Light Duty Vehicle Evaporative Emission Sources and Control," Exxon Research and Engineering, EPA Contract #68-03-2172, April 1976.

Issue - Evaporative Family Concept for Certification

The NPRM proposed a new certification scheme for determining evaporative compliance in the interest of improved sampling of manufacturers' product lines with respect to evaporative parameters and in the interest of reducing the total evaporative testing burden. Comments were requested on the proposal in terms of potential savings and in terms of problems which may arise in attempting to integrate the evaporative family concept into the existing engine family concept of certification.

A. Summary of Comments

AMC - "We endorse the evaporative emission family concept, however, its interpretation and possible application raises questions, especially in the area of alternate suppliers for items such as charcoal canisters. (We currently have three sources). We request further definition of this vital concept, especially in light of the recently proposed 1978 light-duty truck regulations."

Chrysler - Chrysler comments that the definition of evaporative emission families is not entirely clear to them. They ask several specific questions about the limitations placed on the allowable variation in components to be classed within the same evaporative emission family. The final Chrysler comment on the issue is "that the definition of evaporative emission families be more clearly defined."

Fiat - "The introduction of criteria, which further differentiate the various models within an engine family, may involve a greater number of vehicles to be tested for certification, with consequent burden of cost and time both for the Manufacturers and EPA." In Fiat's estimation, a particular problem exists for manufacturers who use only one basic evaporative emission systems for their whole product line, because the new criteria force a subdivision of each engine family into different evaporative families.

"Fiat suggests therefore that the criteria for evaporative families in the final rules be revised to take in due consideration this situation."

Specific comments are:

1. A tolerance on design working capacity needs to be indicated as a limitation for evaporative emission family criteria.

2. Canister housing material has no influence on evaporative emissions and should be eliminated as an evaporative family criterion.

3. Determination of evaporative families based on carburetor model is too restrictive, the word "model" must be deleted and replaced by "type or configuration".

4. Determination of evaporative families based on different fuel filler cap retention mechanism will not minimize testing. The criteria should be revised from "seal mechanism and retention mechanism" to "sealed type or with ventilation valve".

Ford - Ford basically supports the evaporative emission "family concept". However, Ford recommends that, because there is a general lack of data regarding the effect of family determinators on the DF, EPA specify family determinators more generally in the Federal Register so that the MSAPC Advisory Circular system can be used to modify family determinators on a much more timely basis as technical input becomes available.

Specific areas on evaporative family determinants which Ford recommends be revised are:

1. Basic canister design - Parameters to be limited should be an Advisory Circular topic rather than in the regulations.

2. Carburetor type (1V vs. 2V vs. 4V) or fuel injection type should be the family criteria not carburetor model or features such as external carburetor bowl vent or purge control valves.

3. Fuel tank and fuel filler cap parameters should be advisory circular topics rather than in the regulations.

In discussion of the problems which might arise from integration of the evaporative family concept into the exhaust emission family concept Ford points out the following:

1. The relationship between exhaust and evaporative emission "family" certification is not fully defined. It appears that a test vehicle failing evaporative standards would not be certified until it passed both exhaust and evaporative standards, while a vehicle failing exhaust standards and passing the evaporative standards would still be certified for evaporative emissions. Ford recommends that the regulations permit the manufacturer to demonstrate, where applicable, that the evaporative and exhaust emission characteristics are not related, so they can be certified independently.

2. The proposed regulations indicate that after an evaporative emission family has been certified, EPA may waive further evaporative emission testing, currently conducted in conjunction with certification of running changes.

These issues should be clarified in the promulgated regulations.

GM - "Creating additional engine families on the basis of differences in evaporative emission control systems cannot be justified. Therefore, separate engine families for evaporative emission control systems should not be required."

"We believe that SHED testing of exhaust emission certification data vehicles would provide more than adequate demonstration of compliance with evaporative emission standards. The addition of the proposed Evaporative Emission Family is not needed".

Based on the 1977 product line, GM estimates that 25 durability vehicles would be required solely to establish evaporative deterioration, (assuming the capability of exhaust emission data carryover to meet 1978 exhaust standards). GM feels this represents a considerable burden to both EPA and industry.

IH - The evaporative emissions family criteria as related to fuel tanks does not address dual fuel tanks, fuel tank shape or location. Clarifications in the regulations are needed.

The evaporative emission family criteria include such items as canister housing material, basic fuel filler cap type etc. IH fails to see the reason for such items to be included as family criteria. Emission data vehicle testing would be sufficient to evaluate optional designs in these areas. The same procedure should be used for dual fuel tank approval.

Mercedes Benz - "DB asks that an advisory circular be issued shortly after issuing the final evaporative emission regulations in order to clarify under what conditions evaporative control systems are considered to represent the same evaporative control system family."

Nissan - The concept of Evaporative Emission Family is considered quite reasonable. It will be very desirable and favorable for both EPA and manufacturer, as mentioned in the proposed regulations, if testing loads can be reduced by introducing this concept into certification program.

Toyota - "...we feel that it should not be required that the effects of a change in the canister working design be evaluated by using the durability data vehicles because, if other conditions of the system are the same, then a change in the working capacity of the canister would have little effect on the deterioration factor of the evaporative emission."

"If our comments are not accepted as plausible, then some reasonable tolerance for the canister working capacity should be considered in the determination of the evaporative family."

B. Discussion

It is apparent from the comments that there may be a misunderstanding of the evaporative emission family concept. Some manufacturers that do understand the concept do not support it because they feel it does not represent a reduction in testing during MY 1978. These manufacturers do not understand the implications of the regulations for evaporative testing for 1978 if the existing "engine-system" concept remains unchanged.

The existing definition for "engine-system combination" is an engine family-exhaust emission control system - fuel evaporative control system combination. The requirements for certification require that for each "engine-system combination a durability vehicle generate deterioration factors for HC, CO, NOx and evaporative HC, and at least one emission data vehicle generate 4000 mile emission values for HC, CO, NOx and evaporative HC." A provision exists for use of data from a previously certified vehicle to satisfy the requirements in lieu of a manufacturer actually testing durability and emission data vehicles. It is this provision that manufacturers argue will allow them to use carryover exhaust emission data for 1978 if the exhaust emission standards are not significantly different in 1978. They view the testing required under the proposed evaporative emission family regulations as a significant increase over little or no testing (substantial or complete use of carryover). The fact that both the test procedure and standard for evaporative emissions will change for 1978 will require complete recertification under the current certification requirements because no evaporative carryover can be allowed for any engine-system combination as no previously certified engine-system combination will have generated evaporative emission data according to the 1978 procedures.

The proposed evaporative emission family concept should in fact significantly reduce the evaporative emission testing that would be required by the current certification scheme of engine-system combination.

Two manufacturers apparently interpreted the evaporative emission family concept incorrectly as a subgrouping within established engine families with resultant testing required for each evaporative family within each engine family. These manufacturers would not support the evaporative family concept due to the apparent proliferation of testing requirements. The concept of evaporative emission family is that the product line is evaluated for its evaporative emission characteristics independently of its engine family groupings, when vehicle configurations are specified separately for both exhaust emission testing and evaporative emission testing. At the point where the vehicle requirements for both standards are specified, then the product line is examined to see if a single vehicle can satisfy both requirements. In the case of a small manufacturer with a narrow product line and only one evaporative emission control system (by the current definition this is solely a function of vapor storage method; i.e., canister, air cleaner, crankcase), the new evaporative emission family concept could divide his single "control system" into more than one evaporative emission family based on parameters which vary between the models of his product line. If the new criteria created more evaporative emission families than engine families, it would result in an increase in testing requirements compared to the testing requirements under the current system.

A study of 1976 and 1977 light duty vehicle evaporative emission control systems with respect to the proposed evaporative emission family concept was conducted to determine to what extent a further division of existing engine families might occur (rather than the expected consolidation of existing engine families into fewer evaporative families), only three cases occurred which a potential increase in testing might have been realized. In each such case, the additional testing would have been one durability and one emission data vehicle as only one vehicle in the product line employed the unique system components. The purpose of the evaporative emission family concept is to more adequately evaluate the performance of the evaporative control system. A side benefit of the concept was that it would involve less testing as most manufacturers do not use very diverse evaporative emission control systems. The principle of more accurately evaluating the performance of the evaporative control system should not be compromised in the interest of the few manufacturers who choose to proliferate their evaporative controls. The performance of the controls must still be evaluated in these cases.

Some manufacturers proposed revisions to the evaporative emission family criteria, or the application of tolerances to those existing criteria. In general, the manufacturers would prefer to have the evaporative emission family criteria expressed in general terms in the regulations and allow tolerances to be applied by the MSAPC Advisory Circular system on a timely basis as technology changes. The concept is commensurate with that currently employed for engine family and exhaust emission control system definition. The method suggested by the manufacturers is the approach which should be followed in the final regulations. Additional input on the values of tolerance which should be applied and specific recommendations for revisions to the criteria for evaporative emission family determinants would be useful in revising the family and control system criteria in the proposal.

The criteria which will determine evaporative emission families will be expressed in general terms in the regulations but this does not eliminate EPA's concern that the parameters originally identified are significant when evaluating the evaporative performance of a vehicle. The canister parameters which are considered to be significant are the vapor absorption capacity, the housing material and the general configuration including vent and purge mechanism. Several manufacturers suggested that tolerances might be applied to the canister working capacity.

Application of tolerances to the canister working capacity would allow manufacturers to combine families which would otherwise be separated because of different canister capacities. An examination of existing product lines shows that an application of reasonable tolerances on canister capacity would not group any families that would otherwise be separated. None of the manufacturers who suggested that a tolerance be applied suggested levels of tolerance which could be applied nor did they explain the reasons for this request. The canister housing material is considered since it has an influence on the life of the absorption material and that the housing integrity has an influence on the retention of the absorption material as well as the fuel vapors. The canister configuration to the extent detailed in the NPRM has an influence on the basic canister performance with respect to loading, breakthrough and purge characteristics of one canister as compared to another configuration.

The fuel system parameters were probably the most misunderstood parameters, particularly the carburetor related items. The specification of carburetor model was an attempt to characterize the type of significant differences in evaporative emission related parameters that EPA considers necessary to evaluate. Some specific areas of concern are: fuel bowl size and vent configuration, purge controls, location of fuel bowl with respect to the carburetor mounting flanges (as a heat source) and general throttle shaft and accelerator pump shaft configurations. The areas that are to be isolated are of an evaporative related nature and carburetor model seemed like a convenient manner in which to isolate these areas. After an examination of the carburetor model designations from those manufacturers' product lines who specifically commented on the issue, it became apparent that some non-fuel evaporative parameters (as well as some non-exhaust emission related parameters) may in fact determine a different carburetor model for these manufacturers. For this reason, the criteria listed in the regulations were made general enough to alleviate the problem.

The basic fuel tank type was considered important due to its obvious function to store the fuel and to maintain integrity against vapor or liquid loss through vent design, vapor control baffles, bladder like liner, etc. The consideration of material enters here from the standpoint of tank integrity against fuel or vapor loss. The fuel filler cap is also of significant concern due to EPA's experience with caps on test vehicles failing to pass leak checks. The cap retention mechanism and seal mechanism both contribute to the integrity of the fuel cap-fuel tank interface, and the variations in design have to be evaluated.

In summary, the same parameters which EPA felt important to evaluate for evaporative emission characteristics are still going to contribute to the sampling plan to be adopted for certification as no manufacturer has submitted any data or arguments that would adequately support a recommendation to the contrary.

Ford was the only manufacturer commenting on potential problems in integrating the evaporative emission family concept into the existing engine family concept of certification. In addition to the areas pointed out by Ford, some other revisions are necessary to eliminate problems in applying the new evaporative emission family system to the existing certification scheme. The primary issue is that of vehicle representation; i.e., a vehicle selected and tested for exhaust emission compliance only, represents those vehicles of the same engine family-exhaust emission control system; a vehicle selected and tested for both exhaust emission and evaporative emission compliance represents vehicles of the same engine family-exhaust emission control system as well as all vehicles of the same evaporative emission family-evaporative emission control system. This is because a vehicle may be tested for exhaust emission compliance without requiring an evaporative emission compliance test. However, if the vehicle was selected for only evaporative emission compliance determination, it would require both exhaust and evaporative emission compliance testing. An issue related to vehicle representation is that of options available to the manufacturer should a vehicle fail to comply with either the exhaust emission standard, or the evaporative emission standard or both. Revisions have been made to the necessary sections of the regulations to clarify the procedures that will be followed in the areas in question.

C. Recommendations

The proposal for evaporative emission families as a certification scheme should be maintained. The evaporative emission family criteria should be modified to provide good decriptions of the criteria.

The areas in the regulations which provide for integration of the evaporative emission family concept into the existing exhaust emission family scheme should be revised to provide clarity.

Issue - Durability and Evaporative System Deterioration

The certification method proposed in the NPRM for determining evaporative emission compliance was patterned after the existing certification procedure.

Initially, each manufacturer's planned product line is divided into major groups (evaporative families) based on similarities in basic emission-related characteristics of the vehicles and their evaporative control systems. Because it is believed that changes in various fuel system and emission control system calibrations are likely to have a significant effect only on absolute emission levels, and not on changes in emission levels with use, separate evaluations are made for emission deterioration characteristics and for low mileage emission levels.

For each evaporative family, generally one prototype vehicle is built and operated by the manufacturer over 50,000 miles of use. Mileage accumulation is substantially accelerated over what would be typical in actual use. Emission measurements are made on each vehicle at 5,000 mile increments, ending with the 50,000 mile test. Generally a single emission test is performed at each mileage point. Test results for the 5,000 mile through 50,000 mile test points for each vehicle are then used to estimate a linear emission deterioration rate for each pollutant for each vehicle. Finally, deterioration factors, which represent the difference between the 50,000 mile to 4,000 mile values of the linear approximations, are calculated.

To evaluate the various different system calibrations that may be used within a given family a somewhat larger number of prototypes (generally two to six) are built and operated to 4,000 miles at which point they are emission tested. These emission data vehicles are selected based on the manufacturer's projected sales of different designs within the evaporative family as well as on design characteristics judged likely by EPA to lead to higher emissions than other designs in the same family. A single emission test is performed on each vehicle, although if a vehicle is judged to have failed a standard (by a process to be described subsequently) the vehicle may, at the manufacturer's option, be retested. In that case, the second set of emission results is used.

Compliance of a vehicle with standards is determined by adding the appropriate deterioration factor determined in the 50,000 mile testing to each emission data vehicle's 4000 mile emission value. The resulting value for each pollutant must be equal to, or less than, the respective standard. For an evaporative family to be approved (certified) for sale, all emission data vehicles tested in that family must comply with the standard. Systems represented by emission data vehicles which fail must be redesigned and retested until they do comply, or must be dropped from the planned product line. In the latter case, additional vehicles may have to be tested to 4,000 miles to make up the full complement of test vehicles required for that evaporative family.

A. Summary of Comments

Chrysler - "The EPA has failed to demonstrate that evaporative emission systems significantly deteriorate during the useful life of the vehicle. Therefore, the inclusion of evaporative emission deterioration factors for certification purposes is inappropriate." Chrysler states that, to date, experience (no data provided) shows that significant evaporative system deterioration does not exist and that EPA should prove that deterioration does exist prior to requiring durability testing to certify evaporative control systems.

Chrysler also points to the statistical variability associated with the test procedure and use of only a single vehicle to determine deterioration factors as reasons against required durability testing.

Chrysler recommends "that deterioration factors be omitted from the final rulemaking until a need and an objective method for the inclusion of such a factor is demonstrated."

Ford - Ford's position regarding the proposal is as follows:

"Ford has successfully developed evaporative emission control systems that would allow emission data vehicles to meet a 6 gm/test standard when tested by the SHED procedure. However, no durability testing has yet been conducted on these systems and, due to the short time remaining, cannot be conducted prior to the start of 1978 certification. Further, Ford believes that we can adequately demonstrate that there is in fact no need to establish deterioration factors for the Ford evaporative emission control system. Ford proposes that EPA establish optional procedures that permit a manufacturer to show that the evaporative emission control system would function adequately during its lifetime by either of the following methods:

1. Verify the mechanical integrity of the evaporative control system by demonstrating a high component lifetime reliability through appropriate design verification testing. Such verification testing would be in lieu of running a certification car for 50,000 miles and periodically measuring evaporative emissions to establish a deterioration factor. In effect, the verification tests would be required to demonstrate that no deterioration of the system would occur.

2. Conduct 50,000 mile certification vehicle tests to establish appropriate evaporative system deterioration factors for those systems that do deteriorate.

With respect to option 2 above (deterioration factor testing), it must be noted that no data currently exists at Ford or to our knowledge within the public domain, to show a 6 gm/test SHED evaporative emission standard that includes system deterioration as being technologically feasible. Accordingly, Ford recommends that the proposed regulations for a 6 gm/test SHED standard for 1978 be revised to delete deterioration factors."

GM - "We believe that sufficient data exist to demonstrate that the GMEC System does not deteriorate with mileage accumulation. Certification data, albeit obtained by the charcoal trap method, show that the deterioration factors generated by the GMEC System are equal to 0.00." The data GM presents is combined evaporative emission deterioration factor data for various model years (1973 through 1975). These data are carbon trap data and are basically an average deterioration factor for vehicles tested for the particular model year. The resultant D.F.'s were all negative (lower high mileage emissions than low mileage).

The SHED data presented by GM, based on tests of 1972 certification vehicles, shows a deterioration factor spread from -7.07 to +2.37, the average was -1.21.

"It seems clear to us that, this substantial history clearly demonstrates that the GMEC System does not deteriorate with use, and therefore no deterioration testing should be required. Compliance with standards would be shown by SHED tests on data cars only."

B. Discussion

Although their approaches differ, the three commenters on the issue of evaporative system deterioration share the concept that evaporative control systems do not deteriorate, Chrysler states that experience shows that there is no deterioration of evaporative control systems and that EPA should prove otherwise prior to requiring durability testing. Ford has no deterioration information on their evaporative control system when tested by the SHED procedure, and believe that no data exist to support a 6 gram per test standard with evaporative deterioration as technically feasible. Ford feels that some sort of "design verification testing" could prove that certain systems do not deteriorate. In some instances, however, Ford concedes that vehicle durability testing may be required. General Motors supplies some data to support their contention that their evaporative control system does not deteriorate appreciably and that, therefore durability testing should not be required.

The commenters' contention that evaporative emissions systems do not show a deterioration is not supported by the information supplied. The carbon trap data does not show significant deterioration levels for the evaporative control systems certified to date, but the carbon trap test does not measure all sources of fuel evaporative losses. Some sources which will be measured by the SHED technique, which were previously not measured by the carbon trap technique, have a potential for significant deterioration. Some such sources are, carburetor throttle shafts, accelerator pump shafts and bowl vent switches, all of which may provide an increased evaporative loss due to wear. The fuel filler cap has been the most significant single cause for leak down failure in certification testing. The problem has been one of poor sealing due to seal or retention mechanism deterioration. All of these areas have a potential to significantly increase the fuel evaporative losses with increased time and mileage.

The SHED data provided by General Motors which provided average evaporative emission deterioration factors (average of all deterioration factors) indicating a negative evaporative deterioration is misleading for two reasons:

1. The average evaporative emission deterioration may show that for those GM vehicles tested, the average deterioration was negative. The individual vehicle configurations and evaporative emission system configurations represented, however, showed a range in deterioration from -7.07 to +2.37. This indicates that at least some systems did show a significant deterioration level. The certification program does not address average deterioration levels but specific deterioration levels for a distinct evaporative system configuration; therefore, the information does show a need to determine the system deterioration.

2. The predominance of the negative deterioration factors from the SHED data may not reflect actual evaporative fuel hydrocarbon deterioration due to the possibility of significant vehicle non-fuel emissions (background) decay skewing the early test points. GM did not indicate that any attempt had been made to stabilize the non-fuel emissions levels from the test vehicles included in the 1972 SHED sample. Decay of non-fuel emissions could conceivably skew the measured SHED levels from a significant portion of the durability testing.

The evaporative contribution of the vehicle over its life is a combination of fuel evaporative losses and non-fuel evaporative losses. The non-fuel evaporative losses exhibit a relatively high level early in the vehicle's life, and then decay primarily as a function of time. The fuel evaporative losses exhibit a trend of increasing HC emissions primarily as a function of mileage or cycles. The total evaporative contribution of the vehicle is then relatively high when new, decreases with time to the point where fuel HC losses become significant, and then begins to increase with mileage towards the level of the new vehicle. Figure 1 exhibits this.

In summary, while previous carbon trap durability data indicated little if any system deterioration, the new SHED test procedure provides a method of measuring all fuel evaporative losses from a vehicle and thereby enables an evaluation of the deterioration characteristics of the total fuel system as well as the evaporative control system. The limitations of the previously used test procedure did not allow an evaluation of certain components that technical judgment indicates may deteriorate significantly. The data presented by GM that was generated by a SHED test procedure bears out that some evaporative control systems do deteriorate significantly. Therefore this evaporative deterioration should be quantified, if possible, to assess the evaporative performance of the vehicle over its useful life.

The question that now arises is how can EPA evaluate the fuel systems and evaporative control systems to be used on new vehicles to determine 1) if a system deteriorates and if so, 2) how much does that system deteriorate? A test procedure to evaluate system durability must focus on the intended function of the system and on the evironment in which it will operate to identify the possible failure modes, and then establish criteria for acceptable performance in view of the failure modes.

The purpose of the evaporative control system is to control the loss of fuel vapor from the vehicle. The predominant control technology currently used is that which stores the fuel vapors during non-operational vehicle modes and then "purges" the storage mechanism and burns the vapors during operational vehicle modes. The control and the sequencing of the storage and purging operations is critical for some systems and therefore some additional hardware is required to accomplish this control. With the advent of the SHED test technique, particular attention must be given to total fuel system integrity as well as the evaporative control system, as any leakage may be a significant source of vapors. The environment in which this system must function is that which is encountered in typical consumer usage of the vehicle. The potential failure modes of individual components are numerous and will be treated later. The synergistic effects of fuel and evaporative system operation with respect to all other vehicle systems must be evaluated. In any system, proper operation depends on the function of all components as any single failure may induce other component malfunctions, and in the case of the fuel system and the evaporative control system, a failure in some related vehicle system may adversely influence evaporative emissions levels. For example, a failure in a carburetor air cleaner seal which allowed the induction of excess air might reduce the "purging" of the fuel vapor storage medium and thereby allow excess fuel vapors to escape. The same failure may also allow carburetor fuel vapors to escape into the atmosphere.

Total Vehicle Evaporative Emissions

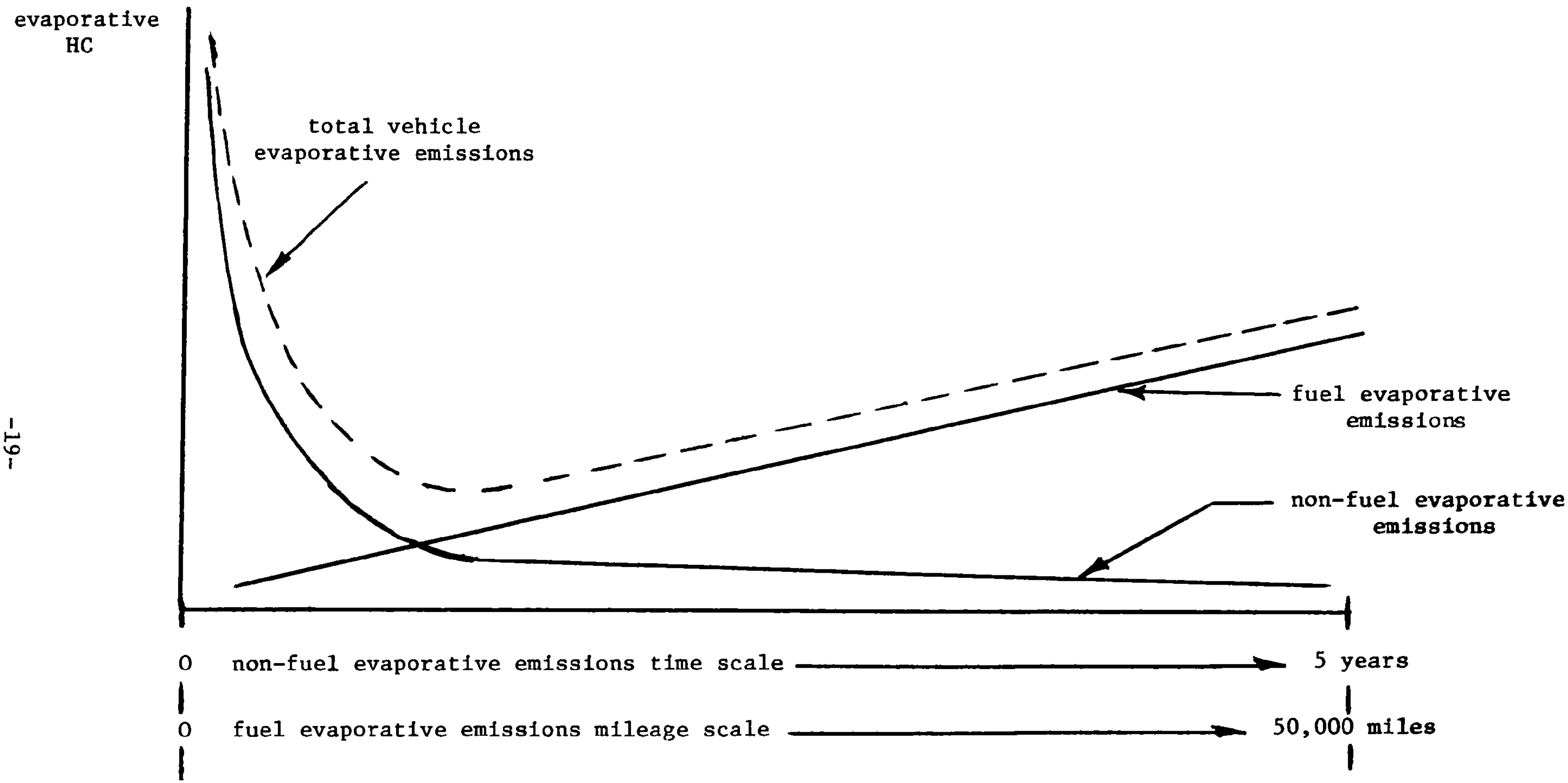

Figure 1

The criteria for acceptable performance of the systems are dictated by the Clean Air Act where vehicles are required to meet emission standards for their useful life (50,000 miles) and control system components are required to be warranted by the manufacturer for the same period with reasonable maintenance precautions. EPA, in the case of Evaporative Emissions is then required to determine:

1. That the evaporative emissions control systems are designed to not exceed the standards for 50,000 miles and

2. That maintenance of the control system is reasonable in light of anticipated consumer usage.

Because of these criteria, any malfunction or failure, whether partial or total, and any change in performance of a component must be quantified in terms of how many grams of evaporative hydrocarbons does this represent, both directly, and indirectly through synergistic influence on the related evaporative or fuel system functions. In addition, maintenance required as a result of, or to prevent component or system failure must be evaluated in light of customer usage to determine its reasonableness.

Ford has suggested that some systems could be "design verification tested" through a serious of functional checks of individual components, following some cyclic tests designed to simulate the intended component function and its expected environment. The immediate inadequacies of this proposal which become apparent in light of the past discussion are:

1. Inability to account for synergistic influences on component performance.

2. Difficulty of adequately simulating actual component environment.

3. Inability to quantify in forms of evaporative hydrocarbon losses, the various failure modes or variations in component performance.

4. Inability to quantify in terms of evaporative hydrocarbon losses, the various synergistic influences component failure or performance variations may induce.

These same inadequacies limit any "design verification" type test where the acceptance criteria are actual "real world" performance characteristics of a total system. Even if this sort of test program were designed to provide adequate information on single components, or even total systems, if EPA required testing of this type, the resulting individual test programs would be diverse considering the number of manufacturers, systems and applications. That is not to say that this sort of testing is not useful. It becomes extremely useful in comparing the performance of a component with that of a similar component which has previously demonstrated that it functions satisfactorily in a system which has demonstrated that it meets "real world" performance criteria.

Data generated by this type of testing is currently used in the LDV Certification program for consideration of exhaust emission related running changes and durability data carryover. This type of test program would be very useful in conjunction with other types of durability evaluation.

The time factors and time related failure modes and a few failure modes related to engine off cycle cannot be adequately evaluated by the present method of 50,000 mile durability vehicle testing that is used for the evaluation of exhaust emission control durability, as the 50,000 miles are accumulated by continuous driving in three to six months rather than the 5 years and numerous engine off cycles associated with vehicle useful life. Not enough information is currently available on the potential time related failure modes to determine the extent to which time can influence fuel and evaporative system performance, and EPA intends to investigate these issues. The commenting manufacturers have proposed other methods of durability information on these aspects of the systems. The influence of fuel tank and line oxidation, rubber seal ozone aging, plastic component embrittlement and other similar issues need to be explored.

C. Evaluation of Key Specific Issues

The key questions brought out by the manufacturers with regard to durability testing are:

1) Do fuel and evaporative emission control systems deteriorate?

2) If so, how can system deterioration best be evaluated?

The data that are currently available indicate that there is a strong probability that present fuel and evaporative control systems do deteriorate. SHED test results from a 1972 Surveillance Program study showed an average emission level of 24 g/test on in-use vehicles. These vehicles represented a statistical cross section of in-use vehicles. The 24 g/test emission level is substantially higher than the 9 g/test emission level which the manufacturer's contend is representative of new car levels. The 24 g/test value has received criticism from the manufacturers who contend that actual in-use levels are much lower. GM has tested 20 1970-72 GM vehicles which showed emission levels ranging from 2.45g to 28.4g with an average of 8.73g. However, EPA has evaluated the surveillance program data in detail and has found no reason to believe these data are incorrect. Evaporative emission levels measured in 4 other program studies in 1971 through 1973 showed average emission levels from controlled vehicles above 20 g/test. Again this is much higher than the manufacturer's value for new cars.

The results of the 5 surveillance programs imply that either the condition of the vehicles prior to testing was different than the condition of the vehicles tested in other studies (due to preconditioning or vehicle handling differences) or that the vehicle systems deteriorated while in-use. It should be noted that vehicle preconditioning or handling prior to testing should not have affected hot soak levels and that hot soak levels measured in the surveillance programs were still much higher than the 9g level measured for both the diurnal and hot soak by the manufacturers. Thus, there is at least a strong implication based on the surveillance programs that fuel and/or evaporative control systems do deteriorate.

The fuel system and evaporative control system would, from an engineering point of view, be expected to deteriorate. The failure mode analysis indicated that such things as valves, pumps and other moving parts would be expected to wear out as a result of use. Also, some materials used in these systems could also be expected to deteriorate with age, or as a result of exposure to high temperatures, vibration or foreign material. The contention that these systems will not deteriorate, does not seem reasonable considering the many failure modes possible.

Based on the above discussion it is concluded that there is evidence that fuel and evaporative emission control systems probably deteriorate, and that this conclusion is supported by an engineering evaluation of expected deterioration of certain fuel system components.

The second question that requires answering is "How can evaporative emission control system durability be evaluated?" There is no question of the need for such an evaluation: Available data suggests that there potentially is deterioration of evaporative emission control effectiveness, and Section 206(a)(1) requires the EPA to determine whether emission control effectiveness will be sustained for the useful life of the vehicle. Nevertheless, the EPA is currently unable to specify a single test protocol that can be demonstrated to be a valid durability test for all vehicles likely to be produced; in the absence of being able to specify a test protocol for which such a demonstration can be made, there is little sense in specifying some arbitrarily selected test protol, even if that test protocol were to be the traditional 50,000 mile durability test.

Much more experience and data is needed before the EPA can reasonably expect to be in a position to design and specify a single test protocol for evaluating the durability of evaporative emission control systems. One way of providing such experience and data is to require each manufacturer, for such number of model years as it may take EPA to develop and promulgate a single test protocol, to design his own test protocol and to report the results of his testing to EPA as a part of the certification process. It is recognized that some manufacturers may use this opportunity for establishing their own test protocols as an excuse for doing no testing at all; but if they do so, that will become apparent very quickly, and would become a basis for prompt Federal remedial action. It is also possible that through this approach all manufacturers will do a responsible job of evaluating the durability of their evaporative emission control systems, and that in that manner there may never be a need for the promulgation of a standardized durability testing protocol. In any case, this approach provides the only feasible way, at the present time, for generating any valid data on the durability of evaporative emission control systems, data that can in subsequent years be checked against the results of surveillance testing of in-use vehicles to identify the valid and the invalid durability evaluation procedures.

D. Recommendations

The recommended procedure for establishing the deterioration and durability espects of the evaporative emission families is to require the manufacturers to perform testing to establish a deterioration factor for each evaporative emission family. This testing should be designed by the manufacturer to provide him with the data that he judges necessary to quantify the evaporative performance of his various fuel system and evaporative control system designs.

The manufacturer should be required to file his test plans with EPA in his Part I Application for Certification. The manufacturer would be expected to pursue his test plans to completion, and would be required to provide in the Part II Application the data from the test plans and the resultant deterioration factor for each evaporative emission family, to be used in determining the adjusted evaporative level of the 4000 mile emission data vehicles tested by EPA. The projected 50,000 mile levels of the 4000 mile emission data vehicles would then be used to determine compliance.

This procedure will provide the manufacturer with the flexibility of designing his own test programs to quantify evaporative emissions deterioration and system durability without imposing the restrictive requirement of the existing 50,000 mile durability vehicle test procedure. EPA hopes to gain information from the variety of test plans which are anticipated, based on NPRM Comments, to aid in the development of an optimum certification durability test program for evaporative emissions.

Issue - Need for Evaporative Regulations

A 1973 surveillance test program used the SAE recommended procedure for measuring evaporative emissions in a sealed enclosure. The results of those tests on in-use 1973 MY vehicles showed a 31 g/test (diurnal plus hot soak) emission level, which was stated in the NPRM. Recently a computation error has been found which resulted in a lower average value than the reported 31 g/test value. The actual average was 26.5 g/test. Based on this and other studies, however, the current "carbon trap" evaporative emission test has been found to greatly underestimate evaporative emissions.

The 1972 surveillance test program, which was similar to the 1973 program, showed evaporative emissions at a 24 g/test level. The urban gram per mile equivalent of a 24 g/test level is 1.76 g/mile as compared to the current Federal hydrocarbon exhaust emission standard of 1.5 g/mile and the statutory standard of 0.41 g/mile. The amount of control over evaporative emissions thought to exist does not in fact exist.

A study of the cost effectiveness of reducing evaporative emissions to a 6 g/test level from the 24 g/test level indicated it would cost $50/ton of pollutant removed. The cost effectiveness of reducing exhaust hydrocarbon emissions from the current standard of 1.5 g/mile to the statutory 0.41 g/mile level is between $500 and $1400 per ton of hydrocarbon removed. The urgency of the proposed evaporative emission regulations is based on the fact that a sizable reduction (24 g/test to 6 g/test) can be made initially, the cost effectiveness is better than other control actions, and if action is not taken evaporative emissions would exceed and possibly nullify exhaust emission improvements from the tailpipe.

In a letter from the Motor Vehicle Manufacturer's Association (MVMA) to the EPA[1], the validity of the 31 g/test level reported for the 1973 surveillance program results was questioned. The validity of the results has been questioned due to a study by the California Air Resources Board (CARB), which indicates that a leak in the fuel cap could have resulted during the tests due to the insertion of a thermocouple wire through a drilled hole in the cap. Also, the MVMA cites the results of testing done by the manufacturers which show emission levels on 1975 vehicles to be at a 9 g/test level instead of 31 g/test. It is, therefore, charged that the environmental impact and the cost effectiveness of the proposed regulations is not as good as indicated in the environmental and inflationary impact study, and therefore, the urgency of the proposal has been over-emphasized.

A. Summary of Comments

AMC - We believe that the 31 g/test assessment of in-use vehicles may overstate the situation by as much as 50 percent. It is recommended that more recent data be used to arrive at a more realistic conclusion.

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(1) Letter from Lou Duffing, MVMA, to Ron Kruse, EPA, January 15, 1976.

Chrysler - By utilizing the 31 g/test level, EPA's cost effectiveness analysis shows $56/ton of pollutant removed. The 31 g/test level is erroneously high and should actually be 9.06 g/test as reported in the letter by MVMA. If one assesses the cost effectiveness of a 6 g/test standard using the 9 g/test level and a $6.00 retail cost to achieve the 6 g/test standard, the cost effectiveness is $181/ton. The cost effectiveness of achieving the 2 g/test standard could be $630/ton based on a cost of $50 per vehicle. The cost effectiveness of going from a 6 g/test to a 2 g/test level is $1,023/ton. This analysis indicates the cost effectiveness of the proposed regulations is grossly overstated by the EPA. The cost effectiveness of going to the 2 g/test requirement must seriously be reconsidered.

Ford - It is Ford's understanding that the 31 g/test average cited as representative of in-use vehicles has been determined to be abnormally high because of fuel tank vapor leaks introduced with the installation of a thermocouple through the fuel cap. Actual levels from in-use vehicles have been reported to be at a 9 g/test level.

GM - "EPA has greatly over estimated the contribution of vehicle evaporative emissions as an atmospheric hydrocarbon source and therefore ascribed unnecessary urgency to imposition of the proposed rules."

Volkswagon - Tests by EPA and CARB show test results of 2 g/test and 11.7 g/test respectively on similar fuel-injected Volkswagons. This discrepancy indicates that the amount of hydrocarbons emitted from a motor vehicle is highly influenced by the service condition of the test vehicle. The reliability of the surveillance program results is felt to be very poor.

The relationship between exhaust hydrocarbons and evaporative hydrocarbon emissions is significantly different from the estimation made by EPA, because the maximum part of the exhaust hydrocarbons must be considered to be reactive while only 20% of the evaporative hydrocarbon emissions are reactive. Based on our analysis the contribution of reactive hydrocarbons from evaporative emissions is only 0.04 g/mile from uncontrolled vehicles. An average of seven 1975 and 1976 VW vehicles showed an average evaporative emission level of 8 g/test. The corresponding contribution of reactive hdryocarbons from these controlled vehicles is only 0.06 g/mile.

B. Discussion

The consensus of the U.S. manufacturers is that the regulations are not as urgent as previously thought due to inaccurate baseline data. The 31 g/test (actually 26.5 g/test) level for current vehicles is thought to be too high and the actual level is thought to be 9.06 g/test. Volkswagon commented that evaporative emissions were not as serious as exhaust emissions due to the higher relative reactivity of exhaust hydrocarbons.

EPA has responded to the letter from MVMA* (see section D of this issue). The response from EPA indicates that the alleged leaking gas caps should not have been a problem because pressure checks were performed prior to each test with the test gas cap in place. Also, other considerations lead us to believe that the Surveillance test results are representative of in-use vehicles, as discussed in the attached letter. Therefore, the 26.5 g/test value should be valid. The reason for the discrepancy between the results of that test program and the results of tests by the manufacturers has not been determined.

It should be emphasized at this point that the cost effectiveness of the proposed action was not based on the data from the 1973 surveillance program. Instead, it was based on the results of the 1972 surveillance study which showed emissions to be at a 24 g/test level, because the 1972 results are published in Supplement No. 5 for the compilation of Air Pollution Emission Factors, AP-42. Publication in AP-42 is a result of close review of the appropriate data. The 1973 results have not yet received this review and were, therefore, not used.

The comment concerning the relative reactivity of evaporative emissions compared to exhaust emissions makes the point that exhaust emissions are much more reactive than evaporative emissions. The data supplied by Volkswagon, however, did not show the relative magnitude of the reactivity of both evaporative and exhaust hydrocarbons. Only data on the reactivity of evaporative emission was given. Therefore, a definitive statement concerning the comparative reactivity cannot be made.

Further, the definition of reactivity has not yet been agreed upon. Reports** indicate that, "The most important findings from recent chamber experiments, and also from some field work, is that practically <u>all</u> organic compounds can be photolyzed given enough time for reaction." The reactivity data supplied by Volkswagon shows compounds as being nonreactive. Because of the uncertainty of the exact definition of reactivity, their evaluation of the relative reactivity of evaporative emissions seems questionable.

C. Recommendation

Implement the regulations according to the originally proposed schedule.

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* Letter from Mr. Ron Kruse to Mr. Lou Duffing, March 4, 1976. (See Section D of this issue.)

** Memo from Mr. R. Strelow, EPA, to the Regional Administrators, January 29, 1976.

D. Letter from Mr. Ron Kruse, EPA, to Mr. Lou Duffing, MVMA, March 4, 1976.

Mr. Lewis E. Duffing
Environmental Engineering Division
Motor Vehicle Manufacturers Association
320 New Center Building
Detroit, Michigan 48202

Dear Mr. Duffing:

This letter is in response to your critique of the report by Ellsworth entitled "Assessment of Light Duty Vehicle Evaporative Emission Control Technology". In particular we would like to address your comments concerning the validity of the Surveillance Program (SHED) test results. We would also like to get additional information from you concerning your experience with some of the ideas expressed in that report suggesting possible evaporative emission control strategies and their cost.

We are aware of the discrepancies between the evaporative emission levels measured during the 1971 through 1973 Surveillance test programs and emission levels measured by the manufacturers. The possibility that leaks could have occurred where the thermocouple was inserted in the gas cap prompted us to investigate the procedures used during the surveillance programs. During all of the surveillance programs, the fuel thermocouples were inserted through a drilled hole in the gas cap. Therefore, if a pressure check of the fuel system was not performed prior to testing with the test cap in place, a possibility did exist that an undetected leak was present. Discussion with the contractors involved in the various test programs indicated the following:

1) No pressure checks were conducted for tests conducted during 1971, 1972, and 1973 programs conducted by Automotive Testing Laboratories (ATL).

2) Automotive Environmental Systems, Inc., (AESi) did not conduct pressure checks during the 1971 and 1972 test programs, but they did conduct a pressure check of the fuel system prior to each evaporative emission test with the test cap in place during the 1973 surveillance test program. This procedure was spelled out in the test procedure flow chart used during each test and the procedure was verified by the contractor. (See attached flow chart). One of the gas caps with the hole for the thermocouple drilled in it was supplied to EPA. Pressure checks indicated that this cap did not leak.

Therefore, we are reasonably certain that for at least the AESi 1973 program, the modified gas caps did not leak. This is the program cited in Ellsworth's paper. Since gas cap leaks did not contribute to the 31.5 g/test level found in 1973, we doubt that gas cap leaks were a significant factor in any of the other studies. Particularly since results of the other studies were below 31.5 g/test.

Even if the gas caps did leak, the change in the effect upon air quality would be relatively small. A leak in the gas cap should not have had a sizeable effect on hot soak emissions measured, because most of the hot soak losses would be from the carburetor bowl. The only effect of a leaky gas cap would be to increase emissions due to increasing tank temperatures forcing fuel vapors out of the hole in the gas cap. Fuel temperatures during the surveillance testing did rise 1-2°F during the hot soaks.

A simplified approach for estimating the contribution from the fuel tank to total hot soak losses would be to subtract the portion of the diurnal loss value corresponding to a 2°F temperature rise from the measured hot soak levels. The diurnal losses measured during the 1973 AESi program were 15.1 grams. Thus, only 1.3 grams of the hot soak would be attributed to a leaky gas cap (15.1 grams x 2°F/24°F). Therefore, the 16.4 gram/hot soak test could have been made up of 1.3 grams from the tank plus 15.1 grams from the carburetor bowl. While we still don't believe there was a gas cap leak problem for the 1973 AESi data, such a problem could not have been responsible for as large a difference in test results as exists between those data and the manufacturer's data which you cited. The estimated 15.1 grams from the carburetor bowl alone is still much larger than the 9.06 g/test (diurnal + hot soak) value cited.

Evaporative diurnal and hot soak emissions should be converted to a gram per mile equivalent in order to evaluate the effect of evaporative emissions on air quality. If one assumes that the diurnal results from the 1973 AESi program were erroneous due to a leaky cap, such that the actual levels were only 1.5 grams (the value measured on 1975 vehicles in a CARB study), then the gram per mile value obtained by combining this value and the 15.1 g/hot soak test value is 1.75 g/mi.* This value is roughly equivalent to the 1.76 g/mi. value used in the "Draft Environmental and Economic Impact Statement" written in support of the "Proposed Evaporative Emission Regulations". This value, which is the lowest value possible even if a gas cap leak did occur, is still much higher than the 0.9 g/mi. value associated with a 9.0 g/test level (based on assumption of 1.5 g/diurnal test plus 7.5 g/hot soak test). Therefore, even if there were a gas cap leak problem, the emissions that did not result from the leak would have been large enough to pose a serious problem.

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*Based on 3.3 trips per day and 29.4 miles traveled per day model used in "Supplement No. 5. For compilation of Air Pollutant Emission Factors - AP 42."

The differences between the in-use vehicle test data and the manufacturer's data were not due to gas cap leaks. Therefore, other possibilities should be considered. The discrepancy in test results could have been due to a better evaporative control system design employed on 1975 model year vehicles than on the 1973 model year vehicles tested in the 1973 AESi surveillance program. We are, however, not aware of any control system changes capable of making such a difference and we would appreciate any information on such changes if they do exist.

If there were no differences in the control system design, then the difference in emission results could have been due to a difference in the test procedure or in the vehicles used for testing. One difference in the test procedures used in the surveillance program and in testing done by the manufacturers was the type of preconditioning done prior to the evaporative emission test. During the surveillance testing, the preconditioning consisted of driving the vehicle to the test facility. Such a drive would have been somewhat indicative of normal driving. Differences in diurnal losses could have been effected by the preconditioning performed. The hot soak test on the other hand, should not have been affected by the type of preconditioning and as stated before, the hot soak emission levels alone were much higher than the combined emission level cited in your critique.

The condition of the vehicles prior to testing could have had a significant effect on the resulting emission levels. The vehicles used during the surveillance programs were obtained from private owners, inspected and then tested. No attempt to repair defects was made so that the vehicles would be representative of "in-use" vehicles. It is possible that the fuel system and evaporative control system of some vehicles tested deteriorated in use. We would appreciate information regarding the "in-use" condition of the vehicles tested by the manufacturers to determine if there were differences in the selection and handling of test vehicles.

The critique of Mr. Ellsworth's paper also contends that running losses should have been included in the emission levels for pre-controlled vehicles, and that running losses have been eliminated entirely from vehicles with present evaporative control systems. We would appreciate any data from enclosure testing showing the running loss emission levels from vehicles with and without evaporative emission controls to verify this statement.

The assessment report was written in order to promote a discussion of the various evaporative emission control strategies. The conceptual approaches and actual hardware changes needed to implement those conceptual approaches were presented. We are aware that some of the hardware which is suggested may be undesirable, but we still feel that many of the ideas presented hold considerable promise of reducing evaporative emissions at a reasonable cost. As EPA does not have the experience with the actual hardware that the industry must have, we will appreciate receiving the information which you can share with us. Any additional data showing the effectiveness or costliness of evaporative control hardware would be much appreciated so that we can further analyse the industries' capabilities in this area.

Sincerely,

Ronald E Kruse

Ronald Kruse, Project Manager
Standards Development and Support Branch

Issue - Background Emissions

The proposed procedure does not distinguish fuel evaporative emissions from other vehicle hydrocarbon evaporative emissions, nor does it make any allowance for these non-fuel emissions whatsoever, even with regards to a credit based upon sources or vehicle age.

A. Summary of Comments

AMC - No data have been shown that background emissions contribute to air pollution or endangers the public.

Therefore, a subtractive allowance of 1 g/test should be stipulated for the first year or until satisfactory technical analysis is completed that resolves the unanswered questions.

Chrysler - The proposed regulations are unduly stringent, burdensome, and disruptive because they evaluate evaporative vehicle emissions regardless of source. Chrysler asserts background emissions are relatively small when averaged out over the useful life of a vehicle, and have an insignificant effect on ambient air quality and the public health and welfare. Before inclusion into any evaporative emission regulation, EPA must first make a finding that non-fuel background evaporative emissions are harmful to the public health. Chrysler is convinced that the better way to account for such emissions is to have a subtractive correction factor of at least 1 g/test and that the manufacturer have the option of testing the certification vehicle for background emissions and supplying EPA a more accurate subtractive correction factor. Data on a 1975 Dodge Coronet have shown that at the 6g level, background emissions can mean the difference of passing or failing, and at the 2 g level, background emissions alone could exceed the standard.

The majority (98% for 1976 certification) of the prototype vehicles utilized by Chrysler in certification and running change programs are fabricated with new components on new production models. Therefore the brand new vehicle is not a "rare" occurrence as indicated in the NPRM. EPA certification vehicle requirements do not occur until after submission of the Part I Application and this requirement cannot be anticipated by the manufacturer, thus the proposed regulations would add 3 to 4 months to the length of the present certification program, which by itself has added 10 months to the lead time requirements.

Ford - Vehicle background must not be disregarded since it contributes significantly to a 6 g standard and overwhelmingly to a 2 g standard, even after three months of vehicle aging. A means of accounting for vehicle background hydrocarbon emissions must be developed in order to implement a sensible SHED program. Sufficient time is not available to do this for 1978; accordingly, Ford proposes that EPA develop a blanket background factor to be used for 1978 only, based on available industry data.

Based on 43 vehicles in Ford's 1976 certification fleet, the average age of the test vehicle from build to 4 K testing was 92 days.

Only 3 vehicles in this fleet were less than 30 days old and they ranged from 26-30 days. Even at the 92-day average age, background emissions continue to be a dominant portion of the 2 g standard. A comprehensive test program is underway to determine the magnitude of background emissions (non-fuel sources). Results thus far on a 12-vehicle fleet, representative of new 1976 production vehicles, show that the initial mean level is 4.09 g/test and the 90 day (extrapolated) level is 0.75 g/test. It is generally agreed that background levels diminish with age; however, the background emission level continues to be a significant portion of the 2 g standard after three months of the vehicle build date. It is unreasonable for EPA to propose a procedure that would include background levels equaling or exceeding the evaporative level of the vehicle fuel system and not take them into account. The very fact that background levels are changing with time supports the fact that a large test error is generated by including them.

Another factor to consider when vehicle background is not taken into consideration is its effect on the evaporative emission deterioration factor (DF). If the vehicles are aged any length of time prior to starting mileage accumulation, the DF would be influenced greatly. The DF might be more influenced by the relationship between vehicle age and the 5000 mile test point than actual system deterioration over mileage. It is clear that there is a need to develop a technique for background subtraction, which goes beyond the actual testing of the vehicle for this effect. One such method could allow substraction based upon vehicle type and age, this would require that a family of background emissions versus vehicle age curves be generated for the product line or possibly for the industry as a whole. Assuming no change in assembly materials, such curves could also be used for each certification year. These curves could also be constructed to make allowances for the variability found in background emission measurements.

In summary, vehicle background is a significant portion of a 6 g standard and certainly a major portion of a 2 g standard. It is important to develop a standard and procedure which includes consideration of emissions which do not occur in "real life". Ford states very strongly that background emissions should be accounted for in any SHED test procedure, and if, for no other reason the 2 g standard be delayed until this problem can be solved.

<u>GM</u> - Background emissions should not be counted as evaporative emissions and a correction factor should be used. The 60-90 day car background levels in the order of 1.0 g/test (as cited in the NPRM) are not small from a 6 g/standard and are very large in the context of a 2 g standard. The time required to insure that test vehicles are adequately weathered would present unreasonable delays in the certification program. Certification cars are built with new powertrains which are oil-coated for corrosion protection. It is unrealistic to suggest that a manufacturer can select test cars a year in advance to allow aging of body and chassis components. Certification durability cars require 4 months to complete necessary mileage accumulation, and completion of durability testing for a given engine, primarily, is normally accomplished before a

significant amount of calibration work can begin on the 4000-mile data cars. To anticipate the EPA selection and allow time for such test cars to age is totally out of the question. The most serious problem is where a replacement car has been built for replacement of a failed (damaged or crashed) test car. In several instances a replacement has been built for initiation of mileage accumulation within 4 days. With the addition of approximately seven days to complete the 4000 mile accumulation, the chronological age of such cars will likely be about two weeks. Clearly the background emissions from such a car will be substantial.

An age dependent correction factor could be developed, so the correction would not serve as a bonus. Regardless, provisions should be made in the regulations to allow actual measurement of background emissions on an individual test car. The added cost and complexity to the manufacturer to exercise such an option would be a strong deterrent.

IH - International Harvester purchases new vehicles to meet fleet requirements. IH does not have a goodly supply of used chassis on hand such that they "can usually be selected to be sufficiently aged to avoid problems of non-fuel evaporative emissions". The 60-90 day aging time, as noted by EPA to achieve a 1 g/test background, will add considerably to a manufacturer's lead time requirements. IH urges EPA to adopt an alternate of at least 1 g/test subtraction to account for background emissions even in the case where aged vehicles must be used. EPA should provide a method to measure background emissions.

EPA has failed to address the background emissions caused by road materials (tars, oils, etc.) picked up during mileage accumulation. IH's road route contains all types of roads from freeways to two-lane rural roads. A method of cleaning vehicles needs to be developed which in itself will not contribute to background emissions. IH believes that the 1979 standard of 2 g/test, with the present state of the art, is virtually unattainable on IH vehicles with no background allowances.

Mercedes Benz - Mercedes Benz strongly objects to EPA's assumption regarding the use of aged vehicles. It is not at all a "rare" occurrence to use a brand new chassis. Daimler-Benz has always used and will continue to use brand new cars for certification purposes. This procedure guarantees that emission data vehicles are built-up in the assembly plant according to the production vehicles which they represent. An unjustified burden would be suffered if no subtractive factor was allowed to reflect the vehicle's background emissions in this early stage. It is recommended that a certain subtractive value be allowed if the manufacturer can show that he is not using aged chassis and drivetrains. A value of 0.5 g is reasonable in the case of a vehicle tested within 2 to 3 months after its date of production. An additional bonus of 0.5 g is requested since even under utmost precaution, single fuel droplets may be scattered outside the fuel tank during fill-up.

MVMA - If EPA intends that vehicle manufacturers reduce background emissions along with evaporative emissions, then they must first find that such reductions are technologically achievable and that background emissions in fact cause or contribute to, or are likely to cause or contribute to, air pollution which endangers the public health or welfare. No health or welfare finding has been made regarding the transient background emissions and, in fact, MVMA knows of no data or research which would support such a finding.

The available data concurs with the Administrator's indication, that the background hydrocarbon emission from cars decrease with car age at an exponential rate. The available experimental data confirms this type of time-dependent relationship. This suggests that an experimentally determined mean value as a function of car age would predict the background of any given car with reasonable accuracy - beyond some minimum age as 10 to 20 days.

MVMA urges that the procedure be revised to properly take into account non-fuel vehicular background emissions so that such emissions are not counted in the calculations for determining compliance with the standards. One possible method, which was suggested by MVMA to the California Air Resources Board for effecting this result, would be to provide for a constant subtractive correction factor to account for background emissions. Another possible approach would be to establish a variable correction factor based upon vehicle age. In addition the procedure should be revised to afford the manufacturers the opportunity to measure the actual background emissions of a particular test vehicle following an accepted background measurement procedure or take other corrective action, such as cleaning, when evidence of a typically high background emissions exist.

Nissan - Electronic fuel injection vehicles have essentially no evaporative sources in the fuel system, except for the fuel tank. Emissions from fuel tanks are, of course, adsorbed into the canister which is designed to have enough capacity for fuel tank emissions. Nevertheless, 1.2 to 1.5 g/test of evaporative emissions are still observed, which suggests that substantial amounts of emissions come from non-fuel sources of the vehicle.

NRDC - National Resources Defense Council, Inc., supports the decision to measure all evaporative emissions regardless of source, including non-fuel hydrocarbon evaporative emissions. As the preamble notes these vehicle background emissions are pollutant emissions and should not be ignored. This is especially true when development of procedure which would exclude measurement of these emissions would produce a test which is both complex and subject to "test beating" maneuvers by the manufacturers.

Volvo - Although the experience with background emissions on Volvo cars is limited, tests have been carried out on vehicles with different ages. The test results indicate a rather constant level of non-fuel evaporative emissions on vehicles with an age between 4 months and 3 years. Background levels have been 0.9 to 1.0 g/test. Separate measurement of only non-fuel evaporative emissions involves complicated and time consuming procedures. The manufacturers should be permitted to utilize a correction factor that compensates for normal background emissions. The consequence of a correction factor of 1 g/test would be small compared to the current Federal hydrocarbon standard of 1.5 g/mile, but amounts to 50 percent of the 1979 proposed standard. Instead of spending a lot of time and effort in reducing background emissions on certification vehicles (which will not improve air quality), the application of a correction factor would be a better alternative.

VW - Background emissions decrease continuously, but very slowly during the lifetime of the vehicle. The rate of decrease differs from one of our vehicles to another, and in the case of 4K mile certification vehicles less than 25 days old, the background level can be between 0.5 and 1.2 g/test. By extrapolation it is evident that these emissions will be zero long before the vehicle lifetime ends at 5 years or 50,000 miles. Therefore the application of a deterioration factor for the evaluation of the emission data (4000 miles) vehicles is not at all logical.

Summary of Manufacturers' Comments

All responding manufacturers state that non-fuel hydrocarbon evaporative emissions should not be included in the evaporative emission measurement. They further state that no sound basis has been established which indicates that background emissions adversely affect public health and welfare. They contend that usage of new vehicles for certification is not a "rare" occurrence, and thus, background emissions should be allowed for. The manufacturers generally indicated that to force the use of "aged" vehicles is an undue hardship, and to provide "aged" vehicles would require, in most cases, additional lead time for certification. The data submitted by the manufacturers indicate that, even at best, the aged vehicle will have background emission levels of at least 0.5 to 1.0 g/test.

The manufacturers recommend that a means be developed to account for background emissions and that these emissions not be included in the standards. They contend that sufficient time is not available to do this for 1978 and recommended that a subtractive correction factor, possibly based upon vehicle age, be established and that the manufacturers have the option of determining, through testing, a vehicle's unique background level.

B. Discussion

Air Quality Impact of Non-Fuel Evaporative Emissions

There appears to be general agreement, including EPA, that non-fuel evaporative emissions are, indeed, hydrocarbon emissions; however, the manufacturers contend they should not be accountable for such emissions. The formation of photochemical smog does not distinguish non-fuel related hydrocarbons from fuel-related hydrocarbons. There is no reason to consider that the effect on the public health and welfare is any less from non-fuel related hydrocarbon than those evolved from fuel-related sources. Although background emissions decay logarithmically, Volvo points out that even after 3 years of vehicle aging, they still exist and therefore they do occur as a "real-life" emission. Fuel-related evaporative emissions are usually periodic in nature in the sense that they are generated by ambient temperature excursion and vehicle operation. Non-fuel related evaporative emissions, on the other hand, are evolving continuously throughout the day and increase with vehicle operation (as observed in hot background tests). Based upon the premise that all hydrocarbon emissions are detrimental to the public health, the significance of the background emissions can be estimated based upon data submitted by Ford.

A conservative estimate of the overall contribution of background hydrocarbon emissions can be extrapolated from the data obtained from a fleet of six Ford Granadas (Ford comments Exhibit No. 4, page 19). From this we find that, on the average, background emissions for 5 years are 1.38 g/day, and integrating over the first year only, exhibits 2.98 g daily. However, a study presently being conducted by Exxon Research and Engineering Company for the EPA to assess the effectiveness of light duty vehicle evaporative emission sources and control systems, showed that, on a fleet of fifteen 1973 to 1975 model year vehicles, the cold background emissions averaged, with the exception of one vehicle, 0.04 g/hour. By extrapolating the equation developed by Ford (above ref.), this emission level would appear after 992 days ($\sim$ 2.7 years). Therefore, some agreement is shown by both data, although the Exxon data, as shown in Table 1, indicate that the background levels "stabilize" sooner than the Ford projections would indicate. In any case, to the extent that stabilized non-fuel evaporative emissions are emitted, such emissions are real and do have an effect on air quality, and should be included in the evaporative hydrocarbon determination procedure.

Ability to Achieve Low, Stable Non-Fuel Evaporative Emissions

Information submitted by the manufacturers indicates that for vehicles 60-90 days old the non-fuel evaporative emissions have already decayed to levels of 0.5 to 1.0 g/test. Data generated by Exxon under contract to EPA showed that, on a fleet of fifteen 1973 to 1975 model year vehicles, the non-fuel evaporative emissions averaged 0.35 g/test. The range of the background emissions was from 0.0 to 1.5 g/test as shown in Table 1. These data indicate that low, stabilized non-fuel evaporative emissions are achievable even when vehicles are "naturally" aged.

It is EPA's intent to allow the manufacturers maximum flexibility in preparing a test vehicle with low stable background levels. In addition to selecting naturally aged vehicles, manufacturers have several courses of action available to them:

1. Vehicles may be subjected to accelerated aging techniques. These includes baking the vehicles in paint drying ovens or environmental chambers for several hours, or operating the vehicles at high speeds for extended periods.

2. Hydrocarbon emitting materials (paint, sound proofing, vinyl trim, etc.), may be removed from the vehicles. Where necessary aged components, or components of other compositions may be substituted.

3. Older or used vehicles may be rebuilt to certification configurations. EPA's requirements governing the rebuilding of used vehicles for certification purposes are being reviewed and will be eased in the near future, making this alternative even more attractive to the manufacturers.

These are viable alternatives. For example, accelerated aging has been reasonably demonstrated by subjecting a 5 day old vehicle to a 130°F temperature for several hours. The background emissions were reduced by more than 50%.* Alternatively, supplying especially prepared vehicles has been common practice in the past for manufacturers. In order to meet weight restrictions for example, vehicles have been supplied without seats, bumpers, etc.

Table I

Exxon Vehicles, Background Levels

Car No.	Model Year	Background Emissions Cold	Hot	Total	
1	1975	-	-	△1	
2	1975	-	-	△1	
3	1975	0.0	0.1	0.2	
4	1974	0.0	0.2	0.2	
5	1975	0.0	0.1	0.1	
6	1974	-	-	△1	
7	1973	-	-	△1	
8	1975	0.1	0.3	0.4	
9	1975	0.0	0.6	0.6	
10	1974	0.2	0.3	0.5	
11	1974	0.0	0.1	0.1	
12	1973	0.1	0.7	0.8	
13	1974	0.0	0.1	0.1	
14	1974	0.1	0.2	0.3	
15	1974	0.5	1.1	1.6	△2
16	1974	0.0	0.1	0.1	
17	1974	0.1	0.1	0.2	
18	1975	0.0	0.1	0.1	
19	1975	0.7	0.8	1.5	△3
20	1975	0.0	0.0	0.0	

△1 No background data for these cars due to gasoline spillage on carpet.

△2 Evidence of gasoline spillage in trunk prior to test would account for high background (not included in average).

△3 Appears to be coming from external enamel paint.

Lead-Time Implications of Using Vehicles with Low, Stabilized Non-Fuel Evaporative Emissions

To put the lead-time constraint in proper perspective, the basic certification process is shown as a flow chart in Figure 1. Historically, major domestic and foreign manufacturers take 14-16 months to complete their certification program. However, assuming the manufacturer is thoroughly prepared, both administratively and technically, it can be seen that presently, the overall process can be accomplished in approximately 12 months.

The lead-time constraint faced by the manufacturer in providing a test vehicle with typical, naturally stabilized background levels (e.g., 60 to 90 days after production) is certainly understandable. This, however, does not appear to be an insurmountable problem. The manufacturers' recommendation for a subtractive correction factor (1 g/test) is based upon the assumption that non-fuel related hydrocarbons should not be included in the standard. Ford indicated that the 43 vehicles in its certification fleet had an average age of 92 days, from vehicle build to the EPA official certification test point of 4000 miles. None of these vehicles were less than 26 days old. The data submitted indicated that background levels were generally in the order of 1.0 g/test on vehicles 60-90 days old. Therefore, it must be assumed that, if a 1 g/test subtractive allowance were allowed, the manufacturers would supply test vehicles that have aged 60-90 days.

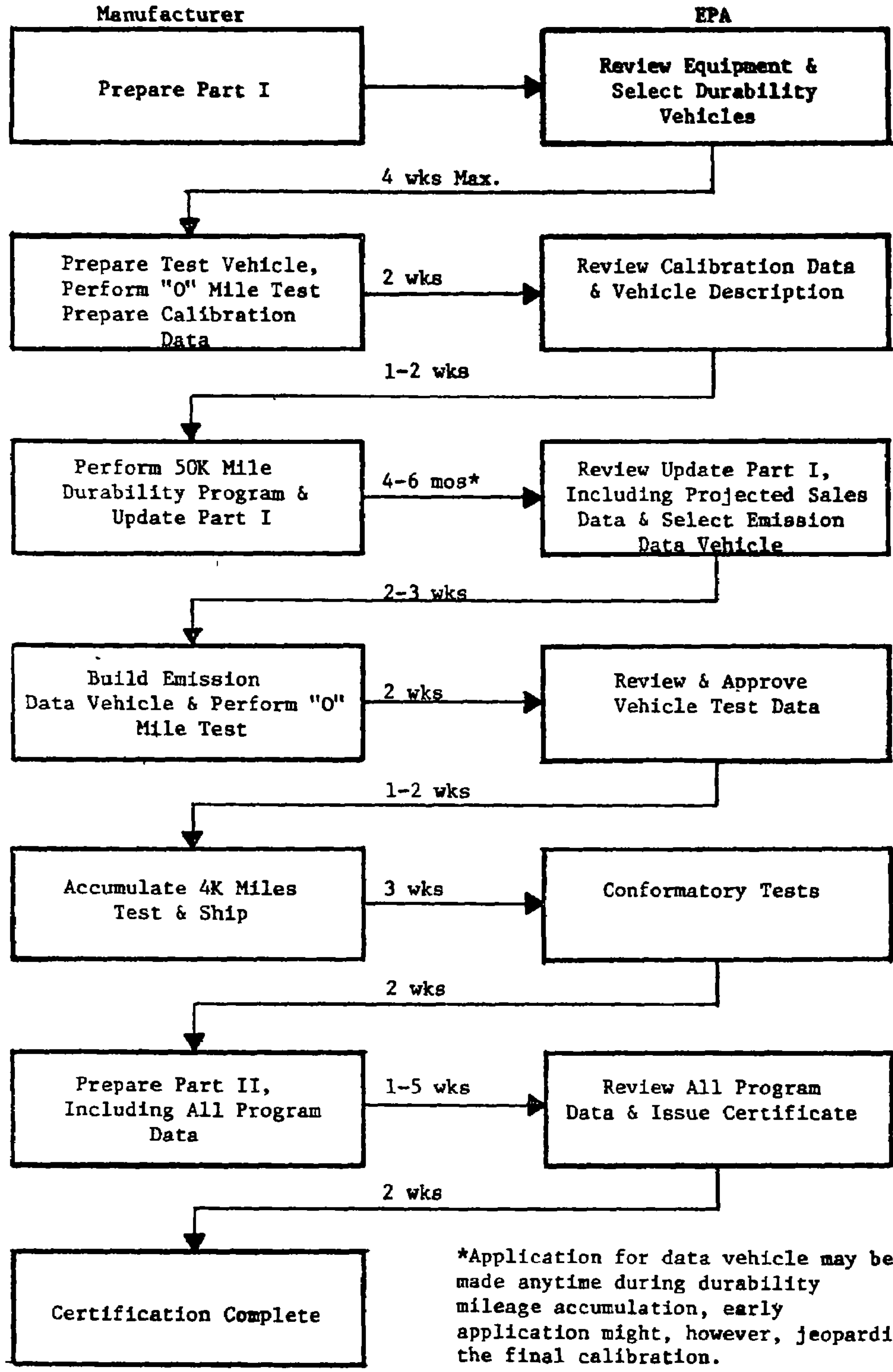
Therefore, there is no reason to believe that the same test vehicles cannot be available when no subtractive allowance is made. Also, since special vehicle preparation, even stripping of the car to obtain low background levels is feasible and within the capabilities of the manufacturer to do, there is no reason to expect that such a procedure will not be done regardless of whether or not a subtractive correction factor is allowed.

Alternative Methods of Handling Non-Fuel Evaporative Emissions

The most accurate means of determining the exact level of hydrocarbon emissions resulting from fuel evaporation only, would be to separately measure and subtract out the non-fuel evaporative emissions. In some few cases, it may be more convenient for the manufacturer to submit vehicles for testing that are less than 90 days old whose non-fuel evaporative emissions are a substantial part of their total evaporative emissions. This option would allow them to do so without risking failing the evaporative standard due to high non-fuel evaporative emissions. However, a separate measurement of non-fuel evaporative emissions involves removing the fuel system and is complicated and costly to perform (takes several times as long as the evaporative test itself),

*Reference EPA Technical Memorandum, "Background Test Evaluation at Ford Motor Co.," dated April 9, 1976, from Gary Wilson, EPA to Charles Gray, EPA.

Figure 1 - Certification Process



*Application for data vehicle may be made anytime during durability mileage accumulation, early application might, however, jeopardize the final calibration.

and would jeopardize the integrity and thus representativeness of the certification vehicles. Also, for very new vehicles, the resultant measured non-fuel background level could only be used for a short period since the background level is changing rapidly. Subtracting total non-fuel evaporative emissions would be ignoring the stabilized background component of the vehicle evaporative emissions.

To provide an allowance (correction factor) for non-fuel evaporative emissions such that a correction factor could be applied to results from the enclosure test to account for non-fuel evaporative emissions (e.g., allow substraction of 1 g/test) has been considered. There could be a single standard correction factor, or different correction factors for different types of vehicles. In this way, the manufacturers would not be penalized for non-fuel evaporative emissions. However, in actual practice, a correction factor has serious disadvantages. It would be difficult to specify a reasonably valid correction factor given the variability and rapid change in non-fuel evaporative emission levels from vehicles less than 90 days old. Also, if vehicles with low non-fuel evaporative emissions were used, as is generally the case, the correction factor would serve as a bonus towards meeting the evaporative emission standard. It should be noted that even a 1 g/test allowance, as recommended by many manufacturers, does not account for new, high background vehicles. So even an allowance of one gram will not solve the problem.

From a regulatory point of view, including the non-fuel evaporative emissions as part of the evaporative emissions to be measured during the certification process is the most straightforward method of handling the non-fuel emissions. No complicated and costly measurements or dubious correction factors are required.

C. Summary and Recommendation

Since stabilized non-fuel background emissions are real life hydrocarbon emissions, there can be no justification in ignoring the effect on the public health and welfare. To the extent that stabilized, non-fuel evaporative emissions are emitted, such emissions should be included in the evaporative hydrocarbon determination.

The available data show that the manufacturers can supply vehicles with low, stable background emissions. It is reasonable to expect that the manufacturers will do so, because it is to their advantage, regardless of whether background emissions are included in the emission measurement. It is therefore recommended that the evaporative emission standard not include an allowance for non-fuel evaporative emissions. For the certification (emission data) vehicles, the manufacturer should be allowed to conduct repeat testing to gain assurance that the evaporative emissions have stabilized before bringing the vehicle to EPA for the certification test.

Issue - Test Variability

The test methodology developed for determining vehicle compliance to emission regulations is influenced by variability of not only the vehicle, but the test procedure and the associated measurement system. The magnitude of such variability will have a significant effect on the ability of a single test to represent the true value of the vehicle emissions.

A. Summary of Comments

Chrysler - The lack of experience by both EPA and the industry with the enclosure method and the inability to obtain test correlation and repeatability between different laboratories and enclosure designs with the various evaporative emission control systems presently being manufactured, makes adopting the evaporative emission standards based upon this technique entirely unobjective and premature at this time. Replicate test data on two vehicles varies as much as 4.0 g/test and indicated:

1. Test variability does not decrease as enclosure emission levels are reduced.

2. Extreme variability can be encountered with the enclosure test even though the same test vehicle is utilized.

3. Test variability alone could exceed the 2 g/test proposed standard.

Lab-to-lab results on the same vehicle varied as much as 3.4 g/test. Chrysler agress with the Administrator's Decision Regarding the Waiver of Federal Pre-exemption Regarding California's 1978 Evaporative Emission Requirements, when he stated, "no emission standards has meaning unless it is stated in terms of a test procedure by which the numbers in the standard can be measured in a repeatable way." Because so many unresolved questions remain regarding the proposed regulation, its test procedure and methods, and the accuracy and objectivity of the test technique, Chrysler believes that EPA must resolve these issues before any final rulemaking is enacted.

Ford - Since the emission systems componentry necessary to the 6 g/test standard has just been developed, test results on these systems are limited. The test-to-test pooled standard deviation is 0.82 at an average emission level of 3.23 g/test. Two vehicles tested back-to-back for background emission had a mean level of 0.81 g/test with an average test-to-test standard deviation of 0.26. An estimate of the variability expected at the 2 g emission level can be made by plotting the standard deviation versus the mean emission level (0.82, 3.23, 0.26, and 0.81). Based on this method the variability expected at the 2 g level is 0.54. This assumes that variability is dependent upon emission level, which is a valid assumption based upon past experience with exhaust emissions.

MVMA - Based upon the preliminary data from the member companies and EPA cross-check program, SHED design, test procedure and testing techniques are not sufficiently defined at the present time to produce reliable, correlatable emission data between laboratories. On a 1975 Valient, emissions ranged from 5.3 to 8.7 g with a 7.0 g average level. On a 1976 Vega, results ranged from 1.6 to 2.4 g with an average level of 2.0 g. Although the program has not been completed as of this writing, a comprehensive analysis of the test data will be undertaken after completion to establish probable cause for lack of correlation and to draft recommended changes to improve test precision and repeatability between laboratories.

Volkswagen - Even if test parameters are maintained as constant as possible, the measuring uncertainty of the procedure, calculated using experimental data, can have values up to ± 46% of the mean. When influenced by the different parameters (e.g., preconditioning, fuel variability, cooling during dynamometer run, thermal characteristics of the enclosure material, background emissions and general correlation problems) uncertainties of the test results up to 200% can occur. To minimize the risk of failing the certification test, the manufacturers have to allow a safety margin beyond the standards when designing evaporative emission control devices. The measured uncertainties lead to engineering goals of less than 1 g/test. The spread of variability, which should be considered for certification testing and standard setting, has to be determined by means of an approved procedure for correlation testing. The margin of error inherent in the proposed procedures leads to the conclusion that the certification of an evaporative emission control device cannot be based on single measurements on a small number of vehicles. Compliance can only be determined by an averaging procedure from a minimum of 5 tests per vehicle.

B. Discussion

It is true that test variability forces the manufacturers to allow a safety margin and establish engineering goals below the established standard (true of exhaust emission, also). One manufacturer suggests establishing an averaging procedure using the results of at least five tests per vehicle.

EPA recognizes that all tests developed to simulate a real-life situation are subject to some variability and this variability exists between test-to-test and lab-to-lab testing. With regards to the MVMA-EPA crosscheck program, it must be pointed out that test techniques improve significantly once experience has been gained. The 1976 Vega used in the program, when tested at EPA, had a coefficient of variation of 2.5% for a mean emission level of 2.01 g; whereas the 1975 Valient had coefficient variation of 6.3% for an 8.5 g level.

EPA has recently completed an extensive test procedure evaluation and refinement program to identify and reduce the sources of test procedure variability and to relax those tolerances which were difficult to achieve (often causing void tests) when such tolerances did not significanty influence variability. The resultant improvements (such as tight time and temperature tolerances for the diurnal and hot soak tests) which have been made to the test procedure are expected to reduce variability significantly while providing a test procedure which is less burdensome to conduct. The variability of the tests conducted on the five 1975 model year test vehicles used in this program were: 12% for a Vega; 8% for a Camaro; 5% for a Matador; 51% for a New Yorker; and 10% for a Volkswagen Beetle (with fuel injection). There were between 6 and 10 tests conducted on each vehicle. The large variability seen for the New Yorker was strongly influenced by one high value out of the eight tests conducted.

The variability of the enclosure test method is similar to, if not somewhat better than, the variability associated with exhaust emission measurements. A study of exhaust emission variability done by an independent consultant for the EPA* showed the variability of exhaust hydrocarbon measurements to be 11-17%. The variability of CO measurements was 24-41%, and the variability of NOx measurements was 6-14%. The study looked at either 10 or 11 replicate tests on three test vehicles.

It is interesting to note that the manufacturers' concern with variability is sometimes tempered by a concern over the difficulty of conducting the test (voiding tests) which relates directly to the "strictness" of the test procedure tolerances. Since the factors of variability and test tolerances are usually at odds, some manufacturers appear to be arguing both sides of the issue, i.e., test procedure is too variable - test tolerances are too tight. For example, EPA proposed tight time tolerances for both the diurnal and hot soak test phases to reduce test variability. Yet, several manufacturers expressed the opinion that these tolerances were too tight. Relaxing these tolerances would, however, increase test variability.

It would be extremely difficult to allow variability in excess of the standard as the magnitude of variability is subject to change with changing procedures and vehicles. An established standard is considered to be an absolute level of control such that any measurement that exceeds such an absolute level of control would result in a failure. Test variability is understood to inherently exist within the absolute value of the standard. Recognition or "credit" of variability in excess of an extablished standard would be tantamount to relaxation of the standard.

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*"Emissions and Fuel Economy Test Methods and Procedures," Consultant Report to the Committee on Motor Vehicle Emissions Commission on Sociotechnical Systems National Research Council, September 1974.

Repeated testing, as suggested by Volkswagen, develops a confidence level to insure that such a failure is due to the vehicle and not to the procedure and associated equipment. This repeated testing does represent a reasonable and statistically valid methodology. However, major disadvantage of repeat testing is the increase in resources required. A compliance technique that is based on averaging 5 tests per vehicle would increase personnel and facility requirements by more than 5 times, considering the normal occurrence of void tests. EPA already allows a second test if the first test is above the standard, which is generally accepted as a reasonable compromise.

C. Recommendations

Although not recommended to be incorporated into the procedures at this time, it is recommended that EPA continue to investigate ways of reducing test variability and the feasibility of establishing a more statistical representation of vehicle compliance.

Issue - Vehicle Preconditioning

Current vehicle preconditioning consists of one hour of road operation according to the durability mileage accumulation schedule, or approved alternatives. This one hour of preconditioning is followed by one UDDS. The proposal eliminates the one hour of road preconditioning since EPA concludes that one UDDS provides sufficient preconditioning for normal circumstances. For vehicles which have received abnormal treatment (extended storage, etc.) additional UDDS's can be requested up to three with one hour soaks between them. The proposed regulation also discontinues the practice of using the test vehicle to set the dynamometer horsepower prior to the UDDS.

A. Summary of Comments

British Leyland - Asks, "Is road preconditioning still to be allowed on vehicles delivered to EPA for certification testing, and at what stage will the specification test now be performed."

Chrysler - "The statement...that a gasoline fueled test vehicle may not be used to set dynamometer horsepower presents severe constraints on a manufacturer's testing operation that are not justified."

Chrysler states that the limitation of only one UDDS to precondition the test vehicle is too extreme. This would place severe constraints on evaporative emission control system design and increase markedly the problem of handling exhaust-evaporative interaction.

Chrysler says that additional preconditioning should be granted routinely for vehicles which receive abnormal treatment and proposes that we retain the alternate Emission Testing Vehicle Preconditioning Procedure as outlined in MSAPC Advisory Circular No. 39, published February 28, 1974. This would allow running of three consecutive runs of the UDDS.

Exxon - States that the one hour preconditioning is a necessary step in the test sequence because Exxon concludes that it is easy to abnormally load the evaporative control system of a test vehicle which has not been in normal use immediately before the test. In their opinion, a one hour trip, would bring the level of the retained hydrocarbons in the evaporative control system from an abnormally high level to about the equilibrium level.

Fiat - Considers that the one hour of preconditioning is necessary and useful for the repeatability of the tests. Fiat suggests that three consecutive UDDS operations be run, as allowed in Advisory Circular No. 39, to represent normal urban driving.

Ford - Aggrees with the proposal provided that section 86.128-78 (3) which permits EPA to grant additional preconditioning for unusual circumstances is retained.

GM - States that the restriction on the use of a test vehicle to set the dynamometer horsepower is "undue". A mileage limit could be set instead. GM strongly objects to the deletion of the one hour of mileage accumulation driving, wants data to support that the practice is wasteful and feels that the need should be established with future control systems. GM claims that the durability mileage accumulation schedule does represent actual vehicle operation since the average speed is about 30 mph. GM proposes that one hour of vehicle operation be allowed on an optional basis for vehicles which receive abnormal treatment.

Honda - States that vehicles which are transported by air or boat should receive additional preconditioning. Feels that the durability driving schedule should be used for the additional preconditioning.

IH - States that even three UDDS may not be enough for some unusual circumstances.

Mercedes Benz - Comments that the provision "...where additional preconditioning may be allowed..." should be retained in the final regulations.

Toyo Kogyo - Are concerned about insufficient time for purging particularly in the case of a retest. They consider that one hour of mileage accumulation would be effective for that purpose.

Toyota - One cycle of the UDDS does not purge the Toyota control system. Three or four cycles of the UDDS should be run and the soak between should be 30 minutes to save testing time.

B. Discussion

Some manufacturers are opposed to changing the current one hour of mileage accumulation preconditioning. Ford and Mercedes Benz will agree with the proposal of one preconditioning UDDS if provisions for additional preconditioning under special circumstances are retained. The other manufacturers would prefer three or four UDDS cycles for preconditioning. Chrysler and GM want to continue the use of the test vehicle for setting dynamometer horsepower.

The manufacturers are all concerned that their vehicles' evaporative emission control system receive adequate purges. EPA is concerned that the vehicle preconditioning be reasonably representative of typical urban vehicle use.

EPA has conducted several studies[1, 2] to evaluate the relationship between preconditioning and emissions, both evaporative and exhaust. These tests were conducted with vehicles of current configuration.

The general relationships developed from the experiments are:

1. For vehicles in normal use, one hour of road preconditioning, whether it is conducted or not, prior to the first fuel drain and fill and dynamometer preconditioning has no effect upon subsequent evaporative or exhaust emission levels.

2. The type of preconditioning conducted during the dynamometer operation does have an effect upon subsequent evaporative and exhaust emission levels.

The conclusion, then, is that the road run preceeding the dynamometer preconditioning is unnecessary and that the dynamometer operation must be carefully defined.

The UDDS is the method for representing urban driving with respect to emissions and fuel economy. It has an average speed of about 20 mph, a distance of 7.5 miles and a duration of about 23 minutes. The durability mileage accumulation schedule may do a reasonable job of representing, for mileage accumulation purposes, combined urban and rural driving. Its average speed of 30 mph is about right for that and it is run continuously. For preconditioning, it is run for one hour and a distance of 30 miles. As stated above, the average urban trip is 7.5 miles and many trips are much shorter.[3] Since the emission measurement-test procedure measures urban emissions, the preconditioning must represent urban operations. Therefore, the preconditioning drive must be a UDDS.

Most frequently the need for additional preconditioning will occur for vehicles shipped to or stored at the EPA test facility. For vehicles tested at the manufacturers' facilities and vehicles driven to the EPA facility and promptly tested, the proposed preconditioning is adequate. Most vehicles tested at the EPA laboratory are driven to the laboratory.

Vehicles shipped to EPA and vehicles stored at EPA for extended periods may be given additional preconditioning. In keeping with the concept of normal urban operation, the preconditioning should consist of one, two, or three UDDS drives. Each UDDS should be followed by a one hour soak. Usually, one additional UDDS drive will be enough to condition the evaporative emission system.

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1. "EPA In-House Test Program Report No. 1 - Vehicle Preconditioning: AMA + LA-4 vs. LA-4", Report No. EVAP 75-1, June 1975.

2. "EPA In-House Test Program Report No. 2 - Vehicle Preconditioning: LA-4 vs. HFET", Report No. EVAP 75-5, November 1975.

3. "A Survey of Average Driving Patterns in Six Urban Areas of the United States: Summary Report - System Development Corporation", January 29, 1971, NTIS PB202-192.

In the past, EPA had allowed the test vehicle to be used to set dynamometer horsepower prior to running the UDDS preconditioning. This practice provides additional evaporative system purging which is certainly not representative of urban driving.

Certification dynamometers can be operated in an automatic mode and need not be set by use of a vehicle. EPA will use the automatic mode of dynamometer operation. Thus, at EPA the test vehicle will not be used to set the dynamometer. To minimize test variability, a uniform practice, of not using the test vehicle to set dynamometer power, must be established.

C. Recommendations

1. Retain the wording of the notice of proposed rulemaking.

2. Modify Advisory Circulars 39 and 50 (and any others which are relevant) to reflect the new preconditioning.

3. Encourage manufacturers to use the automatic method of dynamometer setting.

4. Allow idle settings to be measured according to the manufacturers' recommendations to the vehicle owners any time prior to the preconditioning fuel drain and fill.

Issue - Amount of Fuel Used for Preconditioning

The proposed regulations require the fuel tank to be drained and filled with approximately 2 gallons of the specified test fuel prior to the UDDS preconditioning drive. For instances where additional preconditioning is to be performed, the fuel tank may be filled up to the prescribed "tank fuel volume." The prescribed "tank fuel volume" is 40% of the nominal fuel tank capacity.

A. Summary of Comments

Chrysler - It is recommended that the tank be filled with approximately 8 gallons of the specified test fuel prior to preconditioning. Preconditioning shall consist of four consecutive UDDS's.

Exxon - Stated that a 2 gallon fuel level represents an unrealistic and uncommon practice. If the fuel tank only contains 2 gallons of fuel, the vapor space will be uncommonly large and the fuel may be elevated to unrealistically high temperatures. This, in turn, could generate excessive running losses from the tank during the preconditioning drive so that a representative purge and operation of the evaporative control system would not be possible.

GM - Tank emissions increase with increasing vapor space and temperature excursion. Although the deletion of a temperature specification and the small test fuel quantity for preconditiong represent test conveniencies and economies, they unrealistically aggravate loading of a vapor storage system.

Honda - The 2 gallon value prescribed for use in preconditioning is much smaller than that expected in the field. Fuel evaporative emissions vary very much with the ratio of fuel volume to the tank volume. It is recommended that the prescribed fuel volume be the same as that prescribed for the diurnal breathing loss test.

Togo Kogyo - We desire that the amount of fuel used for preconditioning be amended from two gallons to the prescribed "tank fuel volume" (40% of the nominal tank capacity). An amount of fuel as small as two gallons becomes sensitive to the temperatures encountered during the hot soak which occurs after the preconditioning drive. This can cause a significant variation in evaporative emission data.

B. Discussion

The consensus of opinion among the respondents is that a 2 gallon fuel fill for the preconditioning drive can cause abnormal evaporative emission results. This is due to the fact that the loading of the evaporative control system is sensitive to the size of the vapor space and to the temperature excursion of the fuel. The small amount of fuel can result in a larger than normal vapor volume, and a larger than normal fuel temperature rise during preconditioning. It is generally recommended that an increased amount of fuel be added for preconditioning (preferably 40% of the nominal tank capacity). Also, it is recommended that the fuel be at room temperature.

The purpose of the 2 gallon fuel fill was to conserve test fuel. The comments regarding the sensitivity of emissions to the percent fuel fill has been substantiated by testing done at the MVEL laboratory.* Testing indicated that the emissions from the fuel tank are significantly affected by both the amount of fuel in the tank and the temperature excursion of the fuel.

C. Recommendations

Require the fuel tank to be filled to the prescribed fuel volume (40% of the nominal tank capacity). The fuel should be not warmer than 86°F.

* "In-House Test Program Report No. 4, Part II - Typical Vehicle Diurnal," Report No. EVAP 76-3, March 1976.

Issue - Soak Time between the Preconditioning Drive and the Start of the Cold Start Exhaust Test

The current regulations specify a minimum soak time of 12 hours between the preconditioning drive and the start of the cold start exhaust test. No maximum time specification is made. The proposed regulations specify a minimum 12 hour and maximum 36 hour soak time. The maximum time limit of 36 hours is an attempt to limit test variability by limiting the length of the soak while allowing adequate test scheduling flexibility.

A. Summary of Comments

GM - Twenty-four hours should allow reasonable test scheduling flexibility and prevent the possibility of an additional "tank diurnal" which could be forced into a vapor storage system if the vehicle is allowed to soak for up to 36 hours.

B. Discussion

Testing facilities normally attempt to operate at one set temperature (within the 68-86°F range) during the day. This temperature will not remain constant, but will generally only fluctuate a few degrees. Therefore, even though the allowable soak temperature range is relatively large, the temperature fluctuations should be relatively small. The vehicle's vapor storage system should not be abnormally loaded when the vehicle is soaked under such conditions. Limiting the soak time to 24 hours instead of 36 hours should not decrease the loading on the vapor storage device significantly, but it would limit testing flexibility considerably.

A 24 hour maximum time limit would greatly reduce testing flexibility. A vehicle preconditioned early in the morning would have to be tested early the following morning if a maximum 24 hour soak was specified. A 36 hour soak time allows a test to be performed at any time during the day even when the vehicle was preconditioned early the previous morning. In actual practice the length of the soak will rarely be as long as 36 hours. If testing is being conducted during a single 8-hour shift work day, the maximum time for the soak would be roughly 30 hours due to the time required to run the emissions test.

C. Recommendations

Retain the 36 hour maximum soak time limit.

Issue - Pressure Check of Fuel System

The current evaporative emission regulations for the "carbon trap" test procedure allows for an inspection of the fuel system prior to the certification test. This inspection may be a pressure check (not specified) of the fuel system. If such an inspection indicates leaks to the atmosphere of liquid or vapor fuel, corrective action may be taken under the provisions for unscheduled maintenance. Unscheduled maintenance may be approved by the Administrator if the repair of a part or system malfunction doesn't render a vehicle unrepresentative of in-use vehicles. If the pressure check indicated a leak in the fuel system due to a malfunction that may be representative of in-use vehicles, the source of the leak was trapped and included as an emission source. Since the enclosure measurement method measures evaporative emissions regardless of source, there no longer exists the need to perform a pressure check to identify system leaks representative of in-use vehicles. The proposed regulations, therefore, do not incorporate fuel system inspection using a pressure check as an integral part of the test procedure.

A. Summary of Comments

Chrysler - A pressure leak check of the fuel tank system must be permitted after installation of the fuel tank thermocouples to insure that no leakage is occuring through the thermocoupled sensing unit.

Ford - Certification vehicles are invariably built with some prototype parts. Also, the treatment of test vehicles during certification is atypical of the treatment the vehicle gets in the hands of the public (i.e., fuel systems are drained, tanks heated, thermocouples installed etc.). Without a pressure check, leaks which the manufacturer should be allowed to fix won't be detected since overt indications of such leaks are generally not evident. Because of undetected fuel system leaks, deterioration factors may be adversely affected due to a malfunction related to the test procedure and totally unrepresentative of actual system deterioration. It is proposed that a pressure check be allowed and leaks not representative of in-use vehicles be repaired prior to each emission test. In addition, if SHED test results show an atypical number, the manufacturer should be permitted to investigate for the cause of the atypical result. Again, if the result is due to factors which do not represent in-use vehicles, corrective action should be allowed, the test voided and rerun.

GM - "A pressure check to insure the integrity of the (fuel) system should be mandatory." This is essential to insuring that various test pieces such as the tank drain and fuel tank thermocouples are still sealing.

IH - A pressure check should be allowed when the thermocouple is initially installed and at each test point to develop a history for justification of unscheduled maintenance.

B. Discussion

The consensus of those commenting is that a pressure check is needed to determine if leaks of the fuel system not representative of in-use vehicles are present. Past experience at EPA indicates that leaks of this nature are uncommon. Allowing pressure checks at each test point is, therefore, an unnecessary and time consuming practice. The fuel system should be initially checked when thermocouples and fuel drains are installed. If diagnostic work indicates that an abnormally high test result is due to a leak unrepresentative of in-use vehicles, the regulations allow corrective action to be performed and the test rerun.

C. Recommendations

Retain the proposed wording.

Issue - Length of Enclosure Purge

The evaporative enclosure is required to purge for several minutes prior to the diurnal and hot soak test phases.

A. Summary of Comments

British Leyland - "Could a more positive definition of the phrase 'for several minutes' be provided."

B. Discussion

The length of the purge should not affect the emission results, since the initial hydrocarbon concentration in the enclosure is subtracted from the final concentration. Purging for several minutes is good engineering practice and will prevent excessive buildup of hydrocarbon levels. A particular amount of purging should not be specified in the regulations as it would only serve to complicate the test procedure.

C. Recommendation

Retain the currently proposed wording.

Issue - The Diurnal Test

The proposed test sequence for the diurnal test is as follows:

1.) Drain fuel from the fuel tanks;

2.) Fill the fuel tank with the prescribed amount of fuel. The fuel shall be between 50 and 60°F;

3.) The test vehicle shall be moved into the evaporative emission enclosure, and the windows and luggage compartment opened;

4.) The fuel tank temperature sensor shall be connected to the recording system and the heat source properly positioned with respect to the fuel tank(s);

5.) The enclosure doors shall be closed and sealed;

6.) The temperature recording system started;

7.) When the fuel temperature reaches 60 $\pm$ 1°F, the diurnal test is initiated.

8.) The test length shall be 60 $\pm$ 2 minutes long and the final fuel temperature shall be 84 $\pm$ 1°F.

9.) At any time (t) during the heat build the fuel temperature must be within $\pm$ 2°F of (F) as determined by the following equation:

$$F = 60 + 0.4\ t$$

where:

F = fuel temperature, °F
t = time from the beginning of the test, min.

The ideal heat build is from 60 to 84°F in 60 minutes.

A. Summary of Comments

Chrysler - Final rulemaking should include a requirement that the vehicle tank should not be capped prior to the diurnal test until the fuel temperature reaches 60° $\pm$ 1°F. Capping the fuel tank prior to this point is improper, because the vapors generated due to the fuel being heated from as low as 50°F to 60° $\pm$ 1°F will load the vapor storage device. The enclosure should not be closed and sealed until the fuel temperature reaches 60° $\pm$ 1°F. At that time, the fuel tank should be sealed, the enclosure sealed and the initial hydrocarbon concentration recorded.

Vapor losses from a fuel tank are determined by the temperature excursion and not the heating rate. The proposed temperature control limits are unduly stringent and should be relaxed to ± 3°F to avoid invalidating a test for a minor temperature excursion from the specified heating rate. Relaxing this requirement should not influence diurnal emissions.

The ± 2 minute tolerance for the 60 minute diurnal heat build is too tight. Fuel tank vapors are generated by the temperature excursion and not the heating rate. The length of the diurnal should be specified as 60 ± 4 minutes. This action will lessen the number of voided tests due to the inability to meet the proposed strict time temperature tolerances.

Ford - There exists a possibility of up to a 10°F temperature rise after the fuel fill and prior to the start of the diurnal test. This temperature rise could result in significant differences in the initial canister loading. It is recommended that the fuel cap be left off until the fuel temperature reaches 60° ± 1°F. This could be done either outside the SHED or inside the SHED with the purge blower on and the SHED door open.

"Ford feels that we cannot reach the starting temperature of 60 ± 1°F naturally on dual tank vehicles." In most cases the tanks heat at different rates and it is extremely difficult to get both tanks to the prescribed 84 ± 1°F within a 60 ± 2 minute time limit. For some vehicles with single tanks (particularly with tanks installed vertically in confined areas), it is difficult to stay within the 60 ± 2 minute time constraints. It is recommended that artificial means of heating the tank fuel be allowed to heat the fuel up to the prescribed starting temperature. Also, the time tolerance for the test should be widened to ± 10 minutes.

GM - In order to prevent abnormally loading the evaporative control system as the fuel temperature comes up to 60°F, the fuel cap should be left off until the fuel temperature reaches 58°F. The vehicle should be fueled and pushed to the enclosure, the heat source and other test equipment connected, and the windows and trunk opened. The heat source may be used to bring the fuel up to test temperature. When the fuel reaches 58°F, install the test cap, push the vehicle into the enclosure and seal the enclosure door.

IH - Installing the fuel filler cap immediately after the fuel is added prior to the diurnal test is objectionable. Test to test variability will increase due to a 10°F allowable variation in starting fuel temperatures. It is recommended that the vehicle fuel cap be left off until the fuel temperature reaches 60°F ± 1°F.

Mercedes Benz - They recommend that the requirement of 60 ± 1°F be changed to 60 ± 2°F. A tolerance of ± 1°F is more or less a laboratory type tolerance. For practical use, ± 2°F can be achieved with a far lower probability of error than a ± 1°F temperature tolerance.

B. Discussion

The consensus of the respondents is that the fuel cap not be installed until the fuel temperature reaches either 58 or 59°F. This is due to the possibility of an abnormal loading of the vapor storage device as the fuel heats up from 50 to 60°F. Also, it is claimed that the ± 2°F temperature control limit for the diurnal heat build is too tight. It has been recommended that this tolerance be relaxed up to ± 3°F. The ± 2.0 minute time tolerance for the length of the test is generally stated to be too tight and it has been recommended that this be widened up to ± 10 minutes.

A recent EPA study* looked at the test variables during the diurnal test. It was determined that the controlling parameter was the vapor temperature in the tank, which is in agreement with an earlier study by Wade**. Temperature data from the EPA study showed that the vapor temperature in the fuel tank was roughly 68°F at the start of the diurnal test (i.e., liquid fuel temperature at 60°F). The vapor temperature went through a 14°F temperature rise and was at 82°F at the end of the diurnal test (i.e., after the liquid fuel had gone through a 24°F temperature excursion and was at 84°F). During a real life diurnal these two excursions would be roughly the same.

The current diurnal test procedure has no specification for vapor temperatures. The minimum vapor temperature could be affected by the initial fuel temperature, the ambient temperature, or the method used to bring the liquid fuel up to the prescribed starting temperature (i.e., natural vs. forced heating). Since the emission levels are dependent on the vapor temperature excursion, test variability could be reduced by specifying the tank vapor temperature when the fuel tank is capped. Ideally, this minimum vapor temperature should be 60°F. However, achieving this temperature would probably require lower initial fuel temperatures than currently specified (50-60°F) and a tighter control on the ambient temperature during fueling. Due to the need to explore the practical problems associated with an initial tank vapor temperature specification of 60°F, such a specification should be delayed and be implemented in conjunction with promulgation of future evaporative emission standards.

For the regulations to become effective in 1978, it is recommended that the tank be capped when the liquid fuel reaches at least 58°F as suggested in the comments, and that capping take place in the enclosure with the purge blowers running.

* "In-House Test Program Report No. 4 - Part I; Typical Vehicle Diurnal," Report No. EVAp 76-3, April 1976.

** D. T. Wade, "Factors Influencing Vehicle Evaporative Emissions," SAE Paper No. 670126.

To shorten the length of the test, it is recommended to allow forced heating of the fuel to bring the temperature up to at least 58°F. Also, it is recommended that a temperature rise of 24 ± 1°F be specified instead of specifying the initial and final temperatures. This allows for a broader tolerance on the initial fuel temperature and still maintains a close tolerance on the fuel heat rise. Also, it allows the use of Type "J" thermocouples instead of Type "T", as Type "J" thermocouples should be able to measure a temperature rise as accurately as Type "T" wire.

Preliminary results of testing done at the EPA facility show that time may be an important parameter. Widening the time tolerance to ± 10 minutes could result in increased variability. Therefore, it is recommended that the proposed ± 2 minute tolerance be maintained.

The control limits on the heat build are an attempt to define the degree of linearity of the heat build. Analysis of heat build fuel temperature data for tests conducted at EPA indicate that a ± 2°F control limits would result in an undesirable number of voided tests, as suggested by Chrysler. Experience indicates that a ± 3°F tolerance should virtually eliminate the possibility of a void test. It is, therefore, recommended that the control limits be broadened to ± 3°F.

C. Recommendations

In order to address the problems with the diurnal test brought up by those commenting and to maintain an accurate, repeatable test, the following test sequence is recommended for testing during the 1978 model year:

1.) Drain the fuel from the fuel tanks and leave the fuel cap off;

2.) Fill the fuel tank with the prescribed amount of fuel. The fuel shall be between 50 and 60°F;

3.) The test vehicle shall be moved into the evaporative emission enclosure, and the windows and luggage compartment opened. The purge blowers shall be operating;

4.) The fuel tank temperature sensor shall be connected to the recording system and the heat source properly positioned with respect to the fuel tank(s);

5.) Start the temperature recording system;

6.) When the fuel temperature reaches at least 58°F, the fuel tank(s) shall be capped, the purge blowers turned off, and the enclosure doors shall be closed and sealed. Artificial means to bring the fuel up to 60 ± 2° may be used;

7.) The start of the test shall take place when the fuel temperature is 60 ± 2°F;

8.) The test length shall be 60 ± 2 minutes long and the final fuel temperature shall be 24 ± 1°F above the initial fuel temperature. For vehicles equipped with dual tanks, the heat build will be governed by the larger tank fuel temperature. The smaller tank fuel temperature must be within ± 3°F of the larger tank temperature at any time.

9.) At any time (t) during the heat build, the fuel temperature must be within ± 3°F of the prescribed fuel temperature (F) as determined by the following equation:

$$F = To + 0.4t$$

where:

F = fuel temperature, °F
To = initial fuel temperature, °F
t = time from the beginning of the test, min.

It is further recommended that, in the future, tighter control of tank vapor temperatures be specified.

Issue - Ambient Temperature During the Diurnal Test

The proposed regulations specify the ambient temperature during the diurnal test phase to be 68-86°F.

A. Summary of Comments

NRDC - The ambient temperature during the diurnal test should reflect the average hot summer day average temperature in the hotter portions of the United States. A temperature of 68°F is undoubtedly lower than this average temperature. A lower temperature than the average temperature of a hot summer day should not be permitted unless it can be shown that the use of lower ambient temperatures has no appreciable effect on the total evaporative emissions generated during this test phase.

B. Discussion

An evaluation of ambient temperatures for 31 major urban centers of the United States for the months of July and August showed that the average minimum and maximum temperatures were 64°F and 84°F respectively.* Thus, the average temperature on a summer day is 74°F. The specification of a 68-86°F ambient temperature range allows needed flexibility to the control of ambient test conditions at test facilities. The ambient temperature is normally kept at a level somewhere between the allowable limits. Thus, the ambient temperature during the diurnal may very well be kept near the 74°F average temperature. In addition, diurnal emissions are primarily generated in the fuel tank. The fuel tank is subjected to a diurnal heat build during the diurnal test. The condition of the fuel tank is the important factor and not the ambient temperature surrounding the test vehicle.

C. Recommendations

Retain the proposed 68-86°F ambient temperature limits for the diurnal phase of the test.

*"In-House Test Program Report No. 4, Part I - Typical Vehicle Diurnal", Report No. EVAP 76-3, March, 1976.

Issue - Use of Type "T" Thermocouples

The current evaporative emission regulations specify use of iron-constantan (Type J) thermocouples and specifies a temperature recording accuracy of ± 1°F. Current industry practice is to use standard grade Type J thermocouples which have an accuracy of ± 4°F. Premium grade Type J thermocouples are only accurate to ± 2°F. Recorder error may contribute another ± 0.5°F inaccuracy. Therefore, the equipment currently used cannot meet the requirements of the current regulations. The proposed evaporative emissions regulations have specified the use of type T (copper-constantan) thermocouples which have an accuracy of ± 1.5°F or ± 0.75°F for standard or premium grade wire respectively. The proposed regulations also changed the required accuracy from ± 1°F to ± 2°F. These proposals allow for adequate accuracy and specify the equipment required to meet that accuracy.

A. Summary of Comments

AMC - The switch from Type "J" to Type "T" thermocouples is unwarranted and impractical. Calculation of mass emissions is dependent on the absolute temperature (° F + 460) and, therefore, a ± 2°F error is comparatively small. Also, the emissions are more dependent on the temperature difference than on the accuracy of the individual temperature measurements. Type "J" thermocouples also have the advantage of giving slightly better resolution over the test range than Type "T" thermocouples. It is recommended that the specification of Type "T" thermocouples be removed or made optional.

Chrysler - Type "J" thermocouples can provide the desired accuracy for fuel tank temperature measurement. Also, automatic temperature controllers will have more difficulty "tracking" the specified heat rate due to the decreased resolution (millivolt change per ° F) of the Type "T" thermocouple. There also exists greater likelihood for incorrect temperature measurement due to the possibility of incorrect hookups of Type "T" and Type "J" temperature measuring and recording equipment. The proposed change from Type "J" to Type "T" is costly and unjustified. It is therefore recommended to specify use of Type "J" thermocouple wire.

GM - The cost effectiveness of changing thermocouple specifications should be carefully examined. A changeover will require considerable time and money. Further, the confusion that could result when running changes for 1977 are being processed through the test procedure will be significant.

Mercedes Benz - It is recommended that the type of thermocouple used be left up to the manufacturer as long as the accuracy requirements are met. We currently use Ni Cr Ni - thermocouples which are manufactured with the same accuracy performance as the Type "T" thermocouples specified in the proposal.

B. Discussion

The response to the change from Type "J" to Type "T" thermocouples has been uniformly negative. It has been recommended to either specify Type "J" or to leave the choice of thermocouple to the discretion of the individual manufacturer. The necessity of Type "T" thermocouples is questioned based on its reduced resolution capabilities, the relative insensitivity of the emissions results to an absolute temperature inaccuracy of $\pm$ 2°F, and the fact that Type "J" wire can give sufficient accuracy.

The discussion of the temperature specifications for the diurnal test indicated that Type "J" thermocouple wires would be adequate if the diurnal temperature requirements were changed. It is therefore recommended that type "J" thermocouples be specified.

C. Recommendations

It is recommended that the specification of Type "T" thermocouples be changed to Type "J".

Issue - Time Between the Diurnal and Exhaust Emission Test Phases

The proposed regulations require that the exhaust emission test start within one hour after the end of the diurnal heat build test. Prior to these regulations, the time between the end of the diurnal test and the start of the cold start exhaust test was not specified.

A. Summary of Comments

Chrysler - It is recommended that the cold start exhaust test be started within 15 minutes after the end of the diurnal test. Allowing for up to an hour between test phases is unsatisfactory, because it would allow time for the fuel tank to cool down and then heat up again before the start of the exhaust test. This would, in effect, expose the vehicle to a second diurnal vapor loading of the vapor storage device. Also, care should be taken to avoid heating the test fuel beyond 84 $\pm$ 1°F.

B. Discussion

The fuel tank at the end of the diurnal should be at or near 84°F. During the time of up to one hour before the exhaust test, the fuel tank may cool down somewhat due to cooler surrounding temperatures. The fuel tank should not, however, heat up again during the one hour period as the soak temperature should be relatively constant. A 15 minute maximum time limit between test phases would significantly reduce the flexibility in scheduling tests. A one hour time limit should adequately prevent abnormal loading of the vapor storage device, while maintaining enough flexibility in the overall test.

C. Recommendations

Retain the current one hour maximum time limit between the diurnal and cold start test phases.

Issue - Heat Build Required Prior to Non-Evap Vehicle Exhaust Test

The evaporative emission family concept will result in some vehicles only undergoing the exhaust emission test. Those vehicles must undergo a diurnal heat build (not necessarily in the enclosure) prior to the exhaust emission test.

A. Summary of Comments

IH - For the small effect, if any, of the evaporative system upon total exhaust emission results, the proposed requirement of conducting a diurnal test prior to the exhaust emission test adds unnecessary time to the program.

B. Discussion

There exists a possibility of interactive effects between exhaust emissions and evaporative emissions depending on specific design characteristics of either system. The diurnal heat build prior to the exhaust test will load the evaporative emission storage device. These stored vapors are purged into the engine during the exhaust test and burned. The loading of the canister by a diurnal heat build should therefore take place prior to every exhaust test, regardless of whether evaporative emissions are being measured.

C. Recommendations

Retain the proposed requirement of a heat build prior to every exhaust test.

Issue - Determining the Need for a Running Loss Test

The proposed regulations require a running loss test only if an engineering analysis indicates the possibility of evaporative emissions during vehicle operation.

A. Summary of Comments

NRDC - The proposed regulations do not indicate procedures for determining the possibility of evaporative emissions during vehicle operation. If there are certain design or engineering features associated with future vehicles which make running loss emissions unlikely they should be identified. Vehicles with those features could be considered exempted from the running loss test.

B. Discussion

Hardware employed for the control of hot soak and diurnal evaporative emissions should control running loss emissions. An engineering analysis of specific system designs is required to determine whether the possiblity of running loss emissions exists. There exists no set criteria for determining the possiblity of running loss emissions.

C. Recommendations

Retain the current wording.

Issue - Time Between the Exhaust and Hot Soak Test Phases

The current evaporative emission regulations do not specify the time tolerance for the period between the exhaust and hot soak test phases. The proposed regulations specify 1.0 minute between engine shut-down and the start of the hot soak test, and a total of 5.0 minutes between the end of the exhaust test and the start of the hot soak test. During the time that the engine is idling, the vehicle must be prepared to leave the dynamometer, then driven off the dynamometer to within 10 feet of the enclosure. Also, during this period of engine idling the vehicle's windows and trunk may be opened.

After the engine is shut-down, the vehicle must be pushed into the enclosure, the enclosure doors closed and sealed. When sealing is complete the initial hydrocarbon and temperature readings are recorded. This marks the start of the test.

A. Summary of Comments

AMC - Due to the physical location of the SHED with respect to the chassis dynamometers, and the number of tasks that must be performed in moving the vehicle into the SHED, it is felt that the 1.0 minute time limit from engine-off to the start of the hot soak test is overly constrictive. It is recommended that a 2.0 minute specification be adopted for the time from engine shut-down to the start of the hot soak test. In our judgment, a 2.0 minute time limit would not detract from test integrity.

Chrysler - Allowing the vehicle to coast into the enclosure with the engine shut off should be made an optional procedure. This optional procedure can shorten considerably the time between engine shut-off and the start of the hot soak test.

Ford - It is recommended that the time from engine shut-down to the start of the hot soak test be limited to 2.0 minutes instead of 1.0 minute. Further, it is recommended that the overall time from the end of the exhaust test to the start of the hot soak test be a maximum of 7.0 minutes. California Air Resources Board (CARB) has accepted these recommendations and, to our knowledge, has provided a seven minute maximum specification in their latest procedure draft. Test data (with the time from engine-off to the start of the hot soak held constant at 2.0 minutes) indicate that evaporative emissions are not affected by the total time from the end of the exhaust test to the start of the hot soak test.

GM - A maximum distance requirement of 10 feet from the enclosure at engine shut-down is unnecessary due to adequate specifications of transit, key-off, and test start times. It may cause operational difficulties due to facility layout. It is preferred that the specification be dropped so that the manufacturer has the option of leaving the vehicle further away.

The portion of the procedure dealing with engine shut-down is undesirable in that the engine is required to run up to four (4) minutes. Rewording to allow engine shut down after leaving the dynamometer is suggested. Also, the requirement that the enclosure doors be closed and sealed within one minute of engine shut-down is unduly restrictive. The recording of this time will have to be accurate to within one second. The effect on actual emissions is questionable. Further, many facilities have enclosure doors that take up to 30 seconds to close. It is suggested that no time limit be placed on the time from engine shutdown to the start of the hot soak test, and the time from the end of the exhaust test to the start of the hot soak test be limited to 5 minutes.

Mercedes Benz - Four minutes may be a too stringent requirement for the time interval between the end of the exhaust test and engine-off due to relative location of the chassis dynamometer and the enclosure. We ask that the intervals be changed to 10 minutes between the end of the exhaust test and the beginning of the hot soak test. Also, the time from engine shut-down to the start of the hot soak test should be allowed to be 5 minutes.

Toyo Kogyo - We support the 5 minute upper limit from the end of the exhaust test to the start of the hot soak test. It is recommended that a minimum time of 4.5 minutes be specified to limit test variability.

B. Discussion

The consensus of the comments on this subject is that the proposed time tolerances are too strict. The recommendations for the tolerance on idle time vary from agreement with the proposed time limit to a 5 minute time limit. The recommendations for the time from engine shut-down to the start of the hot soak vary from agreement with the proposal to a recommendation of "no specification". The most frequent recommendation was a 2.0 minute tolerance for the time between engine shut-down and the start of the hot soak. It was also suggested that the distance requirement of 10 ft. be eliminated and that the vehicle be allowed to coast into the enclosure.

The effect of the time between engine shut-down and the start of the hot soak was also evaluated in the EPA study. The results indicated that the length of this time period can affect emission levels. By limiting this time period as much as is practical, test variability can be reduced. However, putting too tight a tolerance on this time could result in an excessive number of void tests. The 1.0 minute time tolerance is a desirable goal to achieve during testing, but it may result in an excessive number of void tests. Therefore, it is recommended that this tolerance be extended to 2.0 minutes in the final rulemaking.

A recent study done at EPA* supports the conclusion which Ford drew from its study of the effect of idle time on emission levels. The studies showed that hot soak emissions were unaffected by idle times of up to 8 minutes duration. Therefore, since a 5 minute upper time limit has been recommended by several of the commentors, and since it will have little effect on emission levels, it is recommended that up to a 5.0 minute idle time be specified in the final rulemaking.

The requirement that the vehicle stop within 10 feet of the enclosure prior to engine shutdown was proposed so that the vehicle could be pushed into the enclosure in the allotted time. Allowing the engine to be shut-down while the vehicle coasts into the enclosure would be somewhat desirable as long as the engine stops prior to entering the enclosure. It is recommended, therefore, to require the engine to stop prior to any part of the vehicle entering the enclosure.

C. Recommendations

Specify the time from engine stopped to the start of the hot soak to be no greater than 2.0 minutes. Specify the overall time from the end of the exhaust test to the start of the hot soak test to be no greater than 7.0 minutes. Specify that the engine be stopped before any part of the vehicle enters the enclosure.

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*In-House Test Program Report No. 5 - Hot Soak Time Constraints, Report No. EVAP 76-2, March 1976.

Issue - Length of the Hot Soak Test

The proposed regulations specify the length of the hot soak test to be 60 ± .5 min.

A. Summary of Comments

British Leyland - "The very tight tolerance placed on the 60 minute period, could lead to unnecessary voiding of tests. Does it have to be as tight as ± 0.5 minutes to retain the required degree of accuracy."

Mercedes-Benz - The time tolerance of ± 0.5 min. for the length of the hot soak test is unnecessarily stringent and complicates the procedure. We recommend a ± 2 min. tolerance as allowed for the diurnal test.

B. Discussion

The time tolerance of ± 0.5 min. will reduce test to test variability and should be an easy specification to meet. A ± 2 min. tolerance could result in variability in the hydrocarbon measurement of up to ± 5% during the hot soak.

C. Recommendation

Retain the ± 0.5 min. tolerance for the length of the hot soak test.

Issue - Maximum Hot Soak Temperature

The proposed regulations require that the ambient temperature in the evaporative enclosure be maintained between 68 and 86°F for the hot soak portion of the test. This temperature range is consistent with the ambient temperature range specified for the other phases of the exhaust and evaporative emission test. The upper limit of 86°F is 4°F lower than the 90°F upper limit currently recommended by the SAE for the hot soak test using the evaporative enclosure technique. The 86°F maximum was specified so that the vehicle would not be subjected to an abnormal ambient condition.

A. Summary of Comments

AMC - The setting of an 86°F maximum temperature (instead of 90°F) is desirable because it would more closely approximate the conditions of a "hot soak" on an actual vehicle. However, the requirement is difficult to accommodate due to the requirement for additional cooling. It is suggested that this requirement will create a greater lead time than the current time table allows.

AESi - The proposed setting of a uniform ambient temperature tolerance of 68-86°F for all test phases is a desirable and practical step to refine and simplify the test procedure. It is felt, however, that the location for the temperature measurement in the enclosure and in the entire soak area needs to be more specific. Due to the temperature stratification with height in the enclosure and in the soak area, it is recommended that the height of the temperature measurement be specified as 1.0 ± 0.1 meters above the floor upon which the vehicle is located. It is felt that this specification would reduce test to test errors between laboratories.

Practical experience with enclosure testing indicates that temperatures in the enclosure during a hot soak test with a hot, average sized vehicle in an enclosure constructed of excellent heat transfer materials will exceed 86°F, if the ambient temperature in the soak area is 80°F. Therefore, some form of cooling is required. It is recommended that an allowance for cooling be made, provided the cooling surface temperature remain above 68°F. Also, due to temperature stratification, requiring the ambient temperature measurement to be made 6-12" from the ceiling surface makes an 86°F maximum temperature even more difficult to achieve.

Chrysler - "The ambient temperature in the test area external to the SHED should be held to 68-72°F during the hot soak portion of the SHED test sequence to prevent the heat buildup in the SHED from exceeding 86°F." If external wall cooling is permitted, cooling methods should be defined with the provision that internal SHED surfaces should not be cooled below 65°F.

NRDC - Widening the ambient temperature range from 76-86°F (current temperature range for hot soak certification tests) to 68-86°F could allow ambient temperatures to be as low as 68°F. A justification for the statement that a 76-86°F temperature range is too restrictive has not been justified. Unrealistically low ambient temperatures such as 68°F may result in lower emissions than would be present in the "real" world. It is believed that the ambient temperature should be representative of maximum temperatures on hot summer days. The minimum allowable hot soak ambient temperature should be 90°F or higher.

B. Discussion

With the exception of the Natural Resource Defense Council (NRDC), the proposed 68-86°F temperature range was considered desirable as it was typical of "real" world conditions. NRDC felt that the temperature range was too large and that the ambient temperature should represent maximum temperatures on hot summer days. Other comments received related to the short lead time involved to implement cooling methods.

A recent EPA study*, examined the effect of hot soak temperatures on emissions. It was concluded that a higher allowable ambient temperature (such as 90°F) could potentially result in significantly higher (10%) emission levels. It was recommended that the maximum temperature be specified as 86°F.

The current evaporative emission test procedure requires hot soak temperatures to be between 76 and 86°F. The temperature rise in the enclosure, however, may be larger than 10°F. Therefore, the lower end of the temperature range was lowered to 68°F to account for the large temperature rise in the enclosure. The temperature range of 68-86°F that was proposed is, therefore, still believed to be an appropriate and practical specification.

NRDC expressed the belief that ambient hot soak temperatures should represent the maximum daily temperature for the hotter regions of the U.S. on the hottest days of the year. Such a requirement would be inappropriate and much too severe. All hot soaks do not occur during the hottest hour of the day, but will take place throughout the day. Therefore, the average ambient temperature during the hot summer months would be a more appropriate ambient soak temperature. Another study done by EPA**, indicates that the average temperature variation during the months of July and August for 31 major U.S. urban areas is 64-84°F. Thus, the average temperature would be 74°F. An ambient temperature between 68 and 86°F would, therefore, be more representative than the temperatures above 90°F as suggested by NRDC.

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* "In-House Test Program Report No. 5 - Hot Soak Temperature Constraints", Report No. EVAP 76-1, March, 1976.

** "In-House Test Program Report No. 4, Part I - Typical Vehicle Diurnal", Report No. EVAP 76-3, March, 1976.

The study of hot soak temperatures done by EPA includes a discussion of ways to maintain an 86°F maximum temperature. There are several ways of achieving cooling, and no one could be considered the "correct" way. The method of cooling was, therefore, left unspecified. Reducing soak area ambient temperatures, blowing air on the inner and outer enclosure wall surfaces, building the enclosure out of materials such as aluminum and use of cooling fins to increase surface area are techniques which can be employed to limit the heat rise within the enclosure. Other techniques such as water cooling or air conditioning can be employed for even more cooling, but use of the above mentioned simpler techniques should be sufficient for most cases.

It is recognized that the lead-time for procuring equipment and preparing for testing is short. However, obtaining the capability for cooling should not require any more lead time than the lead time necessary for obtaining other enclosure testing related equipment.

The suggestion by AESi that the temperature sensor in the enclosure be placed 1.0 ± 0.1 meters above the floor is a desirable change to the proposal. It will help to standardize the height of the temperature measurement and will make it somewhat easier to achieve an 86°F maximum temperature. This should be specified in english units (3.0 ± 0.5 ft.) for consistency, however.

The 68-86°F temperature range was intended to include the inner surfaces of the enclosure. It is recommended that the minimum inner enclosure wall surface temperature be specified as 68°F to emphasize this.

C. Recommendations

1. Retain the proposed 68-86°F ambient temperature requirement for the hot soak phase in the final rulemaking.

2. Specify that the temperature sensor for measuring the ambient temperature in the enclosure be placed 3.0 ± 0.5 feet above the floor of the enclosure.

3. Specify a 68°F minimum inner wall surface temperature.

Issue - Enclosure Specifications

The enclosure was first described in the Federal Register (32 FR 2448) in 1967 as an airtight, readily sealable enclosure, rectangular in shape with an internal volume no greater than six times the external volume of the vehicle (vehicle volume = 1/2 x height x width x length). Since then, the enclosure was more definitively defined by the Society of Automotive Engineers as a recommended practice for measuring evaporative emissions (SAE J171a). The proposed regulations have attempted not to describe a unique enclosure with ancillary equipment, but rather to describe the performance requirements of such. Performance specifications allow the manufacturers to uniquely describe the enclosure and equipment design and placement that best fit their own facility arrangement needs and requirements.

A. Summary of Comments

AESi - The possibility of increasing lab-to-lab variability is increased by not specifying the placement of the enclosure temperature sensor. Although the proposed regulation states that the temperature probe be 6-12 inches below the ceiling, no height of the ceiling is specified. Additionally, no position of the temperature sensor is specified for recording the ambient cold soak temperature where significant temperature stratification may take place. AESi recommends that ambient temperature be uniformly measured at a height of 1.0 $\pm$ 0.1 meters above the floor. This height is also recommended for the enclosure temperature probe. Since the ceiling of the enclosure will normally be a few degrees warmer than other areas of the enclosure at the height of the vehicle, a one meter height on either side of the vehicle can help meet the 86°F maximum enclosure temperature. Practical experience indicates that with a hot average size vehicle, at a room ambient temperature of 80°F, the enclosure temperature would exceed 86°F within the one hour test. This can be overcome with relocating the temperature probe and by allowing cooling of the enclosure by external or internal means. Cooling can be economically accomplished with little or no hydrocarbon condensation or absorption by specifying a minimum cooling surface temperature of 68°F. Further, this would minimize the potential pressure build up within the enclosure, due to a rising temperature, if the expandable section could not handle a 3.41% increase in volume (assuming an enclosure volume of 1500 ft^3).

Although the specifications indicate the enclosure should be "gas tight", this is very subjective. AESi recommends adoption of a pressure/volume expansion specification stating a minimum pressure requirement of 0.5 inches H_2O and shall withstand a pressure increase or shall expand in volume by not less than 0.2% per °F temperature rise.

Chrysler - To decrease test-to-test and lab-to-lab variability in determining enclosure emissions, certain construction parameters require better definition. Internal enclosure dimensions are a critical parameter during the hot soak portion of the test sequence. The volume and shape of the enclosure should be fixed. Recommended dimensions are 10 ft. wide x 22 ft. long x 8.5 ft. high. Any vehicle larger than this can be certified by design. Another critical parameter is the ambient temperature in the cold soak area. The range recommended is 68-72°F. If the surrounding temperature is held to a 72°F maximum, then the enclosure interior temperature can be adequately controlled with little or no cooling. External wall cooling should be permitted, and a requirement that enclosure surfaces not be cooled below 65°F should be specified. Condensation on interior walls has been observed when wall temperatures were cooled below 65°F.

GM - Provisions should be allowed for an internally located heat exchanger and blower. In addition, a more definitive statement regarding homogeneity of the mixture within the enclosure is required along with blower size and location. General Motors is currently studying the mixing within the enclosure and may be able to provide a better statement after the completion of the study. In absence of mixing criteria, and considering the wide variety of enclosures that may be performing these critical tests, the location and length of the FID sampling probe should be specified. Uniformity in components only partially ensures low variability in testing. General Motors recommends that the sampling probe be located within a 6 inch radius of the temperature sensor and that the FID sampling system include a path for returning FID bypass flow to the enclosure. The bypass return is especially important in facilities that continuously monitor the concentrations in the enclosure.

B. Discussion

The generalization associated with describing the enclosure in terms of performance specifications has not been totally accepted. Manufacturers claim the variability of the test supports the need for not only more definitive enclosure specifications, but the dimensional placement of the sample probe and temperature sensor. Further comments regarding the ability of the enclosure to maintain a maximum internal temperature of 86°F suggest the ability to artificially maintain cooling of the enclosure.

EPA has attempted to provide the manufacturer with greater flexibility in defining equipment requirements. To uniquely describe such equipment presents limitations on incentive and innovation. Several of the comments on placement of equipment can be accommodated with no loss to the fundamental approach of performance specifications. Indeed, test variability is a basic problem with all test procedures; however, in a homogeneous mixture, the placement of the FID sample probe should not have any effect on this. The return of the FID bypass cannot have a substantial effect when it is realized that the normal flow rate into the analytical system is less than 10 CFH. In an enclosure with a nominal volume of 1500 ft^3, this represents a change in volume of 0.01% per minute, or 0.67%/hr. This is an unmeasurable effect. Conversely, however, there is no basis for restricting this practice if the manufacturer desires to monitor enclosure concentrations continuously. The ability to artificially cool the enclosure represents added expense and additional test data to be recorded. The design of an enclosure with maximum surface cooling can accommodate the increasing temperatures of the hot soak phase if the initial ambient temperature is maintained at the lower portion of the temperature specification range. Since there is an extreme possibility that some vehicles with large displacement engines can present a marginal situation and that forced cooling may be desirable, external cooling should be allowed, provided that the specified ambient temperature range (68-86°F) is not exceeded.

C. Recommendation

It is recommended that specific placement of the temperature sensor be specified and that no restriction be placed upon returning the FID bypass flow to the enclosure.

To accommodate the concern for high ambient temperatures during the hot soak phase, external cooling should be allowed, provided that no enclosure interior surface temperatures are lower than 68°F.

Issue - Air Circulation in the Enclosure

The air inside the enclosure used for evaporative emission measurement must be mixed thoroughly so that the hydrocarbon concentration is uniform throughout the enclosure. The proposed regulations state that "Maintenance of uniform concentrations throughout the enclosure is important to the accuracy of the test." Mixing is normally accomplished by the use of one or more small blowers or fans. The proposed regulations do not specify limits on mixing or how uniform mixing is to be determined. This is left up to good engineering practice.

A. Summary of Comments

Chrysler - The total flow range of the mixing blowers or fans should be specified to prevent undercooling or overcooling of the vehicle through improper air circulation. An upper limit of 300 cfm is recommended. Also, the airflow from the fan(s) should not be directed onto the surface of the test vehicle.

GM - We are currently studying mixing within the enclosure as it relates to blower size and location. A more definitive statement concerning homogeneity of the enclosure air as related to blower size may be possible after the study is complete.

Volkswagon - The air flow velocity in the enclosure has been determined to influence the level of evaporative emissions especially during the hot soak. The air flow velocity in the enclosure has to be specified as well as measuring points and tolerances.

Since the windows and luggage compartments of the test vehicle are open during the test, adequate mixing within the vehicle must be achieved to assure homogeneity. Certain vehicles due to their geometry may not receive adequate internal mixing. Therefore, either the windows and doors should be opened or a blower should be positioned into the test vehicle.

B. Discussion

The recommendations of those commenting on this issue are to place upper limits on the air flow rate and air velocity of the mixing air, to specify measuring points and tolerances for measurement of the air velocity, to allow vehicles to receive extra cooling in their interiors, and to insure that air not be directed at the test vehicle.

Air circulation is used to achieve uniform concentrations throughout the enclosure and also may be used to increase heat transfer across the enclosure wall. If the air flow rate is to be specified, it should include a minimum value that will insure adequate mixing and a maximum value which will allow for adequate cooling.

Experience gained during testing at EPA indicates that a range of 200-1000 cfm should adequately meet the above criteria. In addition, the recommendation by Chrysler that air not be directed onto the surface of the test vehicle should be adopted.

In reference to the comments from Volkswagon concerning the need for internal mixing, it is EPA's judgment that flow rates of up to 1000 cfm should provide adequate mixing throughout the enclosure including the internal vehicle volume for most vehicle geometries. However, if a manufacturer can substantiate that his vehicle is not susceptible to satisfactory testing by the specified test procedure, special test procedures may be specified by the Administrator (see §85.075-8).

C. Recommendations

1. Specify an allowable air flow rate range of 200-1000 cfm.

2. State that the air flow may not be directed at the test vehicle.

Issue - Enclosure Calibration

The enclosure is calibrated by injecting a measured quantity of propane into the enclosure and then analyzing the enclosure air. The proposed regulations do not specify the quantity of propane to be injected.

A. Summary of Comments

Chrysler - "Since it is good practice to calibrate at levels you are going to measure, it is recommended that 6.0 $\pm$ 0.5 grams of propane be injected into the SHED."

Toyota - Section 86.115-78 describes the procedures to determine the enclosure leak rate. It specifies that the allowable enclosure leak rate is less than 0.4 grams for the 4 hours. However, this leak rate depends on the injection volume of propane, which is used to determine the leak rate. Considering this, as shown in SAE-J-171(A), the injection volume of the propane should be specified in the regulations.

B. Discussion

The amount of propane to be injected should generally be left to engineering judgment. Factors such as SHED volume, instrument ranges and expected hydrocarbon levels should dictate the optimum propane mass to be used for these tests. In order to give general guidelines, however, it is recommended that a nominal propane mass of 4 grams is a convenient quantity.

Also, the criteria for an acceptable retention check should be changed in the final regulations, to specify the change over the 4 hour test as a percentage of the amount injected rather than an absolute value.

C. Recommendations

Specify a nominal 4 grams of propane as a convenient quantity for the enclosure calibration and retention tests. Also, specify that the amount of propane measured at the end of 4 hours not differ by more than 4% of the amount injected for the retention test.

Issue - Enclosure Background Measurements after Maintenance

The proposed regulations require enclosure background measurements to be performed yearly or after any maintenance.

A. Summary of Comments

GM - It is recommended that the background measurement only be required after maintenance that would alter background emission levels. Maintenance on the door raising mechanism, for example, would hardly affect background emissions.

B. Discussion

The intent of the proposed requirement for background measurements after maintenance was to insure that sealing compounds or other materials used for maintenance were not hydrocarbon emitters themselves. It is recognized, however, that some maintenance on the SHED should have no impact on background emissions. Therefore, background emission measurements should only be necessary after maintenance that might alter background emissions.

C. Recommendations

Require background emission measurements of the evaporative emission enclosure only after maintenance which could alter background emission levels.

Issue - The Evaporative Emission Hydrocarbon Recording System

The proposed regulations state that the recording of the hydrocarbon concentration in the enclosure may be done "by means of a strip chart potentiometric recorder, by use of an on-line computer system or other suitable means...". Also, the recording system must provide a positive indication of the initiation and completion of the evaporative emission test phase.

A. Summary of Comments

GM - It is assumed that the phrase "strip chart potentiometric recorder" implies that continuous recording of the FID output is acceptable. Continuous monitoring simplifies automation of the test. Also, a change is required which would allow manual marking of the recorder rather than requiring a "smart" recorder to automatically indicate initiation and completion of the test.

B. Discussion

A continuous recording of the FID output is acceptable. It is agreed that manual marking of the recorder should be allowed.

C. Recommendations

Alter the wording in the final regulations to allow manual marking of the FID recorder.

Issue - FID fuel for evaporative emission measurements

EPA proposed use of hydrogen/helium fuel for the FID analyzer used for evaporative measurements. Hydrogen/nitrogen fuel is used to measure gasoline-fueled light duty vehicle exhaust emissions.

A. Summary of Comments

British Leyland - Since helium is not required in the gas blend for the measurement of exhaust emissions, where the greater synergistic effects might be expected. Why is it required here?

Ford - A recent engineering study concludes that H_2He fuel for FID analysis of exhaust gas results in a 3 percent increase in hydrocarbon readings when compared to the historically used hydrogen/nitrogen FID fuel. More recent preliminary data (Exhibit 6) indicates that this 3 percent relationship also holds for the SHED FID readings.

This 3 percent increase reflects directly on the design task to meet a standard. Historically, EPA has used a hydrogen/nitrogen burner fuel for the FID analyzer. If helium fuel now must be used, EPA should publish the rationale for its use and the standard should be adjusted by the increase over a hydrogen/nitrogen fuel. Ford recommends that the hydrogen/nitrogen fuel be retained (same as for exhaust measuring FIDs) until such time as corrections are provided for the impact of the proposed change on overall measurement.

GM - Recommend the following rewording and additions to §86.112-78(a)(4). "Fuel for the...be a blend of 40 ± 2% hydrogen with the balance being helium. The mixture shall contain less than 1 ppm equivalent carbon response. The heated FID fuel shall use the same fuel as the analyzer used for evaporative measurements. Fuel for the HC analyzer used for bag analysis shall be a blend of hydrogen (40 ± 2%) and the balance nitrogen".

Mercedes Benz - For safety reasons all FID instruments at DB are operated on H_2 gas produced by H_2 generators. The new requirement (60% He/40% H_2) would require costly modification of these instruments without gaining better results.

VW - Investigations show that there is no necessity to apply a special burner gas for the FID analysis of the evaporative emissions. No systematic error of the results has been detected if a pure hydrogen fuel was used in a FID having oxygen compensation. The requirement of using a mixture of 60% He and 40% H_2 adds useless safety problems to an unsafe procedure. The danger of producing explosive mixtures in the test cells can be decreased by the application of hydrogen generators. This important advantage will be eliminated by the requirement of the He/H_2 gas.

B. Discussion

With the exception of General Motors, the response to the proposed use of H_2/H_e fuel was negative. Resultant higher emission levels and safety were the two objections raised. EPA was asked to substantiate the need for a new FID fuel.

The use of a H_2/H_e blend for the FID fuel does give higher results than a gas blend of H_2/N_2. However, the results obtained with a H_2/H_e blend are more <u>accurate</u>, and thus, more technically correct.

The discussion of the safety aspects of this requirement is not considered an issue, because the requirements don't specify how the H_2 is to be obtained. The H_2/H_e mixture can be obtained by using a H_2 generator and precision blending the H_2/H_e mixture instead of using bottled gases. Thus, the regulations do not exclude the use of H_2 generators. It should be noted that gas blends obtained in this fashion must still meet the requirements for analytical gases (§86.114-78).

In the past the manufacturers have been allowed the use of analyzers designed to use pure H_2. It is recommended that this still be allowable as accurate results can be obtained from these instruments. However, if gas analyzers are designed to use a mixture of H_2 and a diluent, the diluent must be H_e. Thus, if a manufacturer wants to use a H_2 generator he may use instrumentation designed for use with pure H_2 (with advanced approved of the Administrator) or precision blend the H_2 with H_e.

C. Recommendations

As proposed, H_2/H_e fuel should be required for evaporative HC emission measurements because of the increased accuracy of such measurements. Instruments designed to use pure H_2 should be allowed with advanced approval of the Administrator. The composition tolerance suggested by GM should be adopted.

Issue - Calculation of Evaporative Emissions

The proposed method for calculating evaporative emissions and for calculating the mass of propane used in the enclosure calibration is as follows:

$$M_{HC} = K\ V_n \times 10^{-4} \left[\frac{C_{HCf}\ P_{Bf}}{T_f} - \frac{C_{HCi}\ P_{Bi}}{T_i}\right]$$

Where:

M_{HC} = hydrocarbon mass, g.

C_{HC} = hydrocarbon concentration, ppm carbon.

V_n = net enclosure volume ft^3 (m^3) as determined by subtracting 50 ft^3 (1.42 m^3) (volume of vehicle with trunk and windows open) from the enclosure volume. For the enclosure calibration the net enclosure volume is the measured enclosure volume.

P_B = barometric pressure, in. Hg (kPa).

T = enclosure ambient temperature, R(K).

k = 2.98 (17.2) for diurnal emissions
k = 2.95 (17.0) for hot soak emissions
k = 3.05 (17.6) for propane
i = initial reading
f = final reading

The above equation is derived from the ideal gas law.

A. Summary of Comments

GM - "Provisions should be made to allow the manufacturers to determined and subtract the actual vehicle volume or the volume of a representative vehicle (instead of using a nominal vehicle volume of 50 ft^3)."

Volkswagen - "The given formula contains the hypothesis that propane can be treated like an ideal gas. Due to the Van-der-Waals-forces the real gases differ from the ideal gas law." The density of propane theoretically calculated is more than 2% smaller than the experimentally measured value. In order to accurately calculate the hydrocarbon mass, the following equation is suggested:

$$M_{HC} = RHO_{HC}\quad V\ 10^{-3} \left[\frac{C_{HCf}\ P_{BF}}{T_f} - \frac{C_{HCi}\ P_{Bi}}{T_i}\right] \frac{To}{P_o}$$

Where:

RHO_{HC} = density of hydrocarbon,

T_o = Temperature which corresponds to the hydrocarbon density used.

P_o = Pressure which corresponds to the hydrocarbon density used.

The experimentally determined value of propane is 2.0096 g/l at 273°K and 101.325 kPa.

The average density of diurnal and hot soak emissions using average hydrogen to carbon ratios of 2.33 and 2.2 are erroneous because analyses show that the major portion of hydrocarbons evaporated from the fuel consists of lower boiling substances which have hydrogen to carbon ratios of 2.4 and higher. Also, the vaporized fuel portions do not follow the ideal gas law, and thus, the average density of evaporative emissions should be experimentally determined. It is recommended that the suggested formula be used to calculate hydrocarbon emissions.

B. Discussion

It has been recommended that the proposed formula for calculating evaporative emissions be altered to allow the use of the measured density of the hydrocarbon(s) and to allow the use of the measured vehicle volume instead of using a standard 50 ft^3.

The comment concerning the fact that pure propane and the pure hydrocarbons found in evaporative emission do not behave as ideal gases is essentially correct. However, the degree to which real gases behave as ideal gases depends on the concentration of the gas. The hydrocarbon concentration of propane or evaporative hydrocarbon emissions is very low in the enclosure. The lower the concentration of a gas the less the importance of the Van-der-Waals forces due to the physical separation of the gas molecules. Thus, for the low concentrations seen in the enclosure, the gases act essentially as ideal gases.

The hydrogen-carbon ratios used for calculating evaporative emissions are 2.33 and 2.2 for diurnal and hot soak emissions respectively. These ratios were originally determined by analysis of evaporated fuel vapors. There exists no current evidence that these ratios would have changed substantially since the original determination was made.

The use of 50 ft^3 as a nominal vehicle volume is specified in the SAE J171a recommended practice for evaporative emission measurements. This simplifies the test procedure by not requiring the vehicle volume to be measured for each test vehicle. No standard, acceptable measurement technique has yet been developed. Also, the errors inherent in using a nominal value are small, due to the relatively large volume of the enclosure (approximately 1500 ft^3) as compared with the relatively small expected deviance from the nominal value (probably no larger than 25 ft^3). For these reasons, the use of a set nominal value is a desirable practice.

If measurement of the vehicle volume is made optional for each vehicle, the option could conceiveably be abused (i.e., opting to measure vehicle volume when the actual vehicle volume is greater than 50 ft^3 and opting to use the nominal value of 50 ft^3 when the vehicle volume is less than 50 ft^3). However, in order to accommodate the problem raised, it is recommended that the option of measuring the actual vehicle volume by a method approved in advance by the Administrator be allowed on a manufacturer by manufacturer basis; i.e., if a manufacturer requests the option of measuring actual vehicle volume, he would then measure the actual volume of all of his certification vehicles.

C. Recommendations

The current method of calculating evaporative emissions is technically correct with respect to the density of hydrocarbons. Therefore, it is recommended that the current equation be retained.

It is also recommended that measurement of the actual vehicle volume, for use in calculating evaporative emissions be allowed on a manufacturer by manufacturer basis, provided the measurement technique is approved in advance by the Administrator.

Issue - Calibration Gases

The concentration of calibration gas was required to be known to within 2% of the true value. To clarify and establish a "true" value it was specified that a true value be defined as a standard gas established by NBS, EPA, or other approved standard. Further that calibration gas should be traceable to within 1% of such true concentrations. Span gas tolerances remained the same as ± 2% of true concentration.

The number of calibration gases required to generate a curve for the carbon dioxide and carbon monoxide analyzers was reduced from eight to six. This accommodated "actual practice" procedures and did not significantly impact curve generation. Curve generation was based upon "best judgment" criteria. If a best-fit straight line could not be fitted within 2% or less of the value at each data point, then a best-fit non-linear equation is to be used which represents the data to within 2% of each data point.

A. Summary of Comments

British Leyland - Questions whether the change in calibration of analytical gases makes the use of analyzers exclusively for labelling purposes mandatory.

Chrysler - Suggests that calibration gases be traceable to only one set of standards.

Fiat - The requirement that gases be traceable to NBS standards within 1% is too restrictive because the same NBS gases are furnished with a tolerance of ± 1%. Further, EPA should specify the procedures which the manufacturers have to follow to obtain approval by the Administrator in having gases traceable to "other approved gas standards." It is suggested that EPA be available for the calibration of the gases by the manufacturers. Further, on the basis of Fiat's experience 6 data points are not sufficient in order to generate a calibration curve. A minimum of 10 data points is deemed necessary.

Ford - By eliminating the restriction of "single" blend calibration gases, manufacturers have the option to use flow blending. Flow blending should remain as an option because of the difficulties of obtaining and storing stable low range gas concentrations.

GM - EPA should specify a method by which manufacturers will have to be required to demonstrate compliance with the requirements. Since this is the first time such requirements have been instituted such approval is critical to the start of 1978 certification. The lead time to obtain such approval is significant. Further the 1% and 2% gas tolerance requirements should include confidence limit statements. Significant investment of time is required to ascertain these confidence levels and to insure that the gases meet the requirements stated. General Motors suggests that this set of requirements be deleted at this time, but through a joint EPA-Industry effort, be included as a technical amendments at a later date. Further, traceability to an NBS standard should be adopted. There should not be three yardsticks (NBS, EPA, other) to establish gas traceability to the NBS standards only.

IH - It is difficult to determine with any confidence that a given calibration gas would be within 1% of the true concentration. It is suggested that calibration gas accuracy be determined in accordance with good laboratory practice.

Volkswagon - No true method has been established which can provide true or absolute composition of the gases. Results of cross-check programs including "approved" gases have shown higher variability than the required tolerance. Even two gas bottles containing NBS standards did not fullfill this requirement. Such procedures have to be developed and until such a time, the gases should be prepared using best engineering practices. According to a report by the NAS Committee and Motor Vehicle Emissions, investigations have shown that in the present state of exhaust regulations, the overall uncertainty of the test results cannot be lessened substantially even by improving the gas accuracy by a richer degree.

Volvo - Considering that the new specifications require that the generated curves be within 2% of point and that commercially available instruments are normally accurate to within 1% of full-scale, the requirement that 1% calibration gases be used will probably not improve the accuracy of the end results as lessen the test-to-test variability. Volvo presently obtains calibration test points with a gas mixing pump with an absolute accuracy of 0.03%. The improvements due to using the 1% calibration gases will be negligible and the cost/benefit relation will be very unfavorable due to the high extra cost of purchasing and storing calibration gases of an accuracy of 1%.

B. Discussion

With the exception of Volkswagen all comments regarding the source of traceability for calibration gases recommended a single entity such as NBS. The implementation of this requirement was considered to be extremely difficult for 1978 and further analysis of the recommendation was considered necessary, particularly with respect to establishing confidence limits around the 1% traceability requirement. In fact a few suggested no change in the gas tolerance because minimal benefits would be derived. One manufacturer considered six calibration test points as too few and others were concerned that the words "single blends", when referring to gases, eliminated the possibility of flow blending.

The traceability of all gases to a known standard is a step in the direction of improving not only accuracy within a facility, but also in minimizing lab-to-lab test variability. The comments regarding more than one standard is understandable and does tend to negate the general intent. The possibility does exist that different standard sources, (i.e., NBS, EPA, other) could introduce a potential 2% difference if each source is only adaptable of a $\pm$ 1% analysis. The capability of each manufacturer demonstrating compliance is a procedure that may indeed be difficult to accomplish in the short timeframe remaining for 1978 certification. However, this does not detract from the purpose and need for establishing reliable traceability requirements.

Six is a reasonable number of calibration points for the establishment of a calibration curve. No data or information is available to suggest that this number is inaccurate. However, this is not to say that six points are a maximum.

The ability to flow blend gases appears to be desirable to some manufacturers and the indication of a "single blend" gas is not to inhibit the use of such equipment. The responsibility of accurate blends and traceability, however, cannot be omitted. The capability of calibrating or checking the flow blending apparatus must still depend on a separate gas standard. It would be remiss if it was assumed that flow blending is a substitute for the eliminating of such quality control procedures.

C. Recommendations

1. Traceability to NBS (only) standards should be established commencing with the 1979 certification. This should include the gas tolerance specifications also.

2. The word "single" will be omitted when describing gas blends and a "minimum" of six calibration gases should now be required for calibration of the infrared analyzers.

Issue - "Evaporative Testing at High Altitude"

Starting with the 1977 model year, EPA is certifying vehicles which are sold at high altitude (> 4000 feet) locations. These certification tests are being conducted at Automotive Testing Laboratories, Inc., where the elevation is 5490 feet. The specifications for the gasoline to be used for these tests are identical to the current Indolene test fuel, except for the RVP and D-86 IBP specifications. The RVP and IBP specifications for the current Indolene test fuel are 8.7 - 9.2 psi and 75-85°F respectively. The RVP and IBP specifications for the high altitude test fuel are 7.9 - 9.2 psi and 75-105°F respectively.

A. Summary of Comments

Chrysler - SHED evaporative emission testing at altitude should employ fuels with volatility characteristics similar to typical summer fuel from the Denver area. The high altitude emission test gasoline specifications for RVP and IBP should be 7.5 - 8.4 psi and 90-105°F respectively.

Ford - With respect to the requirement for testing evaporative emission systems at altitude, no data have been generated to show the feasibility of controlling evaporative emissions to a 6 gram standard at altitude. As such, this requirement should be deleted from the regulations until such time as feasibility has been demonstrated.

Nissan - "We have all the test facilities at low altitude and, consequently, all of our development activities and certification tests are being done at low altitude. Therefore, in order to conduct enclosure tests under the high altitude condition, we will have to make a modification to a soak room so that atmospheric pressure can be adjusted. Vast costs and time are needed. It is our thought that enclosure tests under high altitude condition is not reasonable in terms of cost-benefit and, therefore, should not be required."

Toyo Kogyo - "We consider that the evaporative emissions control at high altitudes should be treated separately, or that the EPA should prescribe a test procedure that would allow us to substitute the tests at high altitudes with those at low altitudes. Reasons:

1. We do not yet have enough knowledge about what the evaporative emissions at high altitudes would be like on our systems as compared with those at low altitudes.

2. Depending upon the degree of severity in technology that the evaporative emission control for the high altitudes would require, it would become necessary for us to construct special testing facilities, as well as to establish the control techniques necessary to meet the stringent requirements. This would of course require a considerable amount of time and cost."

B. Discussion

One comment received suggested that the test fuel at high altitudes should have volatility characteristics similar to typical summer fuel from the Denver area. This manufacturer supplied data from the 1972-73 MVMA fuel survey which showed high altitude commercial gasoline to have average RVP and D-86 IBP values of about 8.0 psi and 95°F. However, an analysis of the 1975 MVMA summer gasoline survey shows that the average RVP for the 13 samples taken above 4000 feet (Albuquerque and Salt Lake City) was 9.7 psi for unleaded, and 9.0 for regular grades. Similarly, the average IBP of these samples was 90°F for unleaded and 92°F for regular grade.

To better define the current volatility of commercial gasoline in high altitude areas, the data which Ethyl Corporation supplied the Energy Research and Development Administration (ERDA) for their 1975 summer survey were analyzed. Twenty-four (24) samples of unleaded gasoline from locations above 4000 feet (Albuquerque, Denver, and Salt Lake City) were inspected. The average RVP and IBP of these samples were 8.8 psi and 92°F respectively.

One manufacturer commented that since the technical feasibility of meeting a 6 g standard at high altitudes has not been demonstrated, the high altitude testing requirement should be deleted. Another manufacturer thought that SHED testing at high altitudes would not be desirable based on cost-benefit considerations. However, neither commenter supplied information showing evaporative emission test results at high altitudes, the relationship between evaporative emissions at low and high altitudes, or the cost of systems required for high altitude.

Theoretical considerations do predict higher evaporative emissions as elevation increases. For a non-evaporative controlled vehicle, the estimated increase in evaporative emission between sea level and 5200 feet is about 30%. However, the difference in evaporative emissions for a controlled vehicle is much more difficult to predict. This is because the particular type and capacity of the control system will determine the amount of additional vapor loss as elevation increases. A system which is marginal at low altitude may show a percentage increase which is considerably higher than an uncontrolled vehicle. On the other hand, a vehicle which has reserve capacity at low altitude, might show essentially no increase.

Because of the expected large variation in difference between evaporative emissions at low and high altitudes on evaporative controlled vehicles, it would be difficult to conduct high altitude certification tests at low altitudes and apply a correction factor. Test programs would be required to determine the correction factor for particular types of vehicle-emission control system combinations. This would likely require more effort than conducting certification tests at high altitudes.

C. Recommendations

1. No change should be made to the current proposed regulations in regard to high altitude testing.

2. The current test fuel being used in Ann Arbor should also be used at high altitude.

Issue - SI Units

The proposed regulations incorporated many SI conversions to aid the user.

A. Summary of Comments

Volkswagen - The orderly transition to the metric system will help to facilitate the work of the engineers and will improve the information. The presentation of SI-units in the sections of the proposal should aid this task.

But this goal cannot be obtained if there are given only the arithmetically translated values in SI-units. The conversion of the numbers should pay regard to the allowable ranges, to the equipment tolerances, and to the importance of the given values. Furthermore all derived units should be included. The numbers should be rounded to set practicable values. Approximate values in US-units should be approximate in SI-units too.

B. Discussion/Recommendation

Incorporating metric conversions is a difficult problem due to rounding errors. A test procedure is written in one set of units with the other included as a conversion, solely for the convenience of the user. In order to insure that both units give the same physical quantity the metric number generally has more significant figures or is not an even quantity. For example 100 yards in the regulations would be expressed as 100 yds (91.44 meters). Any simpler metric expression would not give the same physical quantity.

Issue - California Procedures

A. Summary of Comments

Chrysler - One of the key elements to be included in any new evaporative emission regulation is to insure that the final test procedures, equipment and methods are consistent, compatible and for all practical purposes identical with that required in California. As noted in the Senate Report regarding the California preemption provision, "It is essential that the Federal Government and the State of California cooperate closely in the development of enforcement procedures so that industry, when confronted with different standards, need not be faced with different methods of obtaining certification." The EPA has recognized this requirement in prior rulemaking and Chrysler believes that the agency should take the steps necessary to make sure that the new Federal and California evaporative test procedures for certification are identical.

B. Recommendations

The California waiver should be revoked when these regulations are promulgated. The standard proposed is the same and no purpose will be served by having two separate procedures.

Issue - Miscellaneous Comments and Changes to Regulations

Many manufacturers commented or offered suggested wording changes on various minor points in the regulations. These will be presented in the same order as the regulations with EPA response to each point.

§86.078-26 Mileage and service accumulation; emission measurements.

A. Summary of Comments

Fiat - The reference §86.078-24(c) is not appropriate because this paragraph regards the "durability data vehicles".

Toyota - Section 86.078-26(A)(3)(i) specifies emission data vehicles. This section requires that the vehicles selected for the durability test perform the complete exhaust emission and evaporative emssion tests at 4,000 miles. This, we feel, is quite an unreasonable requirement. Durability data vehicles should be subject to Section 86.078-26(a)(4)(i).

B. Discussion/Recommendations

The commentors are correct, the reference is wrong and should be changed in the final regulation.

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B. Discussion/Recommendations

The commentors are correct, the reference is wrong and should be changed in the final regulation.

§86.107-78 Sampling and analytical system, evaporative emissions.

A. Summary of comments

Chrysler - If external wall cooling is permitted, cooling methods should be defined with provision that internal SHED surfaces should not be cooled below 65°F to prevent condensation. To further improve repeatability, SHED materials, their thermal gradients, and major details of construction should be specified.

The minimum full scale measuring sensitivity (range) of the SHED FID should be increased from 5 to 10 ppm propane. NBS gases below 5 ppm propane are not available with $\pm$ 1% accuracy.

Also, it would be difficult to provide enough ranges that any reading would fall within the upper 80% of the range in use. It is suggested that statement should be changed to the upper 50%.

GM - The sample system to be used by EPA should be described. For example, the sampling system may include a path for returning FID bypass flow to the enclosure. This is of particular importance in facilities that continuously monitor the concentrations in the enclosure. A statement that the enclosure design must pass all performance tests as specified in 86.115-78 is needed. Such a statement would obviate the necessity for much verbiage. Provision for allowing alternate techniques such as an internally located heat exchanger and blower to assist in maintaining enclosure temperature should be included. The requirement that the enclosure accommodate the largest vehicle to be tested is trivial.

It is recommended that selection of ranges be left up to the discretion of the laboratory, that will select ranges based on their ability to meet certain required performance specifications. It is desirable to express these performance specifications as a function of the emission standard for which the analyzer is to measure. It is suggested that 86.107-78(a)(2) be changed to read as follows:

> Evaporative emission hydrocarbon analyzer. A hydrocarbon analyzer utilizing the hydrogen flame ionization principle (FID) shall be used to monitor the atmosphere within the enclosure. The FID shall be capable of meeting certain performance requirements for the measurement of blends of zero air and propane in air. Some of these requirements are expressed as a function of C_{std}, which is that level of enclosure hydrocarbons corresponding to an emission level equal to the evaporative emission standard.

(1) Stability of the analyzer shall be better than 0.01 C_{std} ppm at both zero and $C_{std} \pm 5$ ppm over a 15-minute period on all ranges used.

(2) Repeatability of the analyzer, expressed as one standard deviation, shall be better than 0.005 C_{std} ppm at both zero and $C_{std} \pm 5$ ppm on all ranges used.

(3) Speed of response of the analyzer to 90% of final reading shall be less than 1.5 s when the analyzer is connected to span gas as prescribed in paragraph 86.112-78(c).

B. Discussion/Recommendations

The revised section shown above under GM's comments should be adopted. It has addressed the manufacturers comments as follows:

1. The language is simplified to eliminate redundancy.

2. Continuous recording of hydrocarbons, manual marking of the test record and additional cooling (68°F/20°C minimum) are all specifically permitted.

3. FID analyzer performance specifications have been substituted for the range and accuracy requirements previously used.

4. Chrysler's comment on the number of FID ranges appears to be confused. The NPRM required readings to "fall <u>within</u> the upper 80%"; Chrysler suggested 50% as a looser but adequate tolerance. To clarify, the proposed language is revised to permit readings "between 20 and 100% of full scale".

§86.109-78 Exhaust gas sampling system.

A. Summary of Comments

Chrysler - The CFV-CVS component description. Figure B78-2, does not show the exhaust gas sampling system for diesel HC analysis. This should be included in Figure B78-2.

Ford - Temperature variations for the critical flow venturi (CFV) should be limited to ± 20°F (11.1 C). The ± 10°F gas mixture variation specified in 86.109-78 (b)(2) for a positive displacement pump (PDP) will produce the same magnitude of variation that a ± 20°F variation produces in a critical flow venturi (CFV). In a positive displacement CVS pump, the mass flow rate is a first order power function of the absolute temperature, whereas, in a critical flow venturi CVS, the mass flow rate is a function of the square root of the absolute temperature. Because the allowance temperature range of a CFV is twice that of a PDP, there is no reason to specify a temperature response time for a CFV temperature sensor and not specify a response time for a PDP temperature sensor.

GM - The critical flow venturi system is not a constant volume sampler since sonic velocity varies with temperature and pressure and those characteristics of the bulk stream are not controlled. Temperature and pressure must be continuously monitored and used to continuously calculate flow which is summed or integrated over the test period to be correct. This designation (CFV-CVS) should be amended throughout the NPRM.

Pressure and temperature instrumentation which meets the accuracy and precision requirements as stated (± 2°F; ± 3mm Hg) is expensive and of questionable reliability. EPA should provide data to show the basis for requiring this quality of instrumentation.

The lack of equipment for testing diesel powered vehicles in Figure 2 implies that the CFV system is not approved for diesel testing. The NPRM should so state specifically if that is the case.

B. Discussion/Recommendation

The systems identified in this section are ones which have been used by EPA. (as specifically stated in paragraph (a)(3), other systems yielding equivalent results may be used by manufacturers if approved by EPA)). All specifications and equipment arrangements in the NPRM were taken from EPA practice.

Essentially, both the venturi and pump are metering devices. If fed air at a constant pressure and temperature, a constant mass will flow through them. These devices operate at close to atmospheric pressure so pressure variations are not a problem. However, even if the dilution air is held to a constant temperature, the vehicle exhaust temperature and volume varies during the driving cycle. In the depicted systems, this problem is handled in two ways. The PDP uses a heat exchanger to maintain constant temperature while the CFV has electronic circuits to calculate flow temperature (and pressure) variations.

GM's comment that the CFV is not strictly a constant volume sampler is technically correct. Any change in temperature causes a change in the sonic velocity which changes flow. However, this is also true for the PDP and no objection is made to the term in that case. True, a heat exchanger is used ahead of the pump, but some variations do occur. In the CFV system used by EPA, these variations are compensated for by the electronic system. Although neither system is perfectly constant, the term is fairly descriptive of the system's function.

Diesel testing is slightly more complex than for gasoline fueled vehicles. Due to the nature of the fuel exhaust, hydrocarbons must be measured continuously using a heated detector with sample pick-up close to the tailpipe inlet. The heated detector has its own sample pump. With a CFV, it is possible to have a varying flow through the main venturi, but a constant flow for hydrocarbon analysis. The hydrocarbon measurement would not be strictly proportional to the dilute exhaust stream. (Other pollutants are sampled with a smaller venturi and flow integrated into a sample bag. That is a proportional sample). Possibly, natural temperature fluctuations would be within tolerances to give an essentially proportional sample. Or, the CFV could be used for testing diesels if it was equipped with a heat exchanger.

The section has been slightly revised to include the theory of operation. Examples of acceptable alternate systems are given. Diesel sampling has been specifically addressed.

§86.110-78 Exhaust gas analytical system.

A. Summary of Comments

GM - The inclusion of diesel test instrumentation with the description of the analytical system for gasoline-powered vehicles implies that the Administrator might test both types of vehicles with the same sampling system. General Motors objects to having its gasoline-powered vehicles tested using the same sampling and analytical system as used for diesels. The potential for hang-up and contamination has not been fully determined. The following wording is suggested to define the heated FID response time: "The response time of this instrument shall be less than 1.5 seconds for 90% of full scale response to a span gas as prescribed in paragraph 86.112-78(c).

B. Discussion/Recommendation

EPA has not investigated possible hang-up problems from diesels, a preliminary test on two-cycle motorcycles did not reveal any problems. It is expected that diesel LDVs and LDTs will not cause difficulties since their emissions are much lower than two-cycle motorcycles.

GM's second point is somewhat confusing. The original language that GM objected to is almost identical: "The response time of this instrument shall be less than 1.5 seconds for 90 percent of full-scale response." The only difference is that response time must be measured using a span (as opposed to a calibration) gas. Certainly use of a span gas is acceptable and intended. The original language permits what GM requests, no change is necessary.

It is recommended that no changes be made in response to these comments.

§86.112-78 Analytical gases.

A. Summary of Comments

GM - The paragraph dealing with NOx analyzer gases requires clarification: "§86.112-78(a)(3) Gases for NOx analyzer shall be single blends of NO named as NOx with a maximum NO_2 concentration of 5 percent of the nominal value using nitrogen as the diluent." General Motors suggests that the wording be as follows: "Gases for the NOx . . . be single blends of NO, named as NO and NOx with . . . diluent." Rewording will avoid confusion since paragraph 86.120-78(b)(3) requires NO in N_2 for calibration while clearly indicating that the allowable maximum concentration of NO_2 is not exceeded.

B. Discussion/Recommendation

The gas mixture referred to in §86.120-78(b)(3) need not be a calibration or a span gas, since it is only used to determine the conversion efficiency of the NO_2 to NO converter. There is no purpose in naming the calibration gases as NO as well as NOx, and therefore, it is recommended to retain the proposed language.

§86.114-78 Calibrations, frequency and overview.

A. Summary of Comments

Fiat - On the basis of its experience, Fiat deems that it is sufficent to check monthly the oxides of nitrogen converter efficiency and to perform monthly the CVS system verification.

B. Discussion/Recommendation

EPA disagrees with Fiat's statement that monthly NOx efficiency checks and CVS verifications are sufficient. With the lower levels of emissions from late model cars, it is necessary that these items be checked at least weekly; a month is too long to let any problem go unnoticed.

§86.116-78 Dynamometer calibration.

A. Summary of Comments

Ford - Paragraph (a) as proposed could be deemed to be contradictory. The middle of the paragraph states that other calibration methods that yield equivalent results may be used, but the last sentence states that, "These procedures shall be followed." The inertia of the free (rear) roll, rather than the difference in coast-down time between the free (rear) roll and the drive (front) roll, is the parameter which is actually neglected. The regulations should reflect this.

Paragraph (b) is too restrictive. Manufacturer should be allowed to make more than one check.

GM - General Motors feels strongly that a monthly calibration should be required. Addition of a weekly performance check is desirable, but several inertias and horsepower settings should be required. We suggest rewording paragraph (a) as follows: "The dynamometer shall be calibrated at least once each month and performance verified at least once each week . . . If the load observed during the performance verification is not within $\pm$ 0.5 hp of the specified value, the dynamometer should be recalibrated." General Motors suggests rewording of paragraph (b) as follows: "The performance check consists of conducting a dynamometer coast down at inertia weights and horsepower settings that cover all basic inertia weights . . ." While it is recognized that these rules establish a minimum requirement and that manufacturers may do more than what is required, the comments on (a) and (b) are intended to increase the attention paid by all laboratories to the critical calibration of dynamometers.

B. Discussion/Recommendation

The language should be revised as suggested by Ford. This procedure reflects current EPA practice and is deemed to be sufficient at this time.

§86.117-78 CVS calibration.

A. Summary of Comments

Chrysler - The calibration data measurements itemized in (a)(4) include the parameter "Air temperature into LFE" with a tolerance of $\pm$ .1 F. Equipment normally used to measure this parameter cannot meet this tolerance. It is suggested that the tolerance can be relaxed to $\pm$ .5°F without losing accuracy.

Fiat - Measurements of the CVS pump pressure differentials made with two pressure taps mounted at the top center and bottom center of the pump drive headplate, are meaningful only if they are carried out simultaneously. In the proposed procedure, the two pressure values are measured at different times: therefore, because measurements are not carried out simultaneously, it is not assured that the differential of the two pressure measurements be truly the pressure differential in the pump cavity. In addition, having to use a damper, due to the different modulation of the pressure depression wave form there is the risk of carrying out wrong measurements. On the basis of Fiat experience six data points do not constitute a minimum sufficient for the calibration. A minimum of ten data points is deemed necessary for a correct calibration. The second phrase, §86.117-78 (a)(8), beginning "The calibration curves generated . . ." should be deleted because it is meaningless. In fact, if the Δ P pressure differential is zero, all "Do" points should coincide and correspond with the geometrical displacement of the pump.

GM - General Motors suggests that EPA engage in exchange of technical information on "CVS calibration" techniques and equipment. Calibration standards, equipment specifications, and traceability are of major concern.

VW - The same difficulty with propane densities discussed under SHED calibration occurs with CVS verification.

B. Discussion/Background

As suggested by Chrysler, the temperature tolerance for LFE inlet air during calibration can be broadened. However, the tolerance permitted is $\pm$ 0.25°F, not the $\pm$ 0.5°F requested.

Volkswagon's comment is rejected for the same reasons given in the discussion of SHED calibration.

EPA has used the described calibration procedures for a number of years without difficulty. They are essentially the same procedures as outlined in the Appendix to Part 85. Changes desired by Fiat are not deemed necessary. However, if desired for their particular equipment, Fiat can request to use alternate methods. Of course, any manufacturer is permitted to use more than the specified number of data points in a calibration. The regulations state this explicitly.

§86.118-78 Hydrocarbon analyzer calibration.

A. Summary of Comments

British Leyland - Current practice is to draw the straight line between zero and the top point. Is this still current practice, or do we now use the least squares best fit method? The latter is preferred.

Fiat - For what gasoline fueled light duty vehicles and trucks are concerned, requirements of points (3) and (4) are not justified. Considering the prescribed dilution values of the CVS, the O_2 concentration in the three sample bags is never below 10-15 percent.

Ford - The hydrocarbon detector should be optimized monthly. Alternate methods yielding equivalent results should be permitted.

GM - Annual optimization of the FID is not acceptable. General Motors recommends the optimization be done after any maintenance of capillaries or the burner occurs. In addition, semi-annual optimization should be required. The method described for peaking or optimizing analyzer response is outdated. General Motors suggests that an alternate procedure be allowed if approved in advance. The alternate procedure that General Motors would propose is based on the FID section of SAE J254 which is currently being revised to adopt state-of-the-art knowledge of the FID.

General Motors would appreciate the opportunity to work with EPA to develop a short diagnostic test to check oxygen response of the FID analyzers on a regular basis, perhaps as a part of monthly calibration checks on the analyzers.

General Motors feels that §86.118-78(b) is too demanding. The FID hydrocarbon analyzers should be checked for oxygen response only in the range of oxygen content of the gas mixture being measured. The only FID which measures gas mixtures containing a wide range of oxygen is that used for diesel testing. The FID analyzers used for the evaporative measurements are sampling a mixture of HC and air. Oxygen response is obviously of no concern. Gas mixtures found in bags collected from the exhaust of gasoline fueled vehicles contain oxygen levels such that insignificant errors occur, particularly if the excellent FID practices described in the previously referenced revisions to SAE J254 are observed.

B. Discussion/Recommendation

No curve fitting method is specified. This has been addressed in the fuel economy regulations.

EPA agrees that it is not necessary to measure oxygen interference over various oxygen concentrations. This requirement should be deleted.

Equivalent alternate methods of FID calibration should be permitted.

§86.119-78 Carbon monoxide analyzer calibration.

A. Summary of Comments

British Leyland - Since all NDIR analyzers are substantially non-linear, we need a ruling in the number of inflection points allowable in the use of an "nth" order polynomial curve fitting technique.

Fiat - To our experience, the use of techniques like "best-fit line" or "best-fit non-linear equation" is cause of complications. Results obtained with the "best-fit non-linear equation" do not appear so reliable as those obtained with the "best judgment" method. In consideration of the importance of the question, in our opinion, EPA should exemplify the methods followed for the calibration of its instruments; in addition, EPA should also allow the Manufacturers to continue using the "best judgment" method.

GM - General Motors recommends the following wording for paragraph (a)(1): Adjust the analyzer to optimize performance on the most sensitive range to be used. Paragraph (b)(3) changes the number of required calibration gases from those required to test to 1977 regulations. Since running changes overlap into the following certification year, some provision should be made to make these requirements for 1978 supersede the 1977 regulation at some point in time. As a general comment, there are several areas of the NPRM where the point at which regulations cease to apply and new ones take over should be clarified. Each instance should be considered on its own merits rather than apply a blanket ruling.

B. Discussion/Recommendation

The regulations give the manufacturer some latitude in selecting calibration curves. At this time it is not necessary to be more specific than to require good engineering judgment.

The reduced number of calibration gases will not have any significant impact on test results. The transition period will be addressed in an Advisory Circular.

§86.122-78 Calibration of other equipment.

A. Summary of Comments

GM - General Motors recommends that monthly calibration of the barometric pressure measuring system and the humidity measuring system be required. Further, all temperature measuring equipment should receive monthly calibration checks.

B. Discussion/Recommendation

Calibration of other equipment must be done according to the manufacturer's recommendations. This is sufficient.

§86.131-78 Dynamometer procedure.

A. Summary of Comments

Fiat - The procedure specifies the cooling conditions of the test vehicles during the dynamometer operation. These conditions are not realistic, because the operation on the dynamometer does not reproduce exactly the ventilation conditions met by the vehicles on the road. In fact, Manufacturers are allowed by EPA to use additional fans. However, in our opinion, the procedure prescribed to obtain this permission is very complicated. In fact, in order to use additional fans, Manufacturers are requested to be able to show that during field operation the vehicle receives additional cooling. This means that for any model of their product line, Manufacturers have to measure the real cooling conditions, reproduce these conditions on dynamometer in order to define the additional fans types which are needed to provide a representative test. The request of additional fans must be made already during the phase of the definition of the emission control systems, because the Manufacturers have to know apriori if EPA approves the additional cooling. In consideration of the complexity of the procedure, Fiat deems, therefore, that a revision of the rule on this matter is needed.

GM - Reword to include measurement of carbon dioxide dilution air levels.

VW - A manufacturer may be allowed to apply "additional vehicle cooling during the dynamometer operation" if he "can show that" it will be "necessary". This provision will charge solely the manufacturer with the burden to demonstrate the faultiness of the test procedure again for each type of evaporative control device. This situation is felt to be not acceptable from a legal point of view. To simulate road conditions, a specification of the maximum allowable temperature difference between road measurements and dynamometer run is necessary. An approved procedure to determine the reference temperatures has to be established by cooperation of both the EPA and the manufacturers.

B. Discussion/Recommendation

The regulations should include a requirement that dilution air CO_2 be measured. This was apparently an oversight in previous regulations.

The requirements to obtain additional cooling are unchanged from previous regulations. No change is necessary at this time.

EPA is currently evaluating road load. A revised procedure will appear in the fuel economy package.

§86.133-78 Dynamometer test runs.

A. Summary of Comments

Fiat - It is not clear the meaning of "the standby position". We suppose that it is from "dump position".

B. Discussion/Recommendation

Fiat is correct. The term was changed to promote clarity.

§86.135-78 Exhaust sample analysis.

A. Summary of Comments

GM - Span gases having concentrations between 75% and 100% should be allowed.

B. Discussion/Recommendation

This is a good recommendation and the regulations should reflect it.

§86.138-78 Calculations, exhaust emissions.

A. Summary of Comments

Ford - The following technical changes are needed in paragraph (c)(3) and (5):

(3) Where

$CO_e = (1 - 0.01925\ CO_{2e} - 0.000323R)\ CO_{em}$

The above equation is to be used only if the CO analyzer used in performing the analysis is equipped with conditioning columns. Other conditions require direct substitution of CO_{em} for CO_e.

(5) Where

Tp = Average temperature of dilute exhaust entering positive displacement pump or critical flow venturi during test, R(K).

GM - The emission equation should be modified to show distance traveled during the test, not a constant 7.5 miles. Distance traveled should be calculated using the front roll circumference and number of revolutions of the front roll observed during the test. In paragraph (c), the following changes should be made:

P_4 should be specified as the average pressure depression

T_p should be specified as the average temperature

This paragraph should also include a method for determining V_{mix} for the CFV system. Continuous or instantaneous values should be computed and the results averaged to a final value.

VW - The formulas for NOx correction factor in SI-units should be corrected:

Using the conversion factors:

1 grain = 0.0648 g

1 pound = 0.4536 kg

the formulas will read:

$$k_H = \frac{1}{1-0.0329\ (H-10.71)}$$

$$H = \frac{6.211 \cdot Ra \cdot Pd}{P_B - (Pd \cdot \frac{Ra}{100})}$$

B. Discussion/Recommendation

The rewordings suggested are not necessary and should not be instituted. Actual distance measurement is being proposed in the fuel economy regulations. VW's recommended NOx correction factor is correct and should be used.