Regulatory Support Document
- Section 207(b) NPRM

by

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Office of Mobile Source Air Pollution Control
United States Environmental Protection Agency

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1. Introduction

Section 207(b) of the Clean Air Act provides the Administrator with authority to impose certain warranty conditions upon the motor vehicle and engine manufacturers when he determines that (1) there are available testing methods and procedures that can be used to determine whether in-use vehicles are in compliance with section 202 throughout their useful lives, (2) such testing procedures and methods are in accordance with good engineering practices, and (3) such testing procedures (hereinafter called 207(b) short test (ST)) are reasonably capable of being correlated with tests conducted under section 206(a) (hereinafter called the FTP).

Once these three criteria have been fulfilled, the Administrator can establish the procedure by regulation, and upon the availability of testing facilities, vehicle and engine manufacturers will be required to warrant their emission control devices or systems to the owners of these products. The warranty under these regulations requires the manufacturer to correct, without cost to the owner, any faults in the power-plant and/or emission control systems which caused the vehicle or engine to fail the applicable emission standards, provided that (1) the vehicle has been operated and maintained in accordance with the instructions furnished by the manufacturer at the time of new vehicle purchase and

(2) the failure of the vehicle to pass the applicable emission standards results in a penalty or sanction against its use.

The warranty provisions provide protection for vehicle owners against bearing the costs of vehicle repairs resulting from manufacturer's error when that error results in penalty or other sanction to the vehicle owners.

The determination of test availability, good engineering practice, and correlation with the FTP have been the three major objectives of the Office of Mobile Source Air Pollution Control (OMSAPC) 207(b) program. The other requirements of section 207(b), including prescribing of warranty regulation and determination of the availability of inspection facilities, are being addressed by other EPA program offices.

Prior to FY75, sufficient data to evaluate test availability and correlation were not available. While some vehicles were tested using the FTP and selected short tests, the vehicles tested did not have advanced emission control systems. Since Section 207(b) applies to future models only, it is critical that the test or tests selected as 207(b) tests continue to fulfill the correlation requirement as new control systems are introduced.

In early FY75, a testing and analysis program was developed to address this need. The program collected emission test data on all types of available production vehicles over a range of operating conditions. Analytically, several methods were examined for defining correlation. The information presented and analyzed in this report is based on these studies, which have been ongoing since FY75.

The objective of this document is to provide answers to the following broad questions and to adequately address the issues contained therein.

1. Based on all vehicle testing to date, have short tests been identified that fulfill the three requirements for a 207(b) test?

2. How should "reasonable correlation" be defined?

3. How can the benefits of a 207(b) test be evaluated?

4. What future work would be needed to continue to support implementation of Section 207(b)?

Section 2 presents a short summary of the project along with a summary of conclusions, recommendations and open issues. Following the conclusions, section 3 of the report discusses the design of the ongoing test programs. Included are detailed discussions of test procedures and instrumentation. Section 4 discusses the analytical techniques used to interpret the data. The selection of a technique is influenced by the definition of reasonable correlation. Section 5 addresses the benefits associated with 207(b) implementation. The difficulty of isolating 207(b) benefits from inspection/maintenance benefits is of key importance. The last section discusses anticipated technical objections to the NPRM as well as unresolved technical and policy issues.

2. Summary of the 207(b) Project and Related Issues

This document has been prepared in support of the NPRM for the implementation of Section 207(b) of the Clean Air Act. The document deals primarily with the technological issues involved but also identifies key policy issues which need to be resolved.

2.1 Summary

The technological test procedures for determining emissions by short tests and the methodologies to establish 207(b) short test cutpoints (the numerical values used to predict whether vehicles would pass or fail the Federal Test Procedure) have been identified and have been determined to meet the requirements of the Clean Air Act on the basis of data acquired through experimental programs conducted under well-controlled laboratory conditions. The determination of specific short test cutpoints obtained under real world as compared with laboratory conditions still needs to be performed. A program to examine this issue, to be carried out in the State of Oregon, is in the procurement phase with the proposals having been submitted. The second week of December, 1976, is projected for contract signing. The data obtained from this program will be applied to the generation of future 207(b), cutpoints.

Potential obstacles to implementing 207(b) relate to the extensive resources that may be required annually by the Agency to establish

207(b) cutpoints for new models, and the possibility that adequate correlation may not exist when the short tests are run under real world conditions.

2.1.1 Availability of Test Methods and Procedures

Since the 207(b) test must be capable of being carried out at minimal cost, the available tests are limited to short tests that are simple and quick to perform with minimum instrumentation and equipment requirements. The tests evaluated for availability included:

(1) Idle test - The raw exhaust gas is measured with simple instrumentation to determine HC and CO concentration in the raw exhaust gases with the engine in an unloaded condition. Procedural variations of the idle test studied included running the test with the automatic transmission in neutral vs. drive, and idle speed at normal RPM speed vs. high RPM with the transmission in neutral. NOx concentration cannot be meaningfully measured at idle since NOx emissions are insignificant under idle conditions - an important limitation of the idle test. The idle test has been the predominant inspection test procedure utilized in currently operational state programs.

(2) Steady State Modal Tests. (Federal 3 Mode and Clayton Key Mode)* - The raw exhaust gas is measured with simple instrumentation to determine HC, CO, and NOx concentrations while the vehicle is driven under prescribed load conditions at two different speeds and at idle. A dynamometer is used in this test to simulate non-varying speed and load conditions. Procedural variations of the tests involve the severity of the loads and speeds simulated. The Clayton Key Mode test is currently being evaluated by the States of Arizona and California.

(3) Transient tests. (Federal Short Cycle and NY/NJ Composite) - A sample of the dilute exhaust gas (a CVS unit is used) is collected in a bag while the vehicle is driven on a dynamometer to simulate a driving cycle that includes acceleration, deceleration, and cruise modes. In theory a large number of different transient tests are possible, to correspond with different driving cycles; however, in practice only two cycles have been studied: (1) a composite of the N.J. ACID test and the N.Y. Short Test and (2) the EPA Short Cycle developed by OMSAPC. The sample accumulated in the bag is analyzed for HC, CO, and NOx concentration. The concentration values measured are converted to a mass (gm/mile) basis. At present no state is using or contemplating the use of such a test.

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* The Clayton Manufacturing Company has applied for patents on the Key Mode emissions test procedure and has stated its intent to charge fees for use of the diagnostic information provided with the test results. The status of the patent and the extent to which it applies to other steady state modal tests is unknown at this time.

While all three types of tests are available in the laboratory setting, the idle test and the steady state modal tests have been used in state I/M programs and would thus be able to trigger the 207(b) warranty as soon as it is promulgated. Because of the differences in equipment, manpower requirements and time required to conduct steady state modal tests over the idle test the choice between these two tests is dependent upon the incremental improvement in accuracy and correlation derived by the steady state modal tests. The transient tests although defined and available, have never been implemented in a state I/M setting, presumably because of the significantly greater demands upon personnel and the sophisticated equipment needed. To the extent that significantly greater correlation and/or benefits can be shown for these tests when compared with simpler tests, states may choose to implement these tests either as I/M tests or as a follow-up test for a vehicle failing the I/M test which is covered by the 207(b) warranty.

2.1.2 Good Engineering Practice

The criterion of good engineering practice must be resolved in terms of whether the tests can (1) be conducted with reasonable demands upon test personnel and equipment and (2) can yield reasonably accurate and reproducible results when the test is performed as specified. On the basis of the results of laboratory tests of all five of the test procedures evaluated to date and since under reasonable quality control conditions test result variations can be held within acceptable limits, these five tests can be judged to conform to good engineering practice.

OMSAPC is evaluating commercially available HC, CO, and NOx instrumentation, working with an instrument trade association to make available calibration gases to state authorities, and consulting with dynamometer manufacturers to assure the availability of dynamometers at reasonable cost. The results of these efforts will augment the information currently available for determining that a short test meets the requirements of good engineering practice.

2.1.3 Correlation with the FTP

The requirement that the 207(b) test reasonably correlate with the FTP test has proven to be the most difficult and controversial task in the OMSAPC 207(b) program. A short test must be performed in a short time on a fully-warmed up vehicle, is limited at best to a very few vehicle speed/load conditions, and will be performed under a wide range of environmental conditions (i.e., temperature, humidity, human factors and instrument factors which are either uncontrollable or under limited control). Conversely, the FTP is performed with a cold start, includes a very large number of vehicle speed and load conditions simulating a typical stop and go urban commutation, and is performed under closely controlled laboratory environmental conditions (temperature and humidity are rigidly controlled and test personnel are under engineering quality control supervision).

It was anticipated that the short tests would not correlate with the FTP in a classical statistical sense, i.e., no short test is capable of a reliable and consistent prediction of the FTP mass emissions. The extensive fleet tests by OMSAPC verified that the Pearson statisitcal correlation coefficients were low (generally less than 0.8), indicating unacceptable correlation.

However, there is consensus within EPA that the Clean Air Act requirement of "reasonable correlation" is met if the short test is capable of reliably and consistently predicting whether the vehicle would pass or fail the FTP even if it can not give the magnitude of the passing or failing margin. The reasonableness of such correlation depends on the ratio of incorrect predictions to correct predictions. In the case of the 207(b) test the incorrect predictions are of two types, each with significantly different consequences. An error of commission (i.e. the short test incorrectly predicts failure for a vehicle that really passes the FTP) would cause a vehicle which conforms to all Federal emission requirements to be repaired under warranty at some cost to the manufacturer. It is possible, however, that air quality benefit may still be obtained from vehicles which are in conformance with the emission standards at the time of failure; vehicles in a good state of tune can often emit at levels substantially below the emission standards, especially at low mileage. An error of omission (i.e. the short test incorrectly passes a vehicle that would fail the FTP) has no cost impact on the manufacturer but represents a lost opportunity for air quality improvement.

By varying the severity of the short test cutpoint (i.e., the numerical value used to predict passing or failing on the FTP) it is possible to reduce errors of commission to any desired level, but always at the cost of increasing errors of omission.

Although no specific policy guidance regarding what would be an acceptable error of commission rate was provided to OMSAPC, the original concensus within EPA was that a primary goal had to be the minimizing of errors of commission, since the costs associated with such errors would lead to strong objections to I/M programs by both manufacturers and consumers. Conversely, it was generally recognized that errors of omission have to be kept reasonable to avoid the impact of the I/M program on air quality being marginal and the cost/benefit ratios being unacceptably low. In the absence of policy guidance, OMSAPC determined that an overall error of commission rate of no more than 5% of the total vehicle population would be reasonable based upon known test variability.[1/] Similarly, it was assumed that high omission error rates could be tolerated as long as total vehicle test failure rates no <u>less</u> than those experienced

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[1/] Setting the short test cutpoint on the basis of a fixed error of commission rate does not, however, guarantee that all manufacturers of groups within a manufacturers product line are treated equally, i.e. the same error of omission rate does not exist for all products for a fixed error of commission rate. This situation was brought to light with the very latest data available from the 300 car test fleet and indicates an inequity. This inequity is discussed fully in Section VI and alternative procedures are proposed.

in current I/M program could be maintained (10-30%). It must be noted, however, that error of commission rates of 5% based upon commissions in the total population could result in a much higher percentage if expressed in terms of the population of vehicles which are failed by the short test.

The major technical effort within OMSAPC for the past two years has involved extensive fleet testing to acquire test data for the purpose of developing the above correlation concept. The fleets have involved 150 vehicles of 1974 vintage, a 50 car fleet of identical 1973 model year catalyst-equipped prototypes, a 5 car fleet of catalyst vehicles for defect testing, and 300 [2/] in-use 1975 catalyst and non catalyst vehicles from the FY74 emission factor program. Each vehicle in each fleet was subjected to a full spectrum of short tests as well as the FTP [1/]. With the exception of high altitude vehicles in Denver, testing and analysis of all of the data from these projects has been completed.

1/ The purpose of the test and analysis program was to develop correlation data as a function of FTP vs each short test for:

- (a) each pollutant separately and combined
- (b) general population vs. individual manufacturer
- (c) laboratory instruments vs. garage type instruments
- (d) different weight classes of vehicles
- (e) different engine displacements

2/ Referred to elsewhere in this document as "the 300-car test fleet" or "300-car test data". The actual number of vehicles selected and tested in 4 cities exceeded 400, but approximately 100 of these were tested at high altitude. Consequently, their test results are not included in the analysis presented here.

2.2 Summary of Conclusions

2.2.1 The short tests

1. No short test provides perfect correlation with the FTP; that is, no short test is able to consistently predict the exact FTP emission levels for the majority of vehicles.

2. For purposes of the NPRM the agency can specify a number of short tests and methodologies for establishing short test cutpoints that will meet the availability, good engineering practice, and correlation requirements of the Clean Air Act.

3. Under laboratory conditions, short tests which follow a non-steady state driving trace (the Federal Short Cycle and the New York/New Jersey composite test) show a higher degree of correlation than do the steady state modal tests (the Federal 3 Mode and the Clayton Key Mode) or the idle test. The idle and steady state tests, however, require much simpler and less costly equipment to implement and are substantially less sensitive to errors made by inspection station personnel and to small discrepancies in instrument accuracy.

4. The most practical [1/] short test at low elevations for hydrocarbon and carbon monoxide emissions is the idle test while the most practical test for oxides of nitrogen is the high speed mode of either the Federal 3 Mode or the Clayton Key Mode.

5. The short tests which can be considered to meet the Clean Air Act requirements for correlation with the FTP are the Federal Short Cycle, the Federal 3 Mode, the New York/New Jersey composite, the Clayton Key Mode and the idle tests. If the data trends continue as in the past, the Federal 3 Mode and the Clayton Key Mode tests may be capable of being shortened to two mode tests, i.e. idle and high speed modes.

2.2.2 Manufacturer, vehicle, engine size cutpoints

6. The limited amount of data available indicate that short test correlation may vary with the manufacturer of the vehicle being tested. It must therefore be concluded that the short tests may have different response characteristics to differences in technology than does the Federal Test Procedure. An example of this is given below from the 300 car fleet where a 5% error of commission (E_c) cutpoint was established based

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[1/] Practicality is judged on the relative ability of these tests to correctly identify failing vehicles while controlling implementation costs and minimizing the effects of testing errors. The assessment of practicality assumes that the 207(b) warranty applies to each vehicle's participation in a state I/M program.

on the entire fleet within one engine size class. The short test cutpoint was then used to examine manufacturer specific error rates.

Carbon Monoxide

A Comparison of the Effects on E_c, E_o, FF, PP and $(E_c+FF)/(E_o+FF)$ of individual manufacturers as a result of grouping by engine size.

Data used was from 260 CID and larger engines, idle mode test, $E_c = 5\%$

Manufacturer	E_c	E_o	FF	PP	$\frac{E_c + FF}{E_o + FF}$ 1/
All	5.0	17.8	42.1	35.1	.79
GM	3.0	20.1	34.4	42.5	.69
Ford	13.0	9.4	52.1	25.5	1.06
Chrysler	8.6	5.2	77.8	8.4	1.04

Where:

E_c - percent of total sample which fail the short test but not the FTP

E_o - percent of total sample which fail the FTP but not the short test

FF - percent of total sample which fail both the FTP and the short test

PP - percent of total sample which pass both the FTP and the short test

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1/ Short test rejection ratio = $(E_c + FF)/(E_o + FF)$ and denotes the number of vehicles failed by the short test, $(E_c + FF)$, as a fraction of the number of vehicles which failed the FTP, $(E_o + FF)$. When this ratio is greater than unity, the manufacturer is being forced to repair <u>more</u> vehicles than he should.

The conclusion which is drawn in this example is that the short test cutpoints as determined are not stringent enough for GM and are too stringent for Ford and Chrysler.

7. Data have shown that short test emissions levels are dependent on the vehicle and engine size. A single short test standard for all vehicles by model year is, therefore, inappropriate if the optimum air quality benefit is to be realized through I/M and if all manufacturers are to be equitably treated under Section 207(b). An example of this is given below from the 300 car fleet. HC and CO cutpoints were determined for the idle test while NOx cutpoints were determined for the high speed mode of the Federal 3 Mode. A 5% E_c level was used for each pollutant.

Engine Size	Short Test Cutpoints for 5% E_c for each Engine Size. Idle for HC & CO, High Speed Mode for NOx		
CID	HC(ppm)	CO(%)	NOx(ppm)
≤150	219	1.84	2805
151-259	213	0.71	1395
≥260	151	0.27	1986

With the exception of HC cutpoints for the ≤150 and 151-259 CID groups, the great disparity in cutpoints which are required is clearly seen even when vehicles are grouped into three engine size classes.

8. When the conclusions given in #6 and #7 above are taken together, it becomes apparent that the agency may have to consider setting cutpoints by examining all of the engine and vehicle combinations which are in production in order that any grouping of vehicles would ensure that manufacturers are treated equitably and that the greatest improvement in air quality occurs.

9. Short test pass/fail levels which are applicable at low elevations for the 49 state standards will not be applicable in all cases at high elevations [1/].

10. Short test pass/fail levels, although not able to predict precise FTP levels, are still dependent upon the specified FTP standards. As the FTP standards are changed for new model year vehicles, comparable short test pass/fail levels must, therefore, be introduced.

11. Conclusions 6 through 10 above point out the potential need for the setting of yearly short test pass/fail levels,

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[1/] The exceptions could be those manufacturers who include pressure compensating devices in their carburetors or fuel injection systems and in their ignition timing devices (distributors).

which would account for changes in technology, vehicle and engine size, and emissions standards.

2.2.3 Real World Effects

12. A greater degree of variability will occur in results collected under real world conditions than under closely controlled laboratory conditions. The magnitude of this increased variability and its effect on the accuracy of short test predictions is not presently known. The Portland project is directed, in part, toward the resolution of this unknown. Once the effects of increased variability have been quantified, adjustments may have to be made in the criteria for establishing the cutpoints (eg: E_c = 4% rather than 5% or an upper bound 90% confidence interval selected as the 207(b) cutpoint rather than the best estimate measured value.)

2.2.4 Analysis

13. The conventional correlation analytical technique (Pearson regression analysis) is not appropriate for the evaluation of FTP/ST correlation or for the selection of 207(b) cutpoints.

14. An analytical technique for defining correlation, the contingency table technique, has been developed and is totally applicable where the data base includes a mixture of FTP passing and failing vehicles.

15. All samples of vehicles which have been tested to date have included vehicles which passed the FTP and vehicles which failed the FTP. It is possible however, that cases will occur where all the vehicles sampled in one group could either all pass the FTP or all fail the FTP. A methodology for handling these eventualities has been developed and has been verified on a limited data set.

2.2.5 Inspection Equipment, its Maintenance and Calibration

16. Procedures will be required but have not as yet been developed to ensure that inspection station equipment will be of sufficient quality and will be maintained and operated so as to provide accurate short test results.

17. Procedures have not as yet been developed to ensure that vehicle repair businesses use accurate instrumentation, maintain this equipment in good operating order and properly train their personnel in the repair of vehicles.

18. Facilities are not presently available on a national basis for implementing all-encompassing vehicle inspection programs. Manufacturers of dynamometers and emissions measuring equipment will require several years to produce a sufficient quantity of equipment to meet the requirements of a nation-wide vehicle inspection program.

2.2.6 207(b) Effectiveness of Short Tests

19. Because of the intimate relationship between I/M and 207(b) programs, it is very difficult to separate their respective effectivenesses. If the implementation of 207(b) results in states or regions implementing I/M programs which would not otherwise have been implemented or if the implementation of 207(b) results in states selecting more stringent pass/fail cutpoints than would otherwise have been adopted, then 207(b) implementation can be credited with air quality effectiveness. On the other hand I/M programs can be implemented without 207(b) and can achieve all of the air quality benefit independent of 207(b) implementations. However, analysis performed to date indicates that if states were to implement I/M programs with the 207(b) cutpoints rather than the 33% failure rate cutpoints typical of current programs, significant air quality benefit could be obtained. The predicted effectiveness, of an I/M program in terms of the first five years or 50,000 miles of a vehicle's life, using the 207(b) short test pass/fail levels as computed with a 5% error of commission rate (vehicles grouped by engine size) is between 22.1 and 34.6% reduction for HC, 24.6 and 42.8% reduction for CO and 0.33 and 2.0% reduction for NOx. These predictions are based on the use of the idle test and the assumptions as detailed in Section 5 of this document.

Comparable benefits from an I/M program where 1/3 of the vehicles are failed by the short test, using a single cutpoint for all vehicles, are: HC, between 15.7 and 27.0%; CO, between 16.8 and 34.1%; and NOx, between 0.34 and 1.78%.

2.2.7 Policy

20. While the basic methodology for the technical implementation of 207(b) has been identified, key policy and institutional issues remain to be resolved. These include (a) definition of acceptable error rates (both E_c and E_o rates); (b) an interpretation of what criteria for selection of cutpoints is most equitable (c) a decision on how to include manufacturer differences in test variability[1/] (d) whether state I/M standards will be pre-empted by the federal 207(b) cutpoints, (e.g. can a state set lower or higher I/M standards for purposes of general vehicle compliance and still trigger warranties?); (e) definition of vehicle owner obligations to properly maintain and operate their vehicles (e.g. what type

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1/ This is a complex technical issue with major implications. If errors of commission are to be held to any given level for each type of vehicle, then the more variable the short-test to FTP relationship for a type of car the higher the error of omission rate. This gives manufacturers an incentive to create random variation of emission levels on their cars. This problem does not exist, however, with a fixed Short Test Rejection Ratio.

of maintenance records must be maintained); (f) impact of 207(b) on aftermarket parts and non-dealer associated service industries and (g) potential revisions to the present 5 year or 50,000 mile warranty requirements. Some of these issues have been addressed by other elements in EPA.

2.3 Summary of Recommendations

1. The Agency should proceed with the issuance of an NPRM which identifies five short tests. These short tests are the Federal Short Cycle, the NY/NJ Composite, the Federal 3 Mode, the Clayton Key Mode and the Idle. Any of these tests can be adopted by a state or smaller government body for the implementation of an I/M program which can trigger section 207(b). The state can also have the option of adopting part or parts of either of the steady state short tests, e.g. idle mode for measuring HC and CO and the high speed mode for measuring NOx, if this simplified test meets their particular regional requirements.

2. The NPRM should detail the methodology for the selection of short test pass/fail levels for each short test. This methodology would consist of the following segments:

2.3.1 The procedure for data analysis

1. The contingency table analytical technique should be applied.

2.3.2 Optional procedures for setting the short test cutpoints

1. The short test cutpoints are set at the level which corresponds to a 5% error of commission rate (based on the total number of vehicles tested) within each group.

2. The short test levels are set using the Short Test Rejection Ratio approach. The Short Test Rejection Ratio, $(E_c + FF)/(E_o + FF)$, would be set at unity based on the total number of vehicles tested within each group.

3. The short test levels are set using a fixed level of $E_c/(E_c+FF)$ for each group.

4. The short test levels are set so that equivalent FTP pass/fail levels are enacted for each vehicle group, i.e. each group is allowed to have the same negative effect on air quality.

5. The short test levels are set so that the E_c rate or $E_c/(E_c + FF)$ rate is a function of test variability.

2.3.3 The procedure for determining short test cutpoints

This procedure includes the grouping of vehicles and the setting of as many short test pass/fail levels per pollutant as are necessary to ensure that all vehicles are exposed to either the same error of commission rate, the same short test rejection ratio or one of the other options proposed for the selection of the short test cutpoint.

1. The Agency should, on a yearly basis, set the short test pass/ fail levels for the most recent model year vehicles, and these pass/fail levels should remain in effect through the useful life of the vehicle. This recommendation is necessary because of the dependence of the short test pass/fail levels on the emissions standard to which the vehicles were manufactured and because these standards are changing with time.

2. The Agency should recommend the continued use by the states of the short test cutpoints beyond the useful life of the vehicle.

3. The short test pass/fail levels which are developed on a yearly basis should be established through the testing of approximately 50 privately owned production vehicles from each vehicle - engine group. This number is judged to be the smallest sample size which will provide a statistically meaning-

ful sample of vehicles. The total number of vehicles to be tested on a yearly basis is expected to be between 3000 and 5000, but is dependent upon the manufacturers' production mix, the effects of altitude, and the number of state specific standards which are in effect. Two other options, the testing of a smaller number of vehicle - engine groups and the testing of assembly line vehicles rather than privately owned production vehicles are being considered to see if significant cost reductions are possible without loss of acceptable correlation.

4. The agency testing program for short test pass/fail development should include vehicles which will be inspected at high altitude.

5. If a vehicle has to be inspected prior to the development of its short test cutpoints (e.g. owner moves) use the previous year's cutpoints for that vehicle, provided it is not a new model and provided there has not been significant technology changes between the two model years. If the vehicle is significantly different, use the cutpoints from the previous year for the same manufacturer's product and technology but in the next heavier weight class.

6. Small sales volume vehicles can be handled in more than one way. If the powerplant is from a large volume manufacturer,

then the large volume manufacturer's cutpoint at the appropriate weight would be used. If the product is dissimilar to all others, then the EPA will set the cutpoint based on previous year's data and engineering judgment until a statistical sample has been tested.

7. A manufacturer may appeal the EPA cutpoints if he can show that his vehicle cannot meet the short test cutpoint selected.

8. Any vehicle which can not be tested by the ST or the FTP or which is not required to be certified (e.g. electric car) should be exempted from section 207(b).

9. Any vehicle for which the short test does not correlate should be exempt from Section 207(b) until a suitable short test is developed. For this reason, the present NPRM excludes Diesel powered vehicles.

2.4 Summary of Open Technical Issues

1. The exact effects of real world testing on short test to FTP correlation is unknown. The expected effect is one of lowering correlation, not eliminating it. The Portland project is designed to quantify this issue for light duty vehicles.

Completion of the Portland program can not be accomplished before June of 1978. An additional two to three months will be required after the completion of testing for all analyses to be completed.

2. The agency needs to make a policy decision on equity between manufacturers and within a manufacturer's product line. The decision on equity centers on the use of a fixed error of commission rate, on a fixed short test rejection ratio, on a fixed ratio of $E_c/(E_c+FF)$, on allowing each group to have the same negative effect on air quality or on setting E_c or $E_c/(E_c+FF)$ as a function of variability. This decision will affect the size of the yearly cutpoint program.

3. The agency needs to make a policy decision as to what are acceptable levels of errors of commission if a fixed error of commission rate approach is adopted. A 5% rate has been recommended. The agency has to specify acceptable levels of the short test rejection ratio, $E_c/(E_c + FF)$, and/or acceptable variability if one of the other cutpoint selection methods is implemented.

4. The exact number of short test pass/fail levels which must be accepted to insure uniformity between manufacturers is not known. The number could go as high as 100 for each pollutant, dependent upon manufacturers' product mix.

5. Changes in technology could obsolete one or more short tests presently proposed as acceptable with the result that new short tests would have to be developed.

6. The exact effectiveness of a 207(b) program is impossible to compute because it is dependent upon the existence of an inspection and maintenance program. If a state adopts I/M cutpoints which are less stringent than the 207(b) cutpoints, then a change in the state cutpoints to the 207(b) cutpoints could result in an improvement factor and 207(b) could be credited with the improvement.

7. The proposed mathematical methodology for setting cutpoints where all of the tested vehicles either pass or fail the FTP has been sucessful on one small sample of vehicles. It is not known whether this methodology will hold up when different vehicle test data sets are utilized.

8. A determination must be made on the acceptability of using assembly line test fleet data rather than privately owned production test fleet data to establish the yearly 207(b) cutpoints. This determination will depend upon an analysis of the green engine effect on the ST/FTP relationship along with any possible biases in the assembly line data.

3. Ongoing Test Program

3.1 Overview

The test program has addressed the adequacy of short test correlation for a variety of short tests measured with currently available instrumentation. Since the 207(b) test must be capable of being carried out in large or small volume inspection facilities, the available tests are limited to short tests that are simple and quick to perform with minimum instrumentation and equipment requirements.

3.2 Tests

The tests considered fall into the three broad categories of Idle Test, Steady State Modal Tests and Transient Tests as outlined in Section 2.

The current test program has evaluated tests in each of these three groups. Six short tests were evaluated. Four of these tests required the use of a dynamometer. Two of the four tests which required the use of a dynamometer also required the use of a constant volume sampling system (CVS), analytical equipment of sufficient sensitivity to measure the dilute sample and a driver's aid, i.e. the driver had to follow a prescribed speed vs. time trace. The other four tests required analytical equipment which was suitable for measuring undiluted exhaust gases. A brief description of each short test follows. Appendix A presents graphical representations of each short test.

3.2.1. Federal Short Cycle: This test is a transient test and is patterned on the Federal Test Procedure (FTP). It is 125 seconds in duration and requires a dynamometer with inertia weights, a CVS, sensitive analytical equipment and a driver's aid. Vehicle classes for road load and inertia weight are the same as used in the FTP.

3.2.2. Composite New York/New Jersey Test: This test is a transient test; it was developed by combining the New York Quick Cycle Test and New Jersey ACID test. It is 75 seconds in duration and requires a dynamometer with inertia weights, a CVS, sensitive analytical equipment and a driver's aid. All vehicles are tested at a dynamometer inertia load of 3000 lb. and a road load of 3.5 hp at 30 mph.

3.2.3. Federal Three Mode Test: This short test is a steady state modal test and consists of three steady state modes: a 50 mph mode, a 30 mph mode and an idle in neutral mode. All vehicles are grouped into four weight classes with the dynamometer loading at 50 mph and 30 mph reflecting the road load which the vehicles would experience at those speeds when under acceleration on the FTP. The dynamometer used in this test does not simulate vehicle inertia and is therefore much simpler than that used in the two previous tests. Undiluted exhaust emissions are measured in each mode. Analytical equipment used in this test does not have to be as sensitive as that used in the two preceding tests.

3.2.4. Clayton Key Mode Test: This three mode steady state modal test was developed by the Clayton Manufacturing Company. It consists of a

High Speed Mode, a Low Speed Mode and an Idle Mode (automatic transmissions in drive). All vehicles are grouped into three weight classes with dynamometer loadings approximating the accelerations on the Seven Mode Test. (The Seven Mode Test was the FTP prior to 1972). Undiluted exhaust emissions are measured in each mode. The dynamometer and the analytical equipment used in this test are equivalent to those used in the Federal Three Mode Test.

3.2.5. Idle Test: Undiluted exhaust emission measurements are made with the vehicle engine at idle. The transmission may be in either neutral or drive. Analytical equipment is equivalent to that used in the Federal Three Mode and Clayton Key Mode tests. A dynamometer is not used in this test.

3.2.6. 2500 rpm Unloaded Test: The vehicle engine is operated at 2500 rpm with the transmission in neutral. Undiluted exhaust emissions are measured using equipment equivalent to that used in the Federal Three Mode test. A dynamometer is not used in this test.

3.3 Instruments

Two broad classes of instruments were available for use in the vehicle testing projects. These classes of instruments are: (1) laboratory instruments and (2) garage instruments. The laboratory instrument class consists of those instruments which meet the requirements detailed in the Federal Register for instrumentation to be used in the vehicle certification process. The garage instrument class consists of those instruments which are built and sold for use in vehicle inspection stations and vehicle repair facilities.

In the current test programs, laboratory class instruments were used in the determination of FTP and short test emissions. Garage class instruments were used in the determination of HC and CO during steady state modal tests and idle tests only. As garage class NOx instruments were not available, this pollutant was measured using laboratory class instruments only.

3.4 Vehicle Testing Projects

The vehicle testing project is divided into six separate elements:

1. Fifty car experimental catalyst fleet. (completed)

2. One hundred and fifty, 1974 model year production light duty vehicles. (completed)

3. Five car (catalyst equipped), one hundred defects test project. (completed)

4. Three hundred 1975 model year production light duty vehicles.

5. State/EPA pilot project. (In procurement phase)

6. Instrument Evaluation. (Phase I is in progress, Phase II will be initiated with FY77 funds)

3.4.1 The Experimental Catalyst Fleet

This fleet consisted of approximately fifty 1973 model year Ford Galaxie 4 door sedans, equipped with 400 CID engines, 2 venturi carburetion, automatic transmissions, 3.0 to 1 rear axle, HR78x15 tires, air conditioning, power steering and power brakes to which catalysts and secondary air injection had been added. These vehicles were included in the test project because their availability significantly preceded the availability of production catalyst equipped vehicles. The vehicles had been in general service in California and had accumulated mileages which ranged between 7000 and 36,000 miles. The vehicles were loaned to EPA by the Ford Motor Company and were tested by an EPA Contractor, Olson Laboratories, Inc. in Anaheim, California. Each vehicle was inspected by the Ford Motor Company prior to being picked up by Olson Laboratories. The vehicles were tested by the Federal Test Procedure, the Federal Short Cycle, the Federal Three Mode, the High Speed Unloaded test, the Clayton Key Mode and a composite of the New York and New Jersey short tests. Continuous traces of CO, CO_2, HC and NOx were made during each FTP in an attempt to provide a data base for future short test development.

3.4.2 The 1974 Model Year Fleet

Olson Laboratories, Inc. in Livonia, Michigan procured under EPA contract approximately one hundred and fifty privately owned 1974 model year cars and delivered the cars to the EPA, Ann Arbor Laboratory for testing. The vehicles were equally divided into three groups of cars. Within each group, all cars were mechanically and technically identical. The groups were (1) Ford Pinto Sedan or Runabout with 2.3 litre engine, automatic transmission, 3.40 to 1 rear axle and production size tires, (2) Plymouth Satelite, Dodge Coronet/Charger Sedans with 318 CID engine, automatic transmission, standard 2.71 to 1 rear axle and production size tires and (3) Chevrolet Belair, Impala or Caprice Sedans with 400 CID engine, automatic transmission, standard 2.73 to 1 rear axle and production size tires. These vehicles were tested for two primary reasons: (a) to determine if vehicle weight had any significant impact on short test correlation and (b) to simulate non-catalyst 1975 technology. The vehicles were inspected by Olson Laboratories and their state of tune recorded but not modified prior to delivery to EPA. The vehicles were tested at EPA by the same tests that had been used in testing the catalyst prototype vehicles. Approximately twenty of the vehicles which failed one or more of the 1974 FTP standards were set to manufacturers' specifications and retested.

3.4.3 The Defects Test Fleet

Five of the cars in the catalyst fleet were retained by Olson Laboratories for defect testing. The procedure for incorporating a defect was first, to set all parameters to the manufacturer's specifications and then to introduce the defect or defects. Each defect was corrected before proceeding to the next defect. This procedure ensured that only the selecteddefect(s) was in effect when the appropriate testing was being performed. The defects which were introduced were as follows: 1) Inoperative EGR, 2) Insufficient EGR, 3) Insufficient vacuum advance, 4) No secondary air injection, 5) Insufficient secondary air injection, 6) Leaks in vacuum lines, 7) Excessive fuel at idle, 8) Insufficient fuel at idle, 9) High idle rpm, 10) Low idle rpm, 11) Over-rich main fuel system, 12) Over-lean main fuel system, 13) Low fuel pump pressure, 14) PCV valve stuck open, 15) PCV valve stuck closed, 16) Clogged air filter, 17) Excessive fuel from carburetor power circuit, 18) Insufficient fuel from carburetor power circuit, 19) Defective intake valve, 20) Defective exhaust valve, 21) Intermittent misfires, 22) Bridged spark plug, 23) Reduced efficiency of the catalyst, 24) Advanced ignition timing, 25) Retarded ignition timing, 26) Excessive centrifugal advance, 27) Insufficient centrifugal advance, and 28) Excessive vacuum advance.

3.4.4 300-Car Test Fleet

Three cities with different climatic conditions were selected for testing of 1975 production vehicles. The cities were: Chicago, Houston and Phoenix. Nominally one hundred vehicles were tested in each city. The vehicles chosen for testing were 1975 model-year privately-owned, production cars. The vehicle mix was based on expected sales volumes but was modified to include all major technologies used in meeting the 1975 emission standards, e.g., catalyst (with and without secondary air injection), Wankel, rich thermal reactor with fuel injection, etc. All vehicles were tested by the Federal Test Procedure, the Federal Short Cycle and the Federal Three Mode.

3.4.5 The State/EPA Pilot Project

This project is presently in the procurement phase. It will be performed in Portland, Oregon where there is mandatory vehicle inspection and repair. The objective of the project is the determination of the effects on correlation of variables associated with real world testing of vehicles. Examples of real world variables are (a) human errors due to on-the-job routine (b) ambient temperature changes (c) the length of time that the vehicle waited in line for testing, etc. Approximately 2400, 1975/76 model year light duty vehicles will be tested by the state inspection test (idle test), the Federal Short Cycle and the Federal Three Mode test at the state inspection lane and by the FTP and the same short tests at the contractor's laboratory. Approximately 86 engine-vehicle groups will be represented in the vehicle sample. A target of 50 vehicles in each engine-vehicle group was selected to furnish data on distribution characteristics within each group. The target number of vehicles will not be attainable in some low sales volume groups because of the unavailability of units. The data will be analyzed by techniques incorporating the 207(b) methodology described in the 207(b) NPRM, I/M cost-effectiveness methodology, and other pertinent analytical methods.

3.5 Instrument Testing

The instrument testing evaluation consists of two parts. At the present time EPA has contracted with Olson Laboratories to prepare and distribute a report detailing the qualifications of approximately twenty commerically available inspection type HC, CO, and NOx instruments. The instruments will be evaluated in terms of accuracy, repeatability, response time, deficiencies, and cost. Accuracy is to be determined in laboratory tests by comparison with known standards. Hang-up time, zero drift and other deficiencies which could reduce correlation under real world conditions will be evaluated as will instrument durability. The second part of this project involves an evaluation of instrument to instrument variability within one model line of a manufacturer's product as well as manufacturer to manufacturer product variability. Phase two is anticipated to start in FY77. Both of these projects will provide valuable insight into the effect of instrument variation on correlation.

4. Analytical Techniques

One of the three requirements for implementation of 207(b) is that short test(s) can be reasonably correlated with the FTP. The Clean Air Act did not define correlation nor did it define reasonable correlation. Thus, two issues are apparent. First, what is the proper method for determining correlation and second, what value of correlation is reasonable.

4.1 Correlation Methodology

The dictionary defines correlation as "a close or mutual relation" or "the degree of relative correspondence". This definition does not indicate a method for quantifying correlation. Statistically, three different methodologies are associated with the concept of correlation: regression analysis, ranking analysis and contingency table analysis.

4.1.1 Regression Approach

Regression analysis is a technique by which one parameter of interest is predicted by one or more other variables of interest. Thus, a functional relationship is defined between the variables, and for every value or set of values for the predictor variables there is a value for the predicted variable. In the case of two variables, the relationship can easily be shown graphically as is presented in Figure 1. When there is more than one predictor or independent variable, the relationship must be plotted in more than two-dimensional space. Figure 2 shows a case where there are two predictor variables. Cases with more than two independent variables must be treated mathematically since they cannot be graphed in a simple form.

Regression analysis can be performed with one or more predictor variables (independent variables) and with one or more predicted variables (dependent variables). When there is one dependent variable and one independent variable, the technique is usually called simple regression. When there is one dependent variable and more than one independent variable, the technique is called multiple regression. When there is more than one dependent variable and any number of independent variables, the technique is called multi-variate regression.

A regression analysis is based upon the assumption of a relationship between the dependent and independent variables. This relationship can take any functional form. A generalized expression is given below:

$$Y_1 = a_o + a_1\ f_1(x_1) + a_2\ f_2(x_1) + \ldots a_n\ f_n(x_1) + \ldots$$

$$+ b_1\ f_1(x_2) + \ldots + b_n\ f_n(x_2) + \ldots + Z_n\ f_n(x_m)$$

$$+ \ldots k_j\ f_1(x_m)\ f_i\ (x_n)$$

The functions f_i may be logarithms, exponentials, powers of x, or any other functions. A special case which is often considered is simple linear regression or multiple linear regression. Linear regression assumes that the independent variables take the following form:

$$Y = a_0 + a_1 x_1 + a_2 x_2 + \ldots + a_n x_n$$

There are no interaction terms (such as $x_1 x_2$) among the independent variables nor are there any higher power terms (such as x_1^2).

Once a functional relationship has been hypothesized, regression theory develops estimates for the coefficients (a_i, b_i ... z_i) which minimize the error. Most regression is based upon the "least squares" approach although other approaches could be used. Least squares is the preferred approach since it provides estimates of the coefficients which have the minimum possible variance. Thus, the coefficients are selected to minimize the sum of squares of the actual points minus the predicted values. Mathematically, this is expressed as

$$\sum_i (y_i - \hat{y}_i)^2.$$

One of the measures of the quality of the regression relationsip is expressed by the correlation coefficient. The correlation coefficient, r^2, expresses the percentage of the total variation in the dependent variable that is explained by the independent variables, assuming the functional relationship which was hypothesized. This last point is critical. Figure 3 shows a hypothetical plot of the FTP as the dependent variable and a short test as the independent variable. If the hypothesized functional relationship is linear, FTP = a + b (ST), the correlation coefficient will be quite low. That occurs because there is no single straight line that can be drawn through the points which does a good job of predicting the FTP. On the other hand, if the hypothesized functional relationship is quadratic, $FTP = a + b(ST) + c(ST)^2$, the correlation coefficient will be quite high. Thus, regression analysis evaluates correlation in terms of the hypothesized predictive relationship.

The predictive relationship must be a continuous one. For every value of the independent variable, a specific value is predicted for the dependent variable. The errors in the predicted values of the dependent variable determine the correlation coefficient.

For the case of 207(b) correlation, the dependent variable is the FTP emission for a specified pollutant. The independent variable is the short test emission for the same pollutant. In cases where the short test has more than one mode, there are multiple independent variables. (It would also be possible to have independent variables which are short test emission levels for pollutants other than the one of interest).

The disadvantage of using a regression methodology to evaluate correlation is that a determination of the exact form of the functional relationship is necessary. Also, it is equally important to predict each and every data point of the dependent variable with the same absolute degree of accuracy. In Figure 4, assume data points P_1, P_2, and P_3 are equidistant from the curve as measured vertically. The combined lack of fits of any of these data points will reduce the regression correlation coefficient by the same amount. However, in considering the degree of correlation between the independent and dependent variables in this case (Short Test vs. FTP), only the lack of fit of point P_2 will affect the number of vehicles passing or failing the FTP, whereas the lack of fits of points P_1 and P_3 have no bearing on this.

4.1.2 <u>Ranking Approach</u>

Ranking analysis is a technique by which two variables are compared without any assumption as to a predictable relationship between the variables. Each variable is compared and ordered within itself. For example, assume there are N pairs of observations (X_1, Y_1), (X_2, Y_2), (X_N, Y_N). The X values are ranked with the largest value assigned a rank of 1; the Y values are ranked with the largest value assigned a rank of 1. Then the ranks of each (X, Y) pair are subtracted and the differences are summed. The rank correlation coefficient is defined as one minus a function of the summed differences so that it will be low when the variables are independent and high when they are correlated.

A rank correlation value near 1 indicates that two variables, when normalized, tend to be high or low together. A rank correlation near zero indicates that the relative rank of one variable cannot predict the relative rank of the second variable. A high but non-perfect rank correlation, however, does not allow for an assessment of what magnitude of errors would occur with the prediction process.

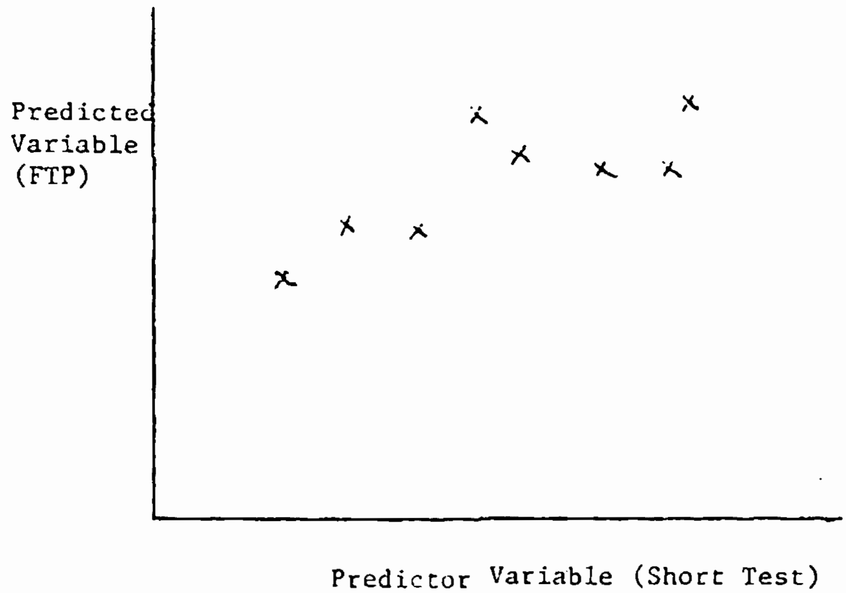

FIGURE 1

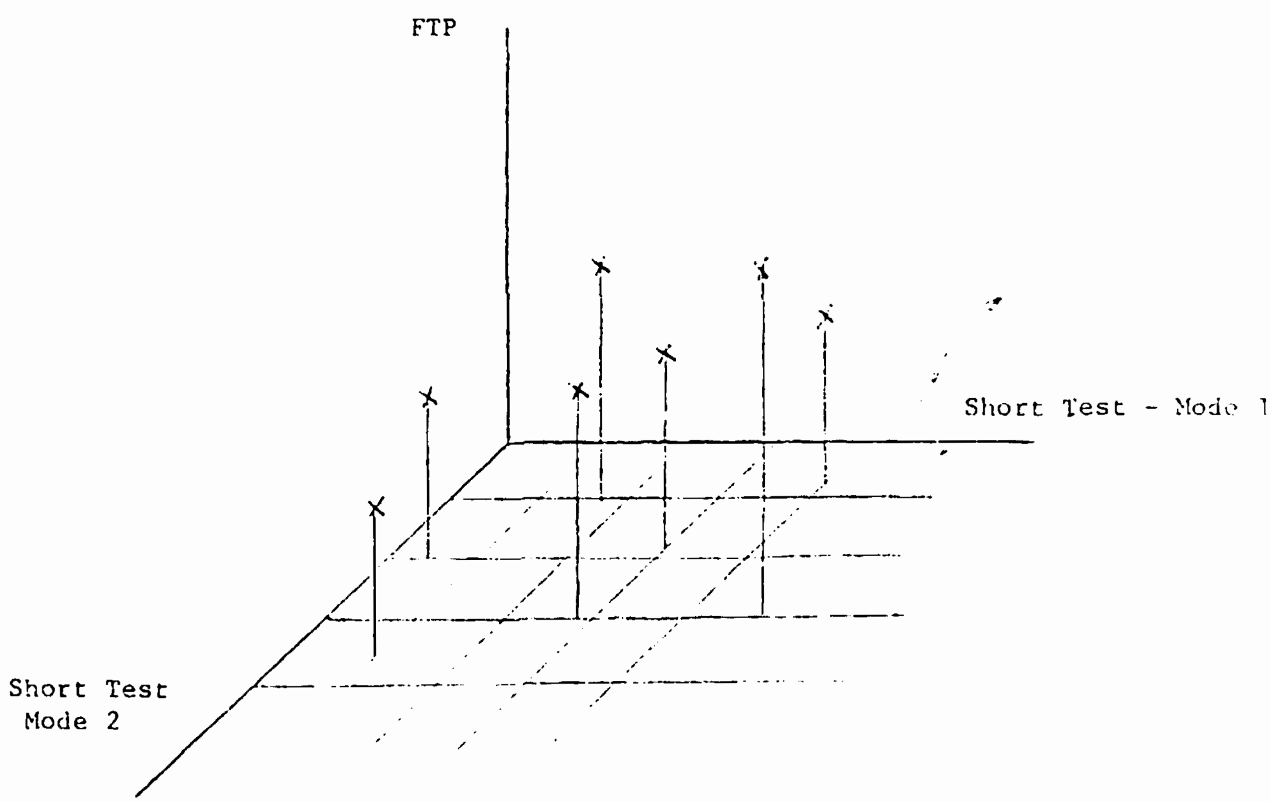

FIGURE 2

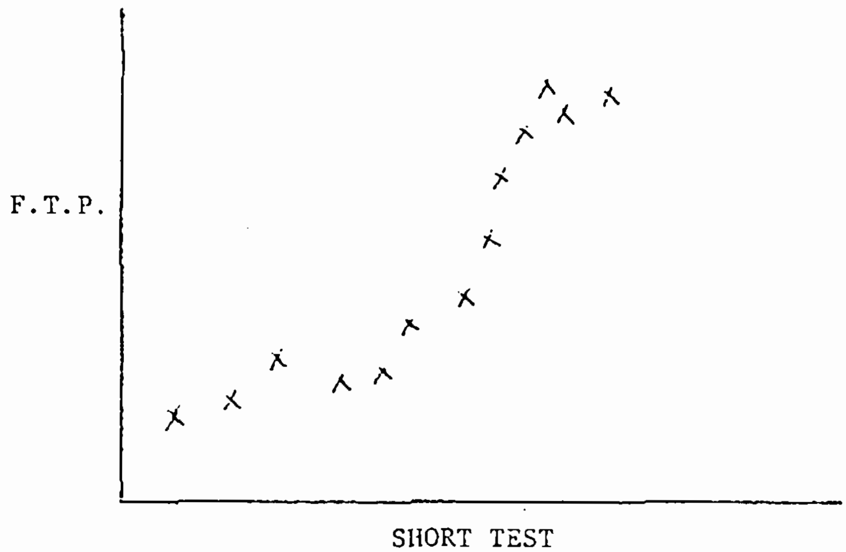

FIGURE 3

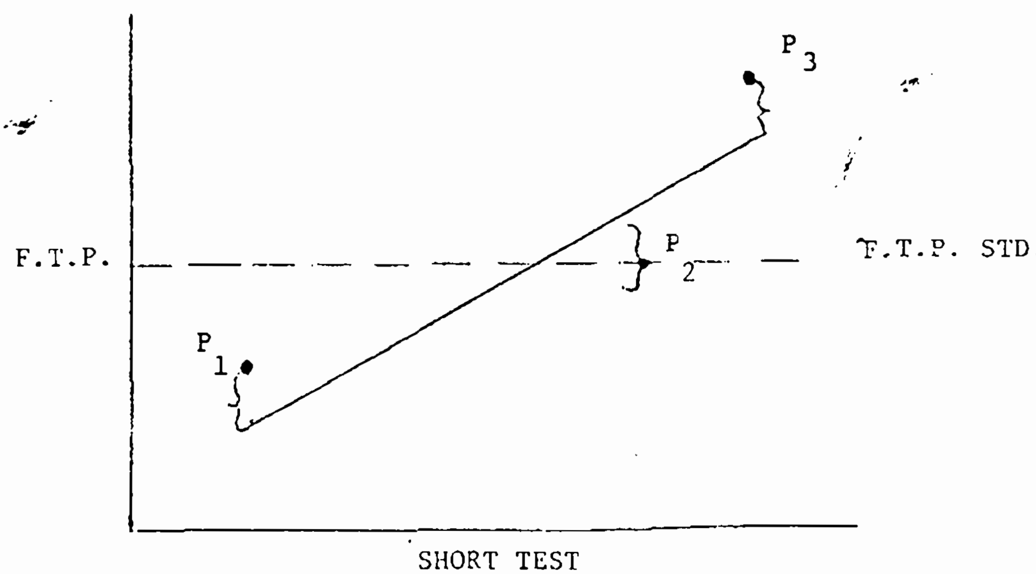

FIGURE 4

4.1.3 Contingency Table Approach

Contingency table analysis assumes that there are a discrete number of groups of individual measurements of a given dependent variable. There are also one or more independent variables. The analysis attempts to find one or more independent variable(s) which can be used to discriminate between the different groups of the dependent variable. In other words, the contingency table approach says that a predictive relationship between the dependent and independent variables is not important. Rather, the only thing of interest is whether the dependent variable belongs to one of the available group categories. Figure 5 is a two-dimensional illustration of the concept of clustering or discrimination. Figure 6 is a three-dimensional illustration of the same concept.

Contingency table analysis is based upon the assumption that cutpoints can be found for one or more independent variables which will discriminate on the groups of the dependent variable. The selection of the cutpoints results in the development of a contingency table as shown in Figure 7. The predictor variable may be a single variable or the combination of several independent variables.

Contingency tables are considerably simpler to deal with than regression analyses since it is not necessary to determine the exact predictive relationship. Rather, it is sufficient to identify the number of important groups into which the dependent variable needs to be

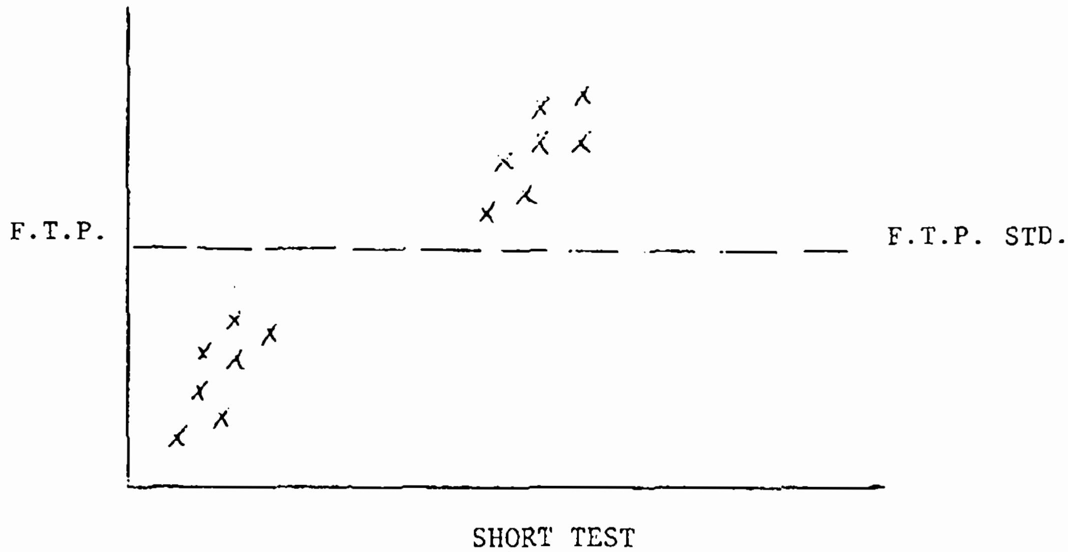

FIGURE 5

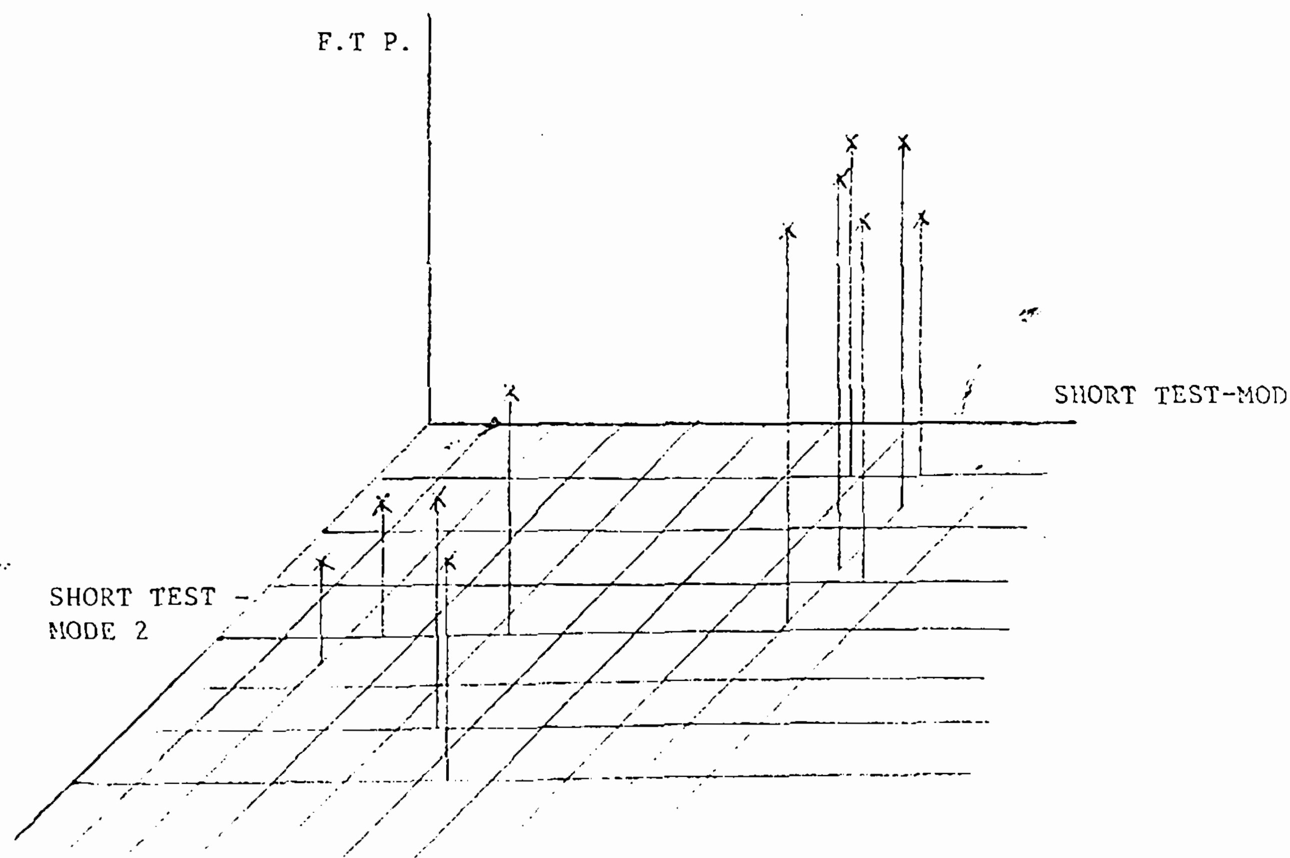

FIGURE 6

classified. For the purposes of 207(b) implementation, there are only two such groups: vehicles which pass the FTP and vehicles which fail the FTP. Thus, Figure 8 shows the 207(b) application of a contingency table. This type of table is called a 2x2 contingency table. (A failure on any of several independent variables would result in an overall predictor variable failure).

Predicted Variable

		Group 1	Group 2	Group 3	.....	Group N
Predictor Variable(s)	Group 1	a_{11}	a_{12}	a_{13}	...	a_{1n}
	Group 2	a_{21}	a_{22}	a_{23}	...	a_{2n}
	⋮					
	Group N	a_{n1}	a_{n2}	a_{n3}	...	a_{nn}

Figure 7

Predicted Variable

(FTP)

		Pass	Fail
Predictor Variable (ST)	Pass	a	b
	Fail	c	d

Figure 8

The definition of correlation in a 2x2 contingency table can be addressed in several ways (unlike regression analysis correlation or rank correlation). First, a measure of independence between the two variables can be determined. This indicator will fall between -1 and +1 just like the other measures of correlation. Because of the simple form of the predictive relationship inherent in a 2x2 table, other more meaningful measurement quantities can be computed. These quantities express the ability of the short test to correctly identify passing and failing vehicles on the FTP. The following notation can be defined:

E_c = c = percent of sample which is incorrectly failed by the ST (commission errors)

E_o = b = percent of sample which is incorrectly passed by the ST (omission errors)

FF = d = percent of sample which is correctly failed by the ST

PP = a = percent of sample which is correctly passed bv the ST

Then, the following quantities can be considered in addition to the rates listed above.

$\frac{E_c + FF}{E_o + FF}$ = the ratio of the cars failing the short test to the cars which failed the FTP, i.e. the Short Test Rejection Ratio.

$\frac{E_c}{E_c + FF}$ = the ratio of the commission error rate to the cars failing the ST.

$\frac{E_c}{E_c + PP}$ = the ratio of the commission error rate to the cars passing the FTP.

$\frac{E_o}{E_o + PP}$ = the ratio of the omission error rate to the cars passing the ST.

$\frac{FF}{E_o + FF}$ = the fraction of the FTP failing cars which are cars correctly failed by the short test, i.e. the Short Test Effectiveness.

$\frac{PP}{PP + E_c}$ = the fraction of the FTP passing cars which are correctly passed by the ST.

A selection as to which of these quantities best expresses correlation depends upon the specific application and the relative importance of the types of errors.

4.2 Applicability of the Analytical Techniques

The Senate report language associated with the 1970 Clean Air Act states that:

> The [Administrator] would be required to develop a test which could be quickly and uniformly applied to individual vehicles on the production line and on the road to determine whether or not those vehicles comply or continue to comply with the standards for which they were certified. The quick test would have to be correlated with the pre-certification test procedure. (Senate Report No. 91-116)

From this excerpt, it is obvious that the intent of Congress is to determine whether or not the vehicles comply with the standards--not by how much they comply. Thus, the contingency table approach best fulfills the intent of Congress in establishing whether correlatability exists between the FTP and one or more short tests.

The standard contingency table correlation coefficient is defined as:

$$\frac{(PP)(FF)-(E_c)(E_o)}{[(PP+E_o)(PP+E_c)(FF+E_o)(FF+E_c)]^{1/2}}$$

This correlation value indicates whether the two tests are related. However, it has the disadvantage of weighting errors of omission and errors of commission equally. Thus, two tests which have 15% errors of commission and 2% errors of omission are equally well correlated as two tests which have 2% errors of commission and 15% errors of omission.

With respect to the implementation of 207(b), there is a difference in importance between the two types of errors. An error of omission results in the loss of potential air quality benefits. An error of commission results in a cost to the manufacturer (or consumer) without a known air quality benefit. (It is not known whether vehicles whose FTP emissions are below Federal standards could have their FTP emissions further reduced as a result of maintenance performed with the intention of lowering short test emissions. It is possible that these vehicles could have their FTP emissions increased as a result of such maintenance). The intent of 207(b) is to improve the emissions performance of vehicles in the field without requiring consumers to pay additional penalties for properly maintained and operated vehicles. Thus, commission errors are extremely important since they increase the cost of 207(b) implementation without any known benefit to air quality. Omission errors are important to the degree that the percentage of correctly failed vehicles is lowered, thereby reducing the air quality benefits. The limiting case occurs where there are so many errors of omission that no significant air quality benefit is realized.

The definitions of correlation which consider the weighting of these error factors are E_c, errors of commission; E_o, errors of omission; $\frac{E_c}{E_c + FF}$, the commission error rate as a fraction of the cars failing the ST; $(E_c + FF)/(E_o + FF)$, the Short Test Rejection Ratio; and $FF/(E_o + FF)$, the Short Test Effectiveness. E_c must be low so that the unnecessary costs of 207(b) implementation are as low as possible. E_o must be low so that the maximum air quality benefit is realized. $E_c/(E_c + FF)$ must be low if the program is to minimize the cost associated with unnecessary maintenance and obtain significant air quality benefit. (It is assumed that E_c is not zero. If E_c is zero, FF must be large rather than $E_c/(E_c + FF)$ small.) $(E_c + FF)/(E_o + FF)$ must not exceed unity. If this occurs, the manufacturer is being required to repair more vehicles than had actually failed the FTP - an inequitable requirement. $FF/(E_o + FF)$ must be high. The higher the value of this ratio, the more effective the short test is in correctly failing vehicles.

4.3 Applicability of short tests

Specific contingency table correlation coefficients drawn from the available data taken by the instruments which are most appropriate to each short test are presented in Tables I, II and III for HC, CO and NOx respectively. Tables IV, V, VI, VII, VIII and IX present the results from the 300 1975 model year car fleet for E_c, E_o, FF, PP, $(E_c + FF)/(E_o + FF)$, $E_c/(E_o + FF)$, $E_c/(E_c + FF)$ and $FF/(E_o + FF)$ based upon the assumption that E_c is 5%. There are no specific values for these correlation measures which are by definition acceptable or not acceptable. It has been recommended that either errors of commission do not exceed 5 percent or that the short test rejection ratio $(E_c + FF)/(E_o + FF)$ does not exceed unity. This is a policy decision and is subject to change. It is also suggested that $E_c/(E_c + FF)$ be less than 15% or that $FF/(E_o + FF)$ be greater than 50%.

It is important to examine how well the FTP correlates with itself on the correlation measures that are tabled. The variability which

SPECIFIC CONCLUSIONS - HYDROCARBON EMISSIONS

Ranking of Short Tests by Contingency Table Correlation Indices @ 5% E_C 1/

1974 MY Fleet		Catalyst Equipped Experimental Fleet		Defects Fleet	
Short Test	Correlation Index	Short Test	Correlation Index	Short Test	Correlation Index
Federal Short Cycle	.77	NJ/NY Composite	.73	Federal Short Cycle	.77
NJ/NY Composite	.73	Clayton Key Mode-Idle	.68	NJ/NY Composite	.71
2500rpm Unloaded	.58	Federal Short Cycle	.66	Clayton Key Mode-Hi	.71
Federal 3 Mode-Idle	.43	Federal 3 Mode-Idle	.56	Federal 3 Mode-Hi	.71
Clayton Key Mode-Low	.32	Federal 3 Mode-Hi	.51	Federal 3 Mode-Hi	.66
Federal 3 Mode-Low	.32	Clayton Key Mode-Hi	.51	Clayton Key Mode-Low	.65
Clayton Key Mode-Hi	.30	Federal 3 Mode-Low	.51	Federal 3 Mode-Low	.65
Federal 3 Mode-Hi	.29	2500rpm Unloaded	.29	2500rpm Unloeaded	.64
Clayton Key Mode-Idle	.26			Clayton Key Mode-Idle	.44

1/ Laboratory Instruments for Federal Short Cycle and NY/NJ Composite. Garage instruments for all other tests.

TABLE I

SPECIFIC CONCLUSIONS - CARBON MONOXIDE EMISSIONS

Ranking of Short Tests by Contingency Table Correlation Indices @ 5% E_C[1/]

1974 MY Fleet		Catalyst Equipped Experimental Fleet		Defects Fleet	
Short Test	Correlation Index	Short Test	Correlation Index	Short Test	Correlation Index
Federal Short Cycle	.70	Federal Short Cycle	.54	Federal Short Cycle	.71
NJ/NY Composite	.69	NJ/NY Composite	.53	Federal 3 Mode-Idle	.63
Clayton Key Mode-Low	.29	Clayton Key Mode-Idle	.30	NJ/NY Composite	.58
Clayton Key Mode-Hi	.28	Clayton Key Mode-Hi	.21	Clayton Key Mode-Idle	.56
Federal 3 Mode-Idle	.28	Clayton Key Mode-Hi	.17	Clayton Key Mode-Hi	.23
Clayton Key Mode-Idle	.27	Federal 3 Mode-Low	.13	Federal 3 Mode-Hi	.22
2500rpm Unloaded	.24	Federal 3 Mode-Lo	.13	2500rpm Unloaded	.12
Federal 3 Mode-Low	.24	Federal 3 Mode-Idle	.13	Federal 3 Mode-Low	.06
Federal 3 Mode-Hi	.22	2500rpm Unloaded	.05	Clayton Key Mode-Low	.00

1/ Laboratory Instruments for Federal Short Cycle and NY/NJ Composite. Garage Instruments for all other tests.

TABLE II

SPECIFIC CONCLUSIONS-OXIDES OF NITROGEN EMISSIONS

Ranking of Short Tests by Contingency Table Correlation Indices @5% E_c 1/

1974 MY Fleet

Short Test	Correlation Index
Federal 3 Mode-Hi	.28
Federal 3 Mode-Low	.28
Clayton Key Mode-Hi	.28
Clayton Key Mode-Idle	.28
Federal 3 Mode-Idle	.26
Clayton Key Mode-Low	.26
Federal Short Cycle	.15
NJ/NY Composite	.08

Catalyst Equipped Experimental Fleet

Short Test	Correlation Index
Federal 3 Mode-Hi	.62
Clayton Key Mode-Hi	.53
Federal Short Cycle	.35
NJ/NY Composite	.33
2500rpm Unloaded	.11
Clayton Key Mode-Idle	.10
Clayton Key Mode-Low	.09
Federal 3 Mode-Low	.02

Defects Fleet

Short Test	Correlation Index
Federal 3 Mode-Hi	.75
Clayton Key Mode-Hi	.69
NJ/NY Composite	.43
Federal Short Cycle	.38
Federal 3 Mode-Low	.16
Federal 3 Mode-Idle	.14
2500rpm Unloaded	.12
Clayton Key Mode-Idle	.06
Clayton Key Mode-Low	.02

1/ Laboratory instruments for all tests

TABLE III

Comparison of E_c, E_o, FF, PP, $\frac{E_c + FF}{E_o + FF}$, $\frac{E_c}{E_o + FF}$, $\frac{E_c}{E_c + FF}$, and $\frac{FF}{E_o + FF}$

from 300 Car 1975 Model Year Fleet

Hydrocarbons 1/

Idle Test - Automatic Transmission in Drive

Manual Transmission in Neutral

Engine Size (CID)	No. of Vehicles	E_c	E_o	FF	PP	$\frac{E_c+FF}{E_o+FF}$	$\frac{E_c}{E_o+FF}$	$\frac{E_c}{E_c+FF}$	$\frac{FF}{E_o+FF}$
≥260CID									
All Vehicles	151	5.0	18.3	14.6	62.1	0.60	0.15	0.26	0.44
General Motors	74	4.0	14.4	16.3	65.3	0.66	0.13	0.20	0.53
Ford	42	3.9	20.6	8.8	66.7	0.43	0.13	0.31	0.30
Chrysler	29	5.7	29.2	31.6	33.5	0.61	0.09	0.15	0.52
AMC	6	0.0	0.0	0.0	100.0	--	--	--	--
151-259CID									
All Vehicles	54	5.0	18.8	8.4	67.8	0.49	0.18	0.37	0.31
General Motors	13	6.5	9.4	22.3	61.8	0.91	0.20	0.23	0.70
Ford	13	1.0	15.1	1.0	82.9	0.12	0.06	0.06	0.06
Chrysler	7	6.8	5.6	13.5	74.1	1.06	0.36	0.33	0.71
AMC	12	5.3	27.3	5.6	61.8	0.33	0.16	0.49	0.17
Others	7	1.7	21.1	2.0	75.2	0.16	0.07	0.46	0.09
≤150CID									
All Vehicles	95	5.0	21.9	10.2	62.9	0.47	0.16	0.33	0.32
General Motors	12	11.3	14.4	19.5	54.8	0.91	0.33	0.37	0.57
Ford	6	3.3	13.3	6.0	77.4	0.48	0.17	0.35	0.31
Datsun	8	5.4	30.3	18.1	46.2	0.48	0.11	0.23	0.37
Toyota	9	2.8	37.8	5.5	53.9	0.19	0.06	0.34	0.13
Volkswagon	21	4.2	23.4	13.1	59.3	0.47	0.11	0.24	0.36
Honda	6	2.9	2.6	5.6	88.9	1.04	0.35	0.34	0.68
Others	33	4.2	21.9	7.8	66.1	0.40	0.14	0.35	0.26

1/ Garage Instruments

TABLE IV

Comparison of E_c, E_o, FF, PP, $\frac{E_c + FF}{E_o + FF}$, $\frac{E_c}{E_o + FF}$, $\frac{E_c}{E_c + FF}$, and $\frac{FF}{E_o + FF}$

from 300 Car 1975 Model Year Fleet

Carbon Monoxide 1/

Idle Test - Automatic Transmission in Drive

Manual Transmission in Neutral

Engine Size (CID)	No. of Vehicles	E_c	E_o	FF	PP	$\frac{E_c+FF}{E_o+FF}$	$\frac{E_c}{E_o+FF}$	$\frac{E_c}{E_c+FF}$	$\frac{FF}{E_o+FF}$
≥260CID									
All Vehicles	151	5.0	17.8	42.1	35.1	0.79	0.08	0.11	0.70
General Motors	74	3.0	20.1	34.4	42.5	0.69	0.05	0.08	0.63
Ford	42	13.0	9.4	52.1	25.5	1.06	0.21	0.20	0.85
Chrysler	9	8.6	5.2	77.8	8.4	1.04	0.10	0.10	0.94
AMC	6	0.2	0.0	0.0	99.8	--	--	1.0	--
151-259CID									
All Vehicles	54	5.0	24.6	34.8	35.6	0.67	0.08	0.13	0.59
General Motors	13	7.4	14.1	50.4	28.1	0.90	0.11	0.13	0.78
Ford	13	1.5	36.2	20.4	41.9	0.39	0.03	0.07	0.36
Chrysler	7	15.3	13.6	55.5	15.6	1.02	0.22	0.22	0.80
AMC	12	5.3	26.1	24.8	43.8	0.59	0.10	0.18	0.49
Others	7	1.0	25.0	30.7	43.3	0.57	0.02	0.03	0.55
≤150CID									
All Vehicles	95	5.0	26.4	18.4	50.2	0.52	0.11	0.21	0.41
General Motors	12	6.7	15.4	64.1	13.8	0.89	0.08	0.09	0.81
Ford	6	0.1	25.6	0.05	74.25	0.01	0.00	0.67	0.00
Datsun	8	10.9	14.7	38.2	36.2	0.93	0.21	0.22	0.72
Toyota	9	4.7	21.6	12.6	61.1	0.51	0.14	0.27	0.37
Volkswagon	21	8.4	30.0	18.3	43.3	0.55	0.17	0.31	0.38
Honda	6	0.0	0.0	0.0	100.0	--	--	--	--
Others	33	2.8	26.5	15.0	55.7	0.43	0.07	0.16	0.36

1/ Garage instruments

TABLE V

Comparison of E_c, E_o, FF, PP, $\frac{E_c + FF}{E_o + FF}$, $\frac{E_c}{E_o + FF}$, $\frac{E_c}{E_c + FF}$, and $\frac{FF}{E_o + FF}$

from 300 Car 1975 Model Year Fleet

Oxides of Nitrogen [1/]

Idle Test - Automatic Transmission in Drive,

Manual Transmission in Neutral

Engine Size (CID)	No. of Vehicles	E_c	E_o	FF	PP	$\frac{E_c+FF}{E_o+FF}$	$\frac{E_c}{E_o+FF}$	$\frac{E_c}{E_c+FF}$	$\frac{FF}{E_o+FF}$
≥260CID									
All Vehicles	151	5.0	16.3	8.5	70.2	0.54	0.20	0.37	0.34
General Motors	74	4.0	15.3	6.2	74.5	0.47	0.19	0.39	0.29
Ford	42	3.0	25.4	12.8	58.8	0.41	0.08	0.19	0.33
Chrysler	29	12.2	6.3	5.8	75.7	1.49	1.01	0.68	0.48
AMC	6	0.0	34.9	3.3	61.8	0.09	0.00	0.00	0.09
151-259CID									
All Vehicles	54	5.0	15.4	4.6	75.0	0.48	0.25	0.52	0.23
General Motors	13	5.8	20.1	1.8	72.3	0.35	0.26	0.76	0.08
Ford	13	2.9	9.0	4.1	84.0	0.53	0.22	0.41	0.31
Chrysler	7	7.4	20.7	13.5	58.4	0.61	0.22	0.35	0.39
AMC	12	2.0	20.0	7.7	70.3	0.35	0.07	0.21	0.28
Others	7	4.8	7.8	3.7	83.7	0.74	0.42	0.56	0.32
≤150CID									
All Vehicles	95	5.0	9.0	6.5	79.5	0.74	0.32	0.43	0.42
General Motors	12	9.9	2.7	8.3	79.1	1.65	0.90	0.54	0.75
Ford	6	0.8	12.5	0.4	86.3	0.90	0.06	0.67	0.03
Datsun	8	27.2	23.8	2.8	46.2	1.13	1.02	0.91	0.10
Toyota	9	0.34	57.0	6.6	36.06	0.11	0.01	0.05	0.10
Volkswagon	21	0.6	0.9	0.4	98.1	0.77	0.46	0.60	0.31
Honda	6	0.7	0.1	0.03	99.17	5.62	5.38	0.96	0.23
Others	33	2.4	9.8	2.8	85.0	0.41	0.19	0.46	0.22

1/ Laboratory instruments

TABLE VI

Comparison of E_c, E_o, FF, PP, $\frac{E_c + FF}{E_o + FF}$, $\frac{E_c}{E_o + FF}$, $\frac{E_c}{E_c + FF}$, and $\frac{FF}{E_o + FF}$

from 300 Car 1975 Model Year Fleet

Hydrocarbons

Federal Short Cycle

Engine Size (CID)	No. of Vehicles	E_c	E_o	FF	PP	$\frac{E_c+FF}{E_o+FF}$	$\frac{E_c}{E_o+FF}$	$\frac{E_c}{E_c+FF}$	$\frac{FF}{E_o+FF}$
≥ 260CID									
All Vehicles	151	5.0	12.5	20.4	62.1	0.77	0.15	0.20	0.62
General Motors	74	4.0	8.9	21.8	65.3	0.84	0.13	0.16	0.71
Ford	42	2.8	11.4	18.0	67.8	0.71	0.10	0.13	0.61
Chrysler	29	4.0	20.3	40.5	35.2	0.73	0.07	0.09	0.67
AMC	6	0.0	0.0	0.0	100.0	0.00	0.00	0.00	0.00
151-259CID									
All Vehicles	54	5.0	14.0	13.3	67.7	0.67	0.18	0.27	0.49
General Motors	13	1.8	13.1	18.6	66.5	0.64	0.06	0.09	0.59
Ford	13	6.0	5.3	10.8	77.9	1.04	0.37	0.36	0.67
Chrysler	7	1.5	14.5	4.6	79.4	0.32	0.08	0.25	0.24
AMC	12	1.9	16.9	21.0	60.2	0.60	0.05	0.08	0.55
Others	7	4.9	0.7	9.1	85.3	1.43	0.50	0.35	0.93
≤ 150CID									
All Vehicles	95	5.0	13.0	19.1	62.9	0.75	0.16	0.21	0.60
General Motors	12	2.9	13.4	20.5	63.2	0.69	0.09	0.12	0.60
Ford	6	2.1	5.4	13.9	78.6	0.83	0.11	0.13	0.72
Datsun	8	3.9	6.7	41.7	47.7	0.94	0.08	0.09	0.86
Toyota	9	0.3	31.5	11.8	56.4	0.28	0.01	0.02	0.27
Volkswagon	21	2.7	18.9	17.7	60.7	0.56	0.07	0.13	0.48
Honda	6	4.9	7.4	0.8	86.9	0.70	0.60	0.86	0.10
Others	33	7.2	10.3	19.4	63.1	0.90	0.24	0.27	0.65

TABLE VII

Comparison of E_c, E_o, FF, PP, $\frac{E_c + FF}{E_o + FF}$, $\frac{E_c}{E_o + FF}$, $\frac{E_c}{E_c + FF}$, and $\frac{FF}{E_o + FF}$

from 300 Car 1975 Model Year Fleet

Carbon Monoxide

Federal Short Cycle

Engine Size (CID)	No. of Vehicles	E_c	E_o	FF	PP	$\frac{E_c+FF}{E_o+FF}$	$\frac{E_c}{E_o+FF}$	$\frac{E_c}{E_c+FF}$	$\frac{FF}{E_o+FF}$
≥ 260CID									
All Vehicles	151	5.0	13.0	44.2	37.8	0.86	0.09	0.10	0.77
General Motors	74	5.2	12.2	38.1	44.5	0.86	0.10	0.12	0.76
Ford	42	10.1	8.4	52.0	29.5	1.03	0.17	0.16	0.86
Chrysler	29	2.0	6.6	76.4	15.0	0.94	0.02	0.03	0.92
AMC	6	0.4	0.0	0.0	99.6	--	--	1.00	0.00
151-259CID									
All Vehicles	54	5.0	14.6	41.0	39.4	0.83	0.09	0.11	0.74
General Motors	13	0.5	20.4	44.1	35.0	0.69	0.01	0.01	0.68
Ford	13	8.7	6.4	38.6	46.3	1.05	0.19	0.18	0.86
Chrysler	7	2.6	30.8	38.3	28.3	0.59	0.04	0.06	0.55
AMC	12	4.1	16.4	34.5	45.0	0.76	0.08	0.11	0.68
Others	7	4.6	5.6	48.4	41.4	0.98	0.09	0.09	0.90
≤ 150CID									
All Vehicles	95	5.0	19.4	25.4	50.2	0.68	0.11	0.16	0.57
General Motors	12	0.1	36.9	40.5	22.5	0.52	0.00	0.00	0.52
Ford	6	0.0	23.8	1.8	74.4	0.07	0.00	0.00	0.07
Datsun	8	0.4	33.1	19.8	46.7	0.38	0.01	0.02	0.37
Toyota	9	3.7	25.6	8.6	62.1	0.36	0.11	0.30	0.25
Volkswagon	21	4.9	24.5	23.4	47.2	0.59	0.10	0.17	0.49
Honda	6	0.0	0.0	0.0	100.0	--	--	--	--
Others	33	6.8	10.7	30.8	51.7	0.91	0.16	0.18	0.74

TABLE VIII

Comparison of E_c, E_o, FF, PP, $\frac{E_c + FF}{E_o + FF}$, $\frac{E_c}{E_o + FF}$, $\frac{E_c}{E_c + FF}$, and $\frac{FF}{E_o + FF}$

from 300 Car 1975 Model Year Fleet

Oxides of Nitrogen

Federal Short Cycle

Engine Size (CID)	No. of Vehicles	E_c	E_o	FF	PP	$\frac{E_c+FF}{E_o+FF}$	$\frac{E_c}{E_o+FF}$	$\frac{E_c}{E_c+FF}$	$\frac{FF}{E_o+FF}$
≥ 260CID									
All Vehicles	151	5.0	11.5	13.3	70.2	0.74	0.20	0.27	0.54
General Motors	74	1.1	10.9	10.7	77.3	0.55	0.05	0.09	0.50
Ford	42	0.6	23.5	14.7	61.2	0.40	0.02	0.04	0.38
Chrysler	29	20.9	2.1	10.0	67.0	2.55	1.73	0.68	0.83
AMC	6	9.0	2.4	38.9	49.7	1.16	0.22	0.19	0.94
151-259CID									
All Vehicles	54	5.0	7.5	12.5	75.0	0.88	0.25	0.29	0.62
General Motors	13	0.5	10.8	11.0	77.7	0.53	0.02	0.04	0.50
Ford	13	6.2	8.4	4.7	80.7	0.83	0.47	0.57	0.36
Chrysler	7	5.0	6.9	27.4	60.7	0.94	0.15	0.15	0.80
AMC	12	13.6	1.7	26.0	58.7	1.43	0.49	0.34	0.94
Others	7	0.6	7.5	3.0	88.9	0.34	0.06	0.17	0.29
≤ 150CID									
All Vehicles	95	5.0	5.8	9.8	79.4	0.95	0.32	0.34	0.63
General Motors	12	3.9	2.2	8.8	85.1	1.15	0.35	0.31	0.80
Ford	6	19.2	5.8	7.1	67.9	2.04	1.49	0.73	0.55
Datsun	8	2.9	10.8	14.7	71.6	0.69	0.11	0.16	0.58
Toyota	9	0.7	35.9	28.6	34.8	0.45	0.01	0.02	0.44
Volkswagen	21	1.2	1.1	0.2	97.5	1.08	0.92	0.86	0.15
Honda	6	0.0	0.1	0.0	99.9	0.00	0.00	0.00	0.00
Others	33	1.7	3.8	8.8	85.7	0.83	0.13	0.16	0.70

TABLE IX

results from repeated FTP tests on the same vehicle results in a potential for errors even if the FTP itself were the 207(b) test. A contingency table example of this is given in Table X.

E_c and E_o from two samples of randomly generated FTP variables

The first generated variable is the assumed FTP and the second generated variable is the assumed short test. The variables were generated assuming a normal distribution with the mean equal to the measured FTP value for each 1975 MY vehicle in the FY74 EFP and a coefficient of variability of 15% for HC and 20% for CO.

Pollutant	E_c	E_o	FF	PP	$\frac{E_c + FF}{E_o + FF}$	$\frac{E_c}{E_o + FF}$	$\frac{E_c}{E_c + FF}$	$\frac{FF}{E_o + FF}$
HC	6	12	21	62	0.55	0.18	0.22	0.64
CO	5	1	47	47	1.08	0.10	0.10	0.98

TABLE X

Based on the model used to develop Table X, a comparison of the results given in Tables IV, V, VII, and VIII with those in Table X indicates that the short tests are doing an acceptable job of categorizing vehicles into the four classes of the contingency table.

4.4 Determination of short test cutpoints

The implementation of section 207(b) will require that short test cutpoints be determined for each vehicle size/engine/technology, hereinafter called a group for each model year of vehicles which is produced after 207(b) final rulemaking. The cutpoints need to be determined in such a way as to continue to assure that the short tests promulgated correlate with the FTP. Thus, the analytical methods used to define acceptable short tests are the same analytical methods which will be used to determine short test cutpoints; that is, the contingency table correlation technique.

The cutpoint analysis can only be performed after an acceptable data base has been collected. The collection of this data base must ensure the following:

a. That emissions be measured by the FTP and by each applicable short test.

b. That emissions be measured from every group which is in production so as to establish group to group differences.

c. That a statistically viable number of vehicles be tested in each group so as to quantify within each group the differences in emissions caused by production tolerance stack-up.

d. That emissions be measured from vehicles which pass and from vehicles which fail the standards.

e. That the effects caused by significant differences in altitude must be resolvable from the data.

It appears logical to expect the short test pass/fail levels to change in response to changes in the FTP emission standards and also to be affected by modifications in technology. For the immediate future, therefore, the Agency should plan on having a yearly program for the collection of data from new model year vehicles. This data will be analyzed to determine model year and group cutpoints. The exact size of such a test program is not known at the present time because it is dependent upon the manufacturers' model mix and changes in vehicle variability. A preliminary estimate of the program would allow for the testing of 50 vehicles from each group in production and could be expected to result in the testing of between 3000 and 5000 vehicles annually. (Although a program of this size would be expensive, the outputs of such a program, if performed under strict quality control conditions on properly maintained vehicles, could also be used to implement section 207(c) of the Clean Air Act). Three methods of collecting these data are under consideration at this time. One is based upon additional testing during certification of new vehicles, another involves assembly line testing and the third is based upon field testing of in-use vehicles. These approaches are described in section 6.2.1.

A pilot program is being performed in Portland, Oregon on 1975/76 model vehicles. This program may allow a decision to be made on whether fewer numbers of cutpoints and, therefore, a smaller test program, could be implemented. Issues pertaining to the implementation of a yearly cutpoint program are discussed in section 6.

5. Projected Emissions Reductions

The projections given in this section are estimates which are based on very limited data, i.e. the 300 1975 model year cars tested in three cities, and must be treated as such. The methodology used in the development of each projection is given in detail so that the reader can fully understand the assumptions which are required to be made in the development of the projections.

Before going into the discussion of each projection, the question must be addressed as to the benefits which can be credited to section 207(b) versus what benefits can be credited to an Inspection and Maintenance program. The issuance of 207(b) short test cutpoints without a vehicle inspection and maintenance program will result in zero reduction in vehicle emissions. An inspection and maintenance program can exist, however, without the implementation of section 207(b) through the selection of the 207(b) cutpoints or based on other criteria such as fixed failure rates. If the implementation of 207(b) results in states or regions implementing I/M programs which would not otherwise have been implemented or if the implementation of 207(b) results in states selecting more stringent pass/fail cutpoints than would otherwise have been adopted, then 207(b) implementation can be credited with obtaining air quality benefits. On the other hand, I/M programs can be implemented without 207(b) and can achieve all of the air quality benefit independent of 207(b) implementation.

It was judged to be reasonable for the purposes of this document to lump the effectiveness of I/M and 207(b) into one projection which is predicated on the use of EPA determined short test cutpoints in viable state or local government operated I/M programs. Cutpoints were determined based upon a 5% error of commission rate. A companion analysis for an I/M program utilizing a failure rate of approximately 33% of the vehicles tested is also presented for comparison purposes. The 33% failure rate corresponded to approximately a 2% E_c rate and is typical of many existing I/M programs. The failure rates for each pollutant were: 7% for HC, 22% for CO and 4% NOx, giving a total failure rate of 33%. The period of time for which the effectiveness is computed corresponds to the useful life of the vehicle as defined in the Clean Air Act. Thus, the difference in effectiveness between the two cases provides an estimate of potential benefits which could accrue if the 207(b) cutpoints were adopted in an I/M program which is typical of current programs. Benefits which can be expected to accrue through the continuation of inspections throughout the actual life of the vehicle should be credited solely to I/M and are not presented in this document.

5.1 Projected Emissions Reductions

Since a multitude of factors must be considered in the computation of emissions reductions projections for the implementation of section 207(b), these factors are grouped below into categories titled Knowns, Unknowns and Assumptions.

5.1.1 Knowns

1. Vehicle emissions tend to increase with age and the accumulation of mileage. This rate of increase referred to as the deterioration factor is known for vehicles which are operated and maintained under the vehicle certification program. The deterioration rates for both catalyst equipped and non-catalyst equipped vehicles are known. The deterioration rates which were derived from the 1975 model year certification fleet (not sales weighted) for use in this analysis were:

HC - 0.014 gm/mile/1000 miles

CO - 0.084 gm/mile/1000 miles

NOx - 0.0 gm/mile/1000 miles

2. Some data are available on the deterioration rates of in-use vehicles from the Emissions Factors Programs (EFP)*. These deterioration rates do not cover extensive periods of time for new model years.

3. The emissions levels of in-use vehicles tend, on the average, to be significantly higher than would be predicted if these vehicles deteriorated at the same rate as certification vehicles and had been in compliance at the time of manufacture.

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* In-house correspondence dated August 6, 1976 and September 16, 1976 on deterioration rates of various aged vehicles.

4. The relationship between short test emissions and FTP emissions is known for the 300 car fleet. The emission standards to which the vehicles were manufactured is also known.

5. Within the 300 car fleet, those cars that failed the FTP tended to do so by a substantial margin, thereby implying a very high rate of deterioration. The majority of those cars which passed the FTP did so by a relatively safe margin, thereby showing a low rate of deterioration. There is a strong indication, therefore, that there is a significant difference in deterioration rates between those cars which pass the FTP and those cars which fail the FTP.

1975 Model Year Cars Tested In Chicago in FY74 EFP

	HC	CO	NOx
FTP Standards	1.5 gm/mile	15.0 gm/mile	3.1 gm/mile
Average of all cars	1.18 "	22.47 "	2.41 "
Average of FTP passing cars	0.76 "	9.52 "	2.11 "
Average of FTP failing cars	2.36 "	34.03 "	3.79 "

6. Statistical tests of both the short test data and the FTP data from the 300 car fleet indicated that the assumption that each exhibited log normal distribution characteristics could not be rejected.

7. A positive correlation (Pearson regression) was observed between HC and CO emissions of the 300 car test fleet as measured by the FTP.

5.1.2 Unknowns

1. The emissions levels of the cars that were tested in this project at the time of manufacture are not known. It is, therefore, not possible to determine exactly the deterioration rate of the vehicles from the time of manufacture to the time of first inspection.

2. The overall deterioration rates of in-use cars in either an I/M or a non I/M environment are not known. The shape of the deterioration curve is also not known, i.e., whether the deterioration is linear or is rapid or slow immediately following maintenance.

3. The reasons why emissions from many vehicles in the EFP are higher than the standards to which the vehicles were manufactured are not known. Possible reasons for the observed elevated emissions are:

   a. The vehicle exceeded the standard at the time of manufacture and shipping from the production facility.

   b. The vehicle was readjusted (incorrectly) by the dealer prior to delivery to the owner.

c. The vehicle was readjusted (incorrectly) after delivery to the owner either by the owner, a mechanic or the dealer, as a consequence of owner dissatisfaction with the vehicle's operation (driveability, hard starting, fuel economy, etc.).

d. The vehicle deteriorated at a much higher rate than would be predicted by the certification process either because of defective parts or methods of operation, e.g., use of leaded fuel in a catalyst equipped vehicle.

4. The effectiveness of maintenance performed by the service industry, with respect to reducing emissions under real world conditions, is not known. Some laboratory data are available but these are rather incomplete.

5. The period of effectiveness of maintenance (i.e., the point in mileage accumulation following maintenance at which the vehicle emissions have returned to their levels before maintenance) is unknown.

6. With the implementation of section 207(b), it is not known whether the manufacturers will attempt to incorporate a larger margin of safety between the emissions standards and their design goals.

7. The frequency of inspection which will be adopted by each state is unknown.

5.1.3 Assumptions

General Assumptions

The premise used in the development of assumptions was to err on the side of producing low program effectiveness predictions rather than high program effectiveness predictions.

1. Because the 300, 1975 model year fleet does not contain a sufficient number of identical vehicle/engine/technology specific vehicles, vehicles are grouped into three engine sizes for purposes of analysis as well as into a single fleet. The engine size groupings are: (1) small, less than 150 CID, and mainly 4 cylinder engines; (2) medium, 151 through 259 CID, and mainly 6 cylinder engines; and (3) large, greater than 260 CID engines.

2. Vehicle inspections are equally distributed throughout the year and as a consequence, each vehicle in the population receives its inspection when it is approximately 1 year old, 2 years old, etc.

3. The rate of vehicle mileage accumulation does not vary significantly from the rates reported in the Department of Transportation Vehicle Usage Survey and as a consequence, vehicle inspections will occur when vehicles have accumulated 17,500 miles (1 year of age), 33,600 miles (2 years of age) and 46,800 miles (3 years of age).

4. Vehicles which are not in a 207(b)/Inspection and Maintenance program basically exhibit two deterioration rates based on their classification at the first inspection. One deterioration rate applies to PP and E_c vehicles, i.e., low emitters, and is the same as that determined in the certification process. The second deterioration rate applies to high emitters, FF and E_o vehicles, and is represented by the levels as determined in the EFP. (Figure 9)

5. The deterioration rates derived from the 1968 through 1974 MY cars in the EFP are applicable to newer model year cars which fail the FTP, i.e. catalyst equipped vehicles which fail the FTP. The deterioration rates which were developed from the EFP data and which were used in this analysis were:

HC	-	0.072 gm/mile/1000 miles
CO	-	0.80 gm/mile/1000 miles
NOx		0.0 gm/mile/1000 miles

6. Deterioration rates are assumed to be linear with mileage between any two points on the mileage-accumulation-versus-emissions plot. This assumption is used irrespective of the assumed period of effectiveness of maintenance.

7. Three periods for the effectivenss of maintenance are assumed for cars that are FF vehicles at the first inspection: 6 months,

9 months and 12 months, and the effectiveness of a 207(b)/Inspection and Maintenance program is computed for each case. These effectiveness of maintenance periods become applicable to E_o vehicles once they become FF vehicles.

8. The effectiveness of maintenance in an inspection program is such that the emissions immediately following inspection and maintenance are assumed to just meet the emissions standards for the pollutant that the vehicle failed. Because of the positive correlation which was observed between HC and CO emissions (Known #7), three methods for computing the level of the short test passing pollutant, following maintenance, were employed.

These methods were:

a. That the pollutant level was unaffected by the maintenance performed to correct the other pollutant.

b. That the pollutant level was affected by the maintenance, and was reduced by the same percentage as was the pollutant that caused the vehicle to fail the short test.

c. That a lower limiting value was applied to (b) above where no short test passing pollutant was reduced to less than one half of the stautory standard.

9. A second set of assumptions was also used in the computation of the effectiveness of maintenance. This assumption sets the FTP level following maintenance at the level which is projected to correspond to the short test cutpoint. There is assumed to be no effect on the short test passing pollutant as a result of maintenance, i.e. the same as case 8.a., above.

Specific Assumptions for PP, FF, E_o and E_c Vehicles

10. The correctly passing vehicles, i.e., PP vehicles, are assumed to perform similarly to certification vehicles and the certification deterioration factor is assumed applicable to these cars. (Figure 10).

11. Error of commission vehicles, E_c vehicles, are assumed to be tuned after inspection so that their emissions just correspond to the standards, i.e., their emissions are increased. Because these vehicles are assumed to be inherently "good" vehicles, the certification deterioration factor is applied following maintenance (Figure 11).

12. Error of omission vehicles, E_o vehicles, because they are truly high emitters but do not receive forced maintenance, are assumed to deteriorate at the same rate as vehicles which are

DETERIORATION CHARACTERISTICS OF VEHICLES IN A NON I/M ENVIRONMENT

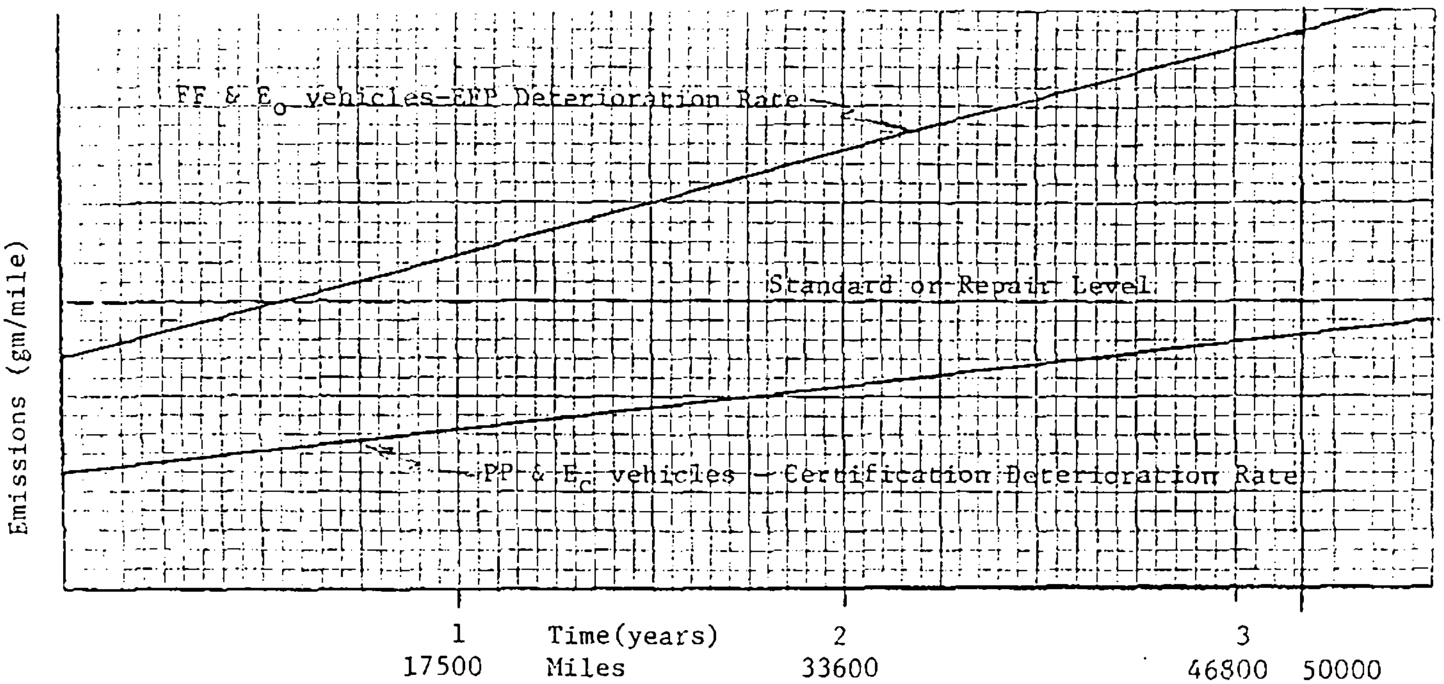


FIGURE 9

DETERIORATION CHARACTERISTICS OF VEHICLES IN A 207(b)/I/M ENVIRONMENT
VEHICLES WHICH PASS THE FIRST INSPECTION

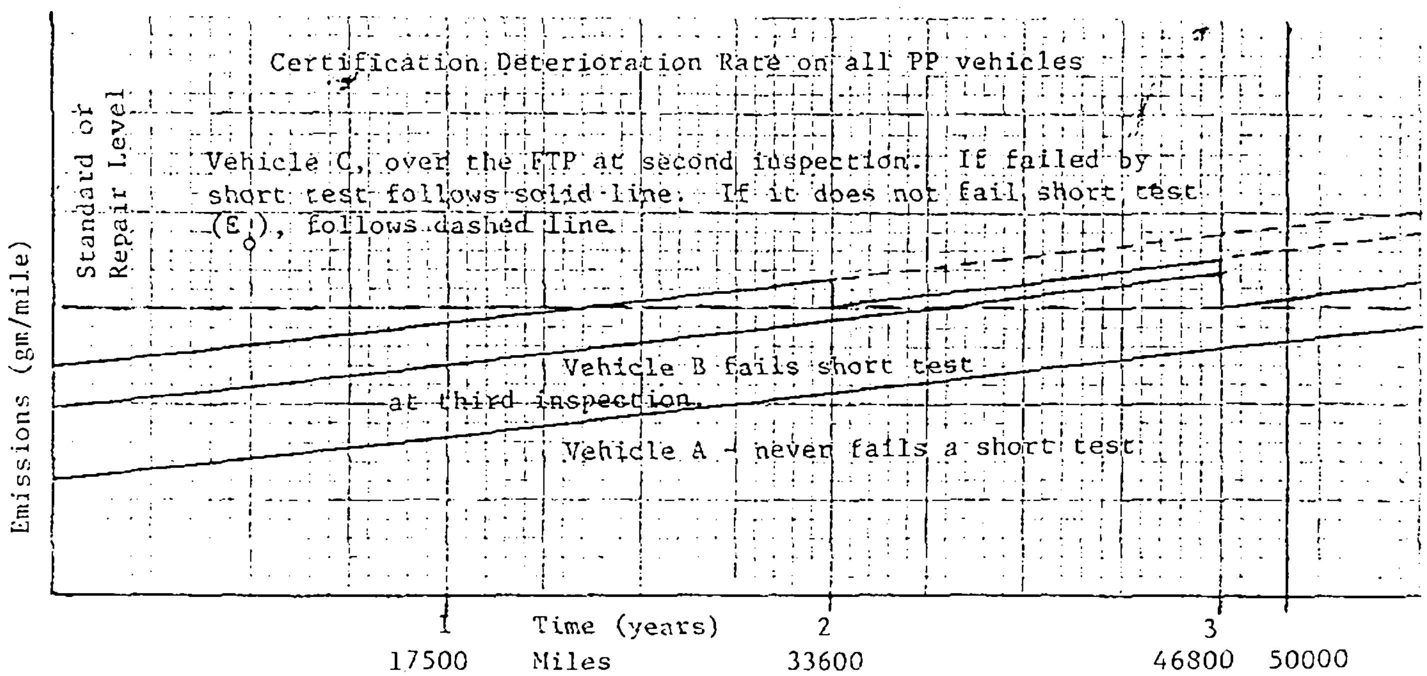


FIGURE 10

DETERIORATION CHARACTERISTICS OF VEHICLES IN A 207(b)/I/M ENVIRONMENT
ERROR OF COMMISSION VEHICLES AT FIRST INSPECTION

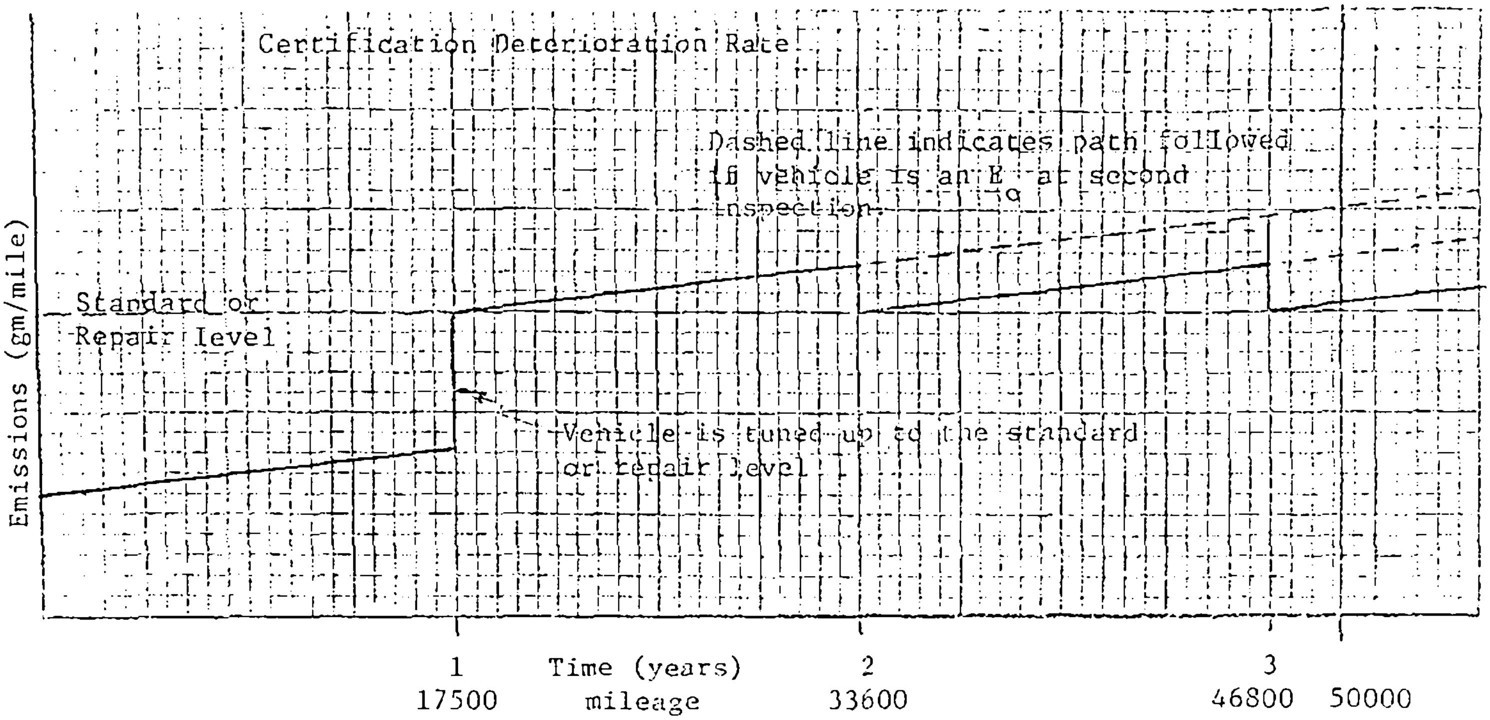


FIGURE 11

DETERIORATION CHARACTERISTICS OF VEHICLES IN A 207(b)/I/M ENVIRONMENT
ERROR OF OMISSION VEHICLES AT FIRST INSPECTION

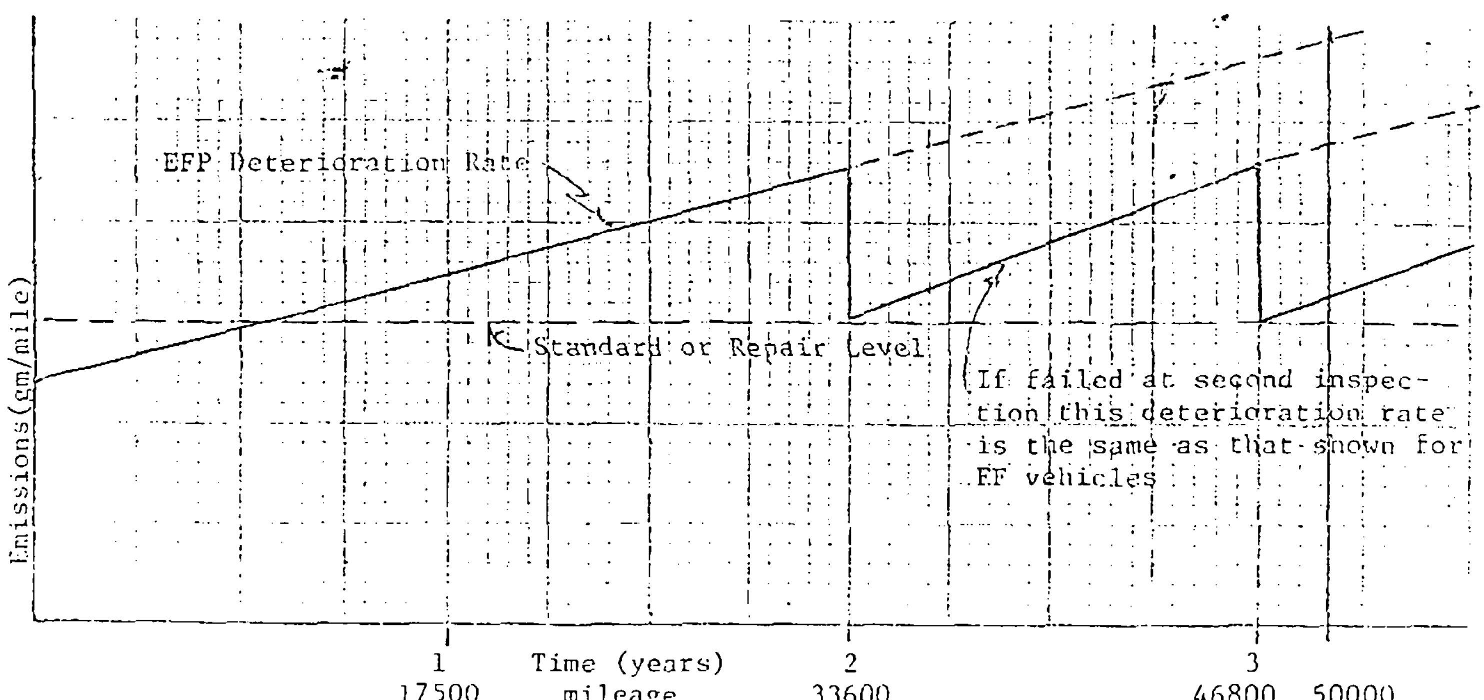


FIGURE 12

not in an I/M program, i.e., at a rate determined from the EFP. The emissions level from which this deterioration begins is that which existed at the time of inspection (Figure 12).

13. Correctly failed vehicles, FF vehicles, are assumed to be repaired so as just to bring them into compliance with the emissions standards or standards set in assumption #9. Because the primary reason for their not being in compliance in the first case is not known, it is assumed that their emissions levels will tend to increase more rapidly than the fleet average following maintenance, and three models are applied to these vehicles so as to bracket the potential eventualities. The three deterioration models which are applied to FF vehicles are:

a. That these vehicles deteriorate to their emissions levels which existed prior to inspection in 12 months (one inspection period). (Figure 13)

b. That these vehicles deteriorate to their emissions levels which existed prior to inspection in 9 months and then continue to deteriorate at a rate which is equal to vehicles in a non-I/M program (the EFP Rate) until the next inspection. (Figure 13)

c. That these vehicles deteriorate to their emisssions levels which existed prior to inspection in 6 months and then continue to deteriorate at a rate which is equal to vehicles

DETERIORATION CHARACTERISTICS OF VEHICLES IN A 207(b)/I/M ENVIRONMENT
VEHICLES WHICH FAIL THE FIRST INSPECTION

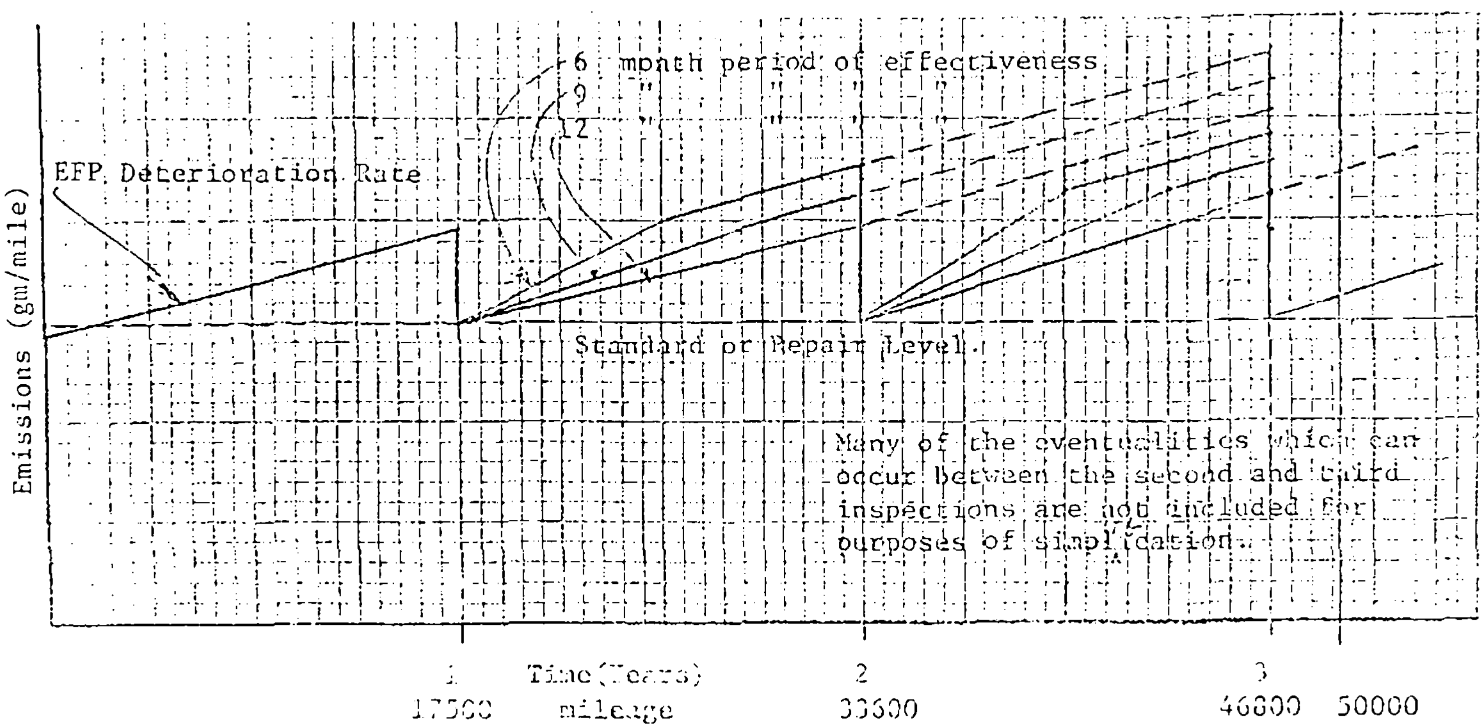


FIGURE 13

in a non-I/M program (the EFP rate) until the next inspection. (Figure 13).

5.1.4 Methodology for Computing the Effectiveness of a 207(b)/ Inspection and Maintenance Program.

The following procedure was utilized in the generation of the results given in section 5.1.5.

1. Since the idle test (normal idle speed) is currently being selected by most states and regions for in-use vehicle inspections for HC and CO, and as the high speed mode of the Federal 3 mode is the most adaptable test for NOx, the projected program effectiveness was computed on the basis of these tests.

2. Vehicles within the 300 car sample were grouped according to engine size. The size groupings followed those specified in section 5.1.3, number 1.

3. The 300 car data set was used to establish emissions distribution characteristics as measured by both the short tests and by the FTP. Distribution characteristics were established based on the total fleet and for each of the three groups within the fleet. In all cases, the distribution characteristics were determined to be log normal.

4. The short test pass/fail levels were determined from the 300 car <u>test</u> fleet data using a 5% error of commission rate. Short test cutpoints were determined for the whole fleet and for each group within the fleet. Also, a set of cut points were determined for the I/M case where a 33% overall failure rate was modeled.

5. A 3000 car fleet was modeled based on the distribution characteristics of the 300 car test fleet. This fleet contained the same relative number of small, intermediate and large engine sizes as was contained in the test fleet. This modeling was necessary to guard against a distortion in results which would have occurred with the small number of vehicles (300) in the test fleet.

6. The emissions as measured by the FTP from <u>each</u> vehicle in the 3000 vehicle model was tracked from its first inspection point, i.e., 17,500 miles, to its 50,000 mile point.

7. The total mass of emissions emitted by each vehicle from its first inspection through 50,000 miles was computed using the appropriate deterioration characteristic for that vehicle as shown in Figures 10 through 13, i.e., the area under each curve was integrated to determine the total mass of emissions emitted. This period was used in the computation of program effectiveness because the vehicle's emissions will not be affected by the program prior to the first inspection. A bivariate log-normal model for distribution was used to establish the short test emissions levels for each vehicle at its second and third inspections. The original, within-group,

short test cutpoints were applied to each vehicle to establish its new classification in the contingency table at the second and third inspections. Because of the assumptions on vehicle deterioration characteristics, the categories into which each vehicle can be placed in any following inspection is dependent upon the categorization of a vehicle in the previous insepction. These possible new categories, together with the results on emissions with time, are given below and are depicted in Figures 10 through 13.

a. If the vehicle was classified as a correctly passing (PP) vehicle in the previous inspection, then it can be classified as either a PP, FF, E_o or an error of commission (E_c) vehicle in the following inspection.

b. If the vehicle was classified as correctly failing (FF) in a previous inspection, then it can only be classified as either an FF or an error of omission (E_o) vehicle in the next inspection. That is, since the FTP emissions are assumed to just meet standards after vehicle repair, once a vehicle fails the FTP, it will always fail the FTP, although it will not necessarily always fail the short test.

c. If the vehicle was classified as an error of commission (E_c) vehicle in a previous inspection, then it can only be classified as an FF or an E_o vehicle in the next inspection.

d. If the vehicle was an error of omission (E_O) vehicle in the previous inspection, then it can only be classified as an FF or an E_O vehicle.

8. The total mass of emissions from each vehicle in a non 207(b) /I/M environment was computed by classing the vehicles as either FTP passing or failing and deteriorating the vehicles as shown in Figure 9.

9. The effectiveness, expressed as a percentage reduction in emissions for each pollutant of a 207(b)/I/M program, was determined for each pollutant by determining the total mass of emissions following the first inspection which would be emitted by the fleet under study in both the non-inspection and inspection cases and expressing the reduction which occurred with inspection as a percentage of the non-inspection case, i.e.,

$$\text{207(b)/I/M Effectiveness} = \frac{\text{(Total emissions without inspection)} - \text{(Total emissions with inspection)}}{\text{(Total emissions without inspection)}}$$

5.1.5 Effectiveness-Results Projections

The resulting projections for the reductions in light duty vehicle emissions associated with an I/M program which uses 207(b) cutpoints are given below:

<u>Case a.</u> The level of the short test passing pollutant was unaffected by maintenance to correct the short test failing pollutant and maintenance lowered the level of the failing pollutant to the FTP standards.

Maintenance Effectiveness Period (Months)	Number of years since first inspection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NOx
12	1	22.7	29.7	2.05
	2	31.6	35.9	1.81
	50,000 miles	34.6	39.1	2.00
9	1	19.5	24.2	1.25
	2	26.7	29.4	1.04
	50,000 miles	30.0	33.0	1.29
6	1	14.6	17.3	0.46
	2	19.8	21.2	0.22
	50,000 miles	23.3	25.1	0.50

TABLE XI

Case b. The level of the short test passing pollutant was unaffected by maintenance and the FTP value of the failing pollutant was corrected to correspond to the short test cutpoint.*

Maintenance Effectiveness Period (Months)	Number of years since first inspection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NOx
12	1	21.1	29.0	1.78
	2	30.0	35.2	1.55
	50,000 miles	32.9	38.3	1.70
9	1	18.4	23.6	1.05
	2	25.4	28.9	0.82
	50,000 miles	28.5	37.3	1.05
6	1	13.8	17.0	0.32
	2	18.9	20.8	0.08
	50,000 miles	22.1	24.6	0.33

TABLE XII

* The FTP values which correspond to the short test values and which were used in this model are:

Engine Size (CID)	HC (gm/mile)	CO (gm/mile)	NOx (gm/mile)
$\leq$150	1.57	18.08	3.10
151-259	1.63	16.66	3.10
$\geq$260	1.81	15.0	3.26

TABLE XIII

Case c. The level of the short test passing pollutant was affected by maintenance and was reduced by the same percentage as was the failing pollutant as a result of maintenance. The failing pollutant was lowered to the FTP Standard.

Maintenance Effectiveness Period (Months)	Number of years since first in-spection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NOx
12	1	22.7	32.6	2.05
	2	31.6	39.2	1.81
	50,000 miles	34.6	42.8	2.00
9	1	19.5	26.4	1.25
	2	26.7	32.1	1.04
	50,000 miles	30.0	36.4	1.29
6	1	14.6	18.8	0.46
	2	19.8	23.2	0.22
	50,000 miles	23.3	27.9	0.50

TABLE XIV

<u>Case d.</u> The level of the short test passing pollutant was affected by maintenance and was reduced by the same percentage as the failing pollutant except a lower bound for improvement of one half of the statutory standard was imposed on the short test passing pollutant. The failing pollutant was lowered to the FTP standard.

Maintenance Effectiveness Period (Months)	Number of years since first in-spection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NOx
12	1	22.7	32.4	2.05
	2	31.6	39.0	1.81
	50,000 miles	34.6	42.5	2.00
9	1	19.5	26.2	1.25
	2	26.7	31.9	1.04
	50,000 miles	30.0	36.1	1.29
6	1	14.6	18.7	0.46
	2	19.8	23.0	0.22
	50,000 miles	23.3	27.6	0.50

TABLE XV

The short test cutpoints which were used in each of the above projections were based on a 5% error of commission rate for <u>each</u> engine size group. These cutpoints are given below:

Engine Group (CID)	Short test cutpoints		
	HC (ppm)	CO%	NOx (ppm)
≤150	219	1.84	2805
151-259	213	0.71	1395
≥260	151	0.27	1986

TABLE XVI

The results of the companion analyses which used a fixed overall failure rate of approximately 33% and grouped all vehicles into the same class* is given below. Results from case (a) in this group compare to results from case (a) in Table XI where the 207(b) cutpoints are used, etc.

Case a.

Maintenance Effectiveness Period (Months)	Number of years since first inspection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NOx
12	1	16.4	22.2	1.59
	2	24.0	27.7	1.58
	50,000 miles	27.0	30.8	1.78
9	1	14.1	18.0	1.04
	2	20.1	22.5	1.03
	50,000 miles	23.2	25.9	1.28
6	1	10.5	12.8	0.50
	2	14.8	16.2	0.45
	50,000 miles	18.1	19.7	0.73

TABLE XVII

* This approach was taken because most existing I/M programs group all vehicles into one class per model year.

Case b.

Maintenance Effectiveness Period (Months)	Number of years since first inspection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NOx
12	1	14.3	18.4	1.04
	2	21.2	23.6	0.99
	50,000 miles	23.7	26.1	1.13
9	1	12.5	15.1	0.63
	2	17.9	19.3	0.58
	50,000 miles	20.3	22.0	0.76
6	1	9.4	10.9	0.23
	2	13.3	14.0	0.15
	50,000 miles	15.7	16.8	0.34

TABLE XVIII

The FTP values which corresponded to the short test values and which were used in this model are*

Engine Size (CID)	HC (gm/mile)	CO (gm/mile)	NOx (gm/mile)
$\leq$150	1.71	17.66	3.10
151-250	1.84	21.82	3.79
$\geq$260	2.69	32.51	4.06

TABLE XIX

* Note the significant differences in FTP values used in these two case comparisons as shown in Tables XIII and XIX:

Case c.

Maintenance Effectiveness Period (Months)	Number of years since first inspection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NO
12	1	16.4	2.15	1.59
	2	24.0	30.5	1.58
	50,000 miles	27.0	34.1	1.78
9	1	14.1	19.6	1.04
	2	20.1	24.7	1.03
	50,000 miles	23.2	28.8	1.28
6	1	10.5	13.9	0.50
	2	14.8	17.8	0.45
	50,000 miles	18.1	22.1	0.73

TABLE XX

Case d.

Maintenace Effectiveness Period (Months)	Number of years since first in-spection and final mileage	Estimated Overall Program Effectiveness in %. Cumulative not yearly.		
		HC	CO	NOx
12	1	16.4	24.3	1.59
	2	24.0	30.3	1.58
	50,000 miles	27.0	33.8	1.78
9	1	14.1	19.5	1.04
	2	20.1	24.5	1.03
	50,000 miles	23.2	28.5	1.28
6	1	10.5	13.8	0.50
	2	14.8	17.6	0.45
	50,000 miles	18.1	21.8	0.73

TABLE XXI

The short test cutpoints which were used in each of the cases where all vehicl were treated as a single group and which produced approximately a 33% failure rate for all pollutant are given below:

Vehicle Class	Short Test Cutpoints* HC (ppm)	CO (%)	NOx (ppm)
All	269	1.71	2833

TABLE XXII

* The substantial differences in cutpoints between Tables XVI and XXII must be noted.

6. Discussion of Issues and Future Work

6.1 Expected Technical Objections to the NPRM by Industry and Environmentalists.

6.1.1 Objection: The data upon which the NPRM are based were all collected under laboratory conditions and do not, therefore, include the effects of real world variables.

Response: This is true and the agency is proceeding with the collection of data under real world conditions to evaluate the effects. The short test pass/fail levels will be determined by a set error of commission rate, a set short test rejection ratio, a set short test effectiveness value and a set air quality level in the Portland study. As the short test data which will be collected at the state inspection station will be under real world conditions, and as the same data will be collected in the laboratory, the magnitude of the real world effects will be documented. The magnitude of this factor will be included in future programs for setting short test cutpoints.

6.1.2 Objection: New vehicle prices will increase because manufacturers will have to include the anticipated Section 207(b) warranty costs.

Response: Those manufacturers whose products experience very low failure rates because of good manufacturing and design practices will experience little, if any, cost increases in their products. Conversely, those manufacturers whose products experience high failure rates could find themselves at a competitive disadvantage because of higher product prices. They can correct this problem by improving product quality control.

6.1.3 Objection: Two of the five tests which the agency is proposing will require relatively expensive dynamometers which must be capable of simulating vehicle inertia loads and sensitive and costly emissions measuring instruments. Much of the repair industry may not be financially capable of purchasing this test equipment so as to ensure that effective repairs have been performed.

Response: These two tests are included because they exhibit a higher level of correlation than do the other tests and the states must be given the opportunity of adopting these tests if they so choose. The agency does not, however, expect that any state will adopt either of these tests because of the reasons given in the objection.

6.1.4 Objection: The quality of instruments used in vehicle inspection as well as maintenance facilities will critically affect the accuracy of the short test results and, therefore, the true error rates. How does the agency propose to handle this problem?

Response: The agency has an ongoing instrument evaluation program which is designed to identify the better "garage" type instruments which are presently on the market. This program will be expanded during FY77 so as to evaluate the degree of quality control which exists in the manufacture of instruments.

The National Bureau of Standards is in a position to furnish standard gases to any state or organization which wishes to maintain the accuracy of its emissions measuring equipment.

The agency has encouraged the states to implement vehicle inspection and mechanic training programs as part of their implementation plans.

Prior to the implementation of Section 207(b), the agency will in conjunction with the states, instrument manufacturers, calibration gas suppliers, the vehicle manufacturers and any other appropriate organizations, develop guide lines and approved practices to ensure that accurate results are obtained in vehicle inspection stations and vehicle repair facilities.

6.1.5 Objection: The agency uses the concept of a deterioration factor in the vehicle certification process. Why hasn't a similar factor been adopted in Section 207(b)?

Response: The Clean Air Act requires that vehicles be in compliance with the emissions standards for which they were designed and manufactured for their useful life. As the purpose of testing of in-use vehicles is to determine whether or not the vehicles are in compliance at the time of testing, and as the short test pass/fail level is based on data obtained from vehicles which passed the FTP and from vehicles which failed the FTP at various mileage accumulation levels, there is no need for the inclusion of a deterioration factor in the short test pass/fail level.

In addition, there is no data to show that short test to FTP correlation is affected by mileage.

6.1.6. Objection: The agency is proposing more than one methodology for the selection of short test cutpoints but has only provided data based on the fixed 5% error of commission rate methodology.

Response: The agency's initial position on this issue was to attempt to minimize errors of commission so as to control warranty costs while accepting a less than desirable improvement in air quality. It was also the agency's judgment that a fixed error of commission rate would be equitable between manufacturers.

Very recently-obtained data has shown that the fixed error of commission concept is not truely equitable between manufacturers because it allows varying error of omission rates between manufacturers. The latest data is being analyzed by the alternative methodologies so as to improve equitability and to evaluate the potential for raising the improvement in air quality which results from Section 207(b). The results from these latest calculations will be published as soon as they become available. Results are expected by February, 1977.

6.1.7 Objection: The fixed error of commission rate is not equitable between manufacturers and does not give the maximum attainable air quality benefit associated with the implementation of section 207(b).

Response: This is true in that all manufacturers do not have an equal error of omission rate and some manufacturers are allowed to repair a lesser percentage of vehicles than others. Additionally, this concept could cause a manufacturer to repair a greater number of vehicles failed by the short test than he should be required to because short test failures can exceed FTP failures. For this reason, the other approaches are proposed and the comments on all proposed methodologies will be considered prior to final rule making.

6.1.8 Objection: Setting the short test rejection ratio $(E_c + FF)/(E_o + FF)$ equal to unity will increase the number of errors of commission and thereby the manufacturers' warranty costs.

Response: This is the only short test selection methodology which ensures true equitability between manufacturers, i.e. the short test cannot fail more vehicles than fail the FTP and every manufacturer is called upon to repair only the maximum number of vehicles which is his share. As this method will usually set lower short test cutpoints than other methods, it is expected to provide the greatest improvement in air quality attainable with the short test selected.

6.1.9 Objection: The following ratios, $E_c/(E_c + FF)$, $E_c/(E_c + PP)$, $E_o/(E_o + PP)$, $FF/(E_o + FF)$ and $PP/(PP + E_c)$ which can be considered for setting the short test cutpoint all offer potential inequities between manufacturers and should not be adopted.

Response: This argument is true as is the fixed error of commission approach. They are being offered, however, in the NPRM so as to obtain comments, both pro and con.

6.2 Technical Issues Associated with A Cutpoint Program

6.2.1 What types of vehicles should be tested in a cutpoint program?

Response: The cutpoint analysis requires a data base which includes the following:

a. that emissions be measured by the FTP and by each applicable short test

b. that emissions be measured from every group which is in production so as to establish group to group differences

c. that a statistically viable number of vehicles be tested in each group so as to quantify within each group the differences in emissions caused by production tolerances

d. that emissions be measured from vehicles which pass and from vehicles which fail to meet the standard (FTP)

e. that the effects caused by significant differences in altitude be resolvable from the data

f. that cutpoint differences caused by significant differences in standards be resolvable from the data

Three methods are available for the collection of data. The first is through the addition of the appropriate short tests to the vehicle certification procedure. The second method is by the collection of short test data at the end of the assembly line. The third is through the collection of data from relatively new, production, light-duty vehicles.

The first method, that of collecting short test data during the certification process meets requirements a, b, e, and f indicated above. This method does not meet requirements d and c, because:

(1) the vehicles tested are prototype, not production units, and do not account for the effects of production tolerances

(2) even if the vehicles were production units, the number tested is insufficient to provide a statistically viable sample for the

establishment of the relative effects of production tolerances on short tests and the FTP

(3) by definition, all of the vehicles **passing** the certification process meet the emissions standards

The second method, end of assembly line testing, does not meet requirements a or e. Requirement a can be met, however, if FTP and additional short test testing is introduced at the assembly line. There does not appear to be a method for meeting requirement e, (i.e. high altitude effects) with this method because most (if not all) assembly plants are at relatively low elevations. Additionally, this method introduces one problem which does not apply to either of the other methods. The problem is that of the new powertrain ("green powertrain") effect. If this method is adopted, an additional correlation step will be introduced, i.e., between zero mileage powerplants and broken-in in-use powerplants. Presently, there are limited statistically-viable data available for quantifying the relationship.

The third method, that of testing fleets of current model year, production vehicles by the FTP and the appropriate short tests meets all of the requirements for acceptability given above. The major weakness of this approach lies in its expense and its inability to provide short test pass/fail levels at the start of the model year. In practice, the short test pass/fail levels will not be available until almost the end of the model year. This schedule can be accelerated somewhat by multiple test sites, but the earliest practical date for the availability of the data is toward the end of the third quarter of the model year. This schedule is not anticipated to be a problem since new vehicles are not normally required to be inspected until they are one year old.

6.2.2 Should different types of vehicles have different pass/fail cutpoints and if so, on what basis are different cutpoints determined?

Response: The purpose of a 207(b) test is to fail all vehicles whose FTP emissions exceed the Federal standards. Data on different groups of 1974 and 1975 model year vehicles clearly indicate that the relationship between the FTP and the short test is group dependent. This can be observed in Tables IV through IX and illustrated graphically in Figure 14.

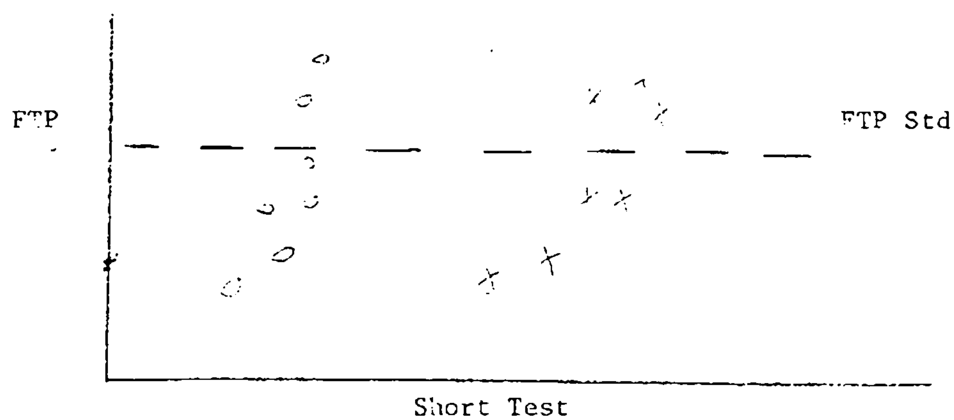


Figure 14

Thus, if all vehicles whose FTP emissions are above standards are to be failed with a short test, different short test pass/fail cutpoints will be needed.

The second question concerns the methodology by which short test cutpoints are selected for different vehicle classes to ensure equitability. The correlation analysis to date has selected short test cutpoints for each group of vehicles studied by setting a five percent limit on the errors of commission. This method has several advantages. First, it is easy to implement. Second, each vehicle group manufacturer will be incorrectly penalized for the same fraction of his sales of that vehicle as every other vehicle group manufacturer. There are some disadvantages to this method. This occurs when the number of vehicle groups is greater than one. First, the mean FTP emissions failed in vehicle group 1 may be very different from the mean FTP emissions failed in vehicle group 2 even though both short test pass/fail cutpoints were set to ensure 5% commission errors. Second, vehicle group 1 may have a total true failure rate of X% while vehicle group 2 has a total true failure rate of 2X%. Thus, the manufacturer of vehicle group 1 is not credited for having produced vehicles which are in better compliance with the Federal standards. Third, assume that vehicle group 1 has extremely high short test variability. Then, it is likely that due to short test variability, cars with low FTP emissions will have high short test levels. This situation will result in a higher short test pass/fail cutpoint than for a low test variability class, since high test variability increases commission errors and omission errors. Thus, a manufacturer could be rewarded for high short test variability. The same situation could occur with high FTP variability.

Several other options are available and are detailed below.

Option 1: Set the short test rejection ratio, $(E_c + FF)/(E_o + FF)$, equal to unity.

This option is no more difficult to implement than the fixed error of commission approach, it treats all manufacturers equitably and does not give any advantage to manufacturers who produce vehicles with high FTP and/or ST variability. Rather, it encourages improvements in quality control because the manufacturer is never allowed to repair fewer vehicles than he should, i.e., true FTP failing vehicles. This approach does not permit the setting of a single ST cutpoint for all vehicles. This is true for all equitable approaches for setting cutpoints and therefore cannot be treated as a negative characteristic of the method. Air quality benefits will tend to improve from the original approach because the error of omission rate will be lowered. However, mean FTP emissions of fueled vehicles in two different groups could still be significantly different. Many manufacturers will have to repair more error of commission vehicles than under the original concept. Also, it would still be possible that some manufacturers would not be credited with producing vehicles which were more in conformance with Federal standards than vehicles of other manufacturers.

Option 2: Set a fixed level of $E_c/(E_c + FF)$ for each group.

This option is more difficult to implement since $E_c/(E_c + FF)$ can be small when FF is large or when E_c is small. Thus, there is more than one way to optimize the function. This option does, however, have the advantage of crediting manufacturers of vehicle classes which have low FTP failure rates. The option does not alter the variability considerations of the existing approach.

Option 3: Set the short test cutpoints so that equivalent FTP pass/fail levels are enacted for each vehicle group, i.e., each group is allowed to have the same negative effect on air quality.

This option would work in conjunction with a fixed acceptable commission error rate. For all groups of vehicles, the five percent error of commission cutpoint is computed using the contingency table technique. Then, the FTP levels equivalent to the short test cutpoints are computed using linear regression estimates with the FTP as the independent variable and the short test as the dependent variable. A sample calculation is shown below where there are 3 groups of vehicles stratified by engine displacement.

Engine Size (CID)	FTP levels equivalent to short test cutpoint @ 5% E_c		
	HC gm/mile	CO gm/mile	NOx gm/mile
≤150	1.57	18.08	3.10
151-259	1.63	16.66	3.10
≥260	1.81	15.00	3.26

In order to treat each group of vehicles equally from an air quality standpoint, the highest FTP levels would be selected as the equivalent FTP levels at the short test standards. In the example above, these levels would be HC = 1.81 gm/mile, CO = 18.08 gm/mile, and NOx = 3.26 gm/mile. Using regression techniques, a set of short test cutpoints equivalent to these FTP levels would be determined for each vehicle group. The commission error rates would then be adjusted for those group/pollutant categories that originally had FTP equivalent levels lower than the worst case levels.

This option credits classes with low FTP emissions and/or low variability. It does lose some potential air quality benefit over the straight five percent error of commission case. However, this option lends itself to a methodology for including the concern over high manufacturer test variability. The FTP and short test variability could be determined for each group. Variability could be defined as the ratio of the standard deviation to the mean of the short test levels within a narrow range of FTP levels. EPA could then specify an acceptable variability. Only those groups with acceptable variability would be used to establish the five percent error of commission cutpoints, the equivalent FTP levels, the FTP worst case cutpoint, and the final short test cutpoints. Groups with high variability might be penalized and have greater than 5 percent commission errors when they have a cutpoint equivalent to the worst case FTP level. In the NPRM, manufacturers should be asked to comment on acceptable variability.

<u>Option 4</u>: Set an error of commission rate or $E_c/(E_c + FF)$ rate as a function of test variability. Allow a five percent error of commission rate when test variability is at the maximum acceptable level.

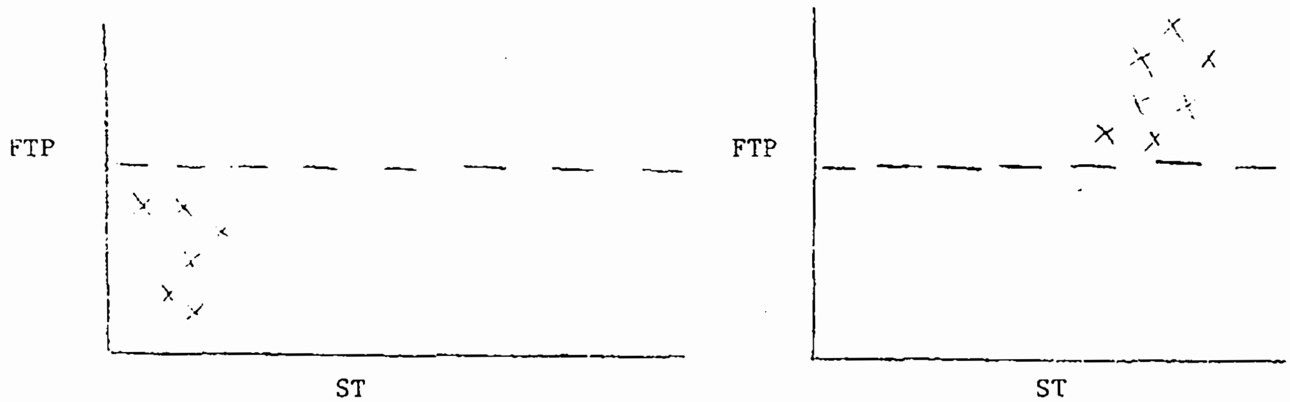
This option eliminates the variability problem in Option 2 and the existing approach. A functional relationship between errors of commission or $E_c/(FF+E_c)$ and variability could be developed using mathematical simulation techniques. This could be accomplished by taking a set of data, and using probability distribution theory and random numbers, variability could be introduced into the data base at different levels. Then, using fixed short test cutpoints, commission errors can be computed and plotted against variability.

The definition of short test variability would be the ratio of the standard deviation to the mean of short test levels within a narrow range of FTP levels. Analyses of the variability of existing data will be undertaken and the NPRM will solicit comments on acceptable variability.

The options given above have to be analyzed in order to determine how different the projected air quality and error rate results are as well as how difficult the methods are to implement. A detailed analysis will require the completion of 207(b) testing in Portland. However, a preliminary analysis based on the 300 car test data can be undertaken with the analysis focusing on three different groups. (Groups will be based on engine displacement.) These preliminary results will be available at the time of final rulemaking and along with comments from manufacturers, should provide the basis for a final rulemaking decision.

6.2.3 How can group cutpoints be determined in cases where all cars tested pass the FTP or fail the FTP?

<u>Response</u>: This issue is shown graphically in Figure 15.



<u>Figure 15</u>

There are six options possible for handling this problem. Two are by mathematical means, two require additional testing and two rely on engineering judgment.

<u>Option 1</u>: This option 1 would fit a linear regression equation to the available data and use it to project the short test/FTP relationship beyond the region of available data. The short test cutpoint would be selected to correspond with the FTP standard allowing a margin of safety to account for correlation. Expressed in equation form, this approach says:

$$ST_{cutpoint} = ST_{\substack{\text{value @ regression} \\ \text{line intercept with FTP}}} \times (f) \left[\frac{1}{\text{correlation coefficient}} \right]$$

In the case where this option has been evaluated, the function, f, for HC and NOx was determined to be a constant, the value of which was 0.78, while for CO the function was also a constant of value 0.5. The results obtained by the 5% E_c method and by this option were:

	Short Test Cutpoints		
	HC (ppm)	CO (%)	NOx (ppm)
E_c = 5%	184	0.71	2265
Model (Option 1)	186	0.75	2365

Option 2: Option 2 would fit a statistical probability distribution to the available data. Then, data could be mathematically generated in the region where they do not exist. A standard method of selecting the cutpoint would then be applied.

Option 3: A defect test program can be initiated to obtain data in the region where the population of vehicles is scarce. In cases where there are no data on passing FTP cars, the program would consist of tune-ups rather than incorporation of defects. Such a program would require a knowledge of what defects to introduce as well as a large number of vehicles and tests so as to include vehicle to vehicle variability.

Option 4: Test an additional group of vehicles. If this second group of vehicles included vehicles dissimilar to those originally tested (i.e. not all either PP or FF vehicles), the ST cutpoint would be set from the second group of vehicles. This option possesses the weakness that the second group would probably behave the same as the first group and nothing would have been accomplished.

Option 5: Transfer standards from a similar group. This option would apply within groups of vehicles produced by the same manufacturer. Provided the same vehicle size/engine size/technology is utilized in meeting emissions standards, it can be argued that the products manufactured by Division A of a corporation are sufficiently similar to the products from Division B for the ST cutpoints to be transferable in this eventuality. An example of this approach is the use of Chevrolet Division intermediate size vehicles short test cutpoints for Pontiac Division intermediate size vehicles provided the same displacement engine (but not necessarily the same engine family) and emissions control technology, e.g. catalyst, was used in both groups.

Option 6: Use the manufacturers' HC and CO idle specifications for the idle test cutpoint. This option only applies to inspection programs where the idle test is utilized.

Options 1 and 2 can be evaluated based on available data from the 300-car test program. Data from the passed vehicles only or failed vehicles only can be used to predict cutpoints. These cutpoints can then be compared with the cutpoints determined from the entire data base. These analyses show promising results. They will be completed prior to final rulemaking and if they are successful, there would be no need to implement additional testing programs or adopt either of the other two options.

6.2.4 Should each pollutant be treated independently in setting cutpoints?

The main advantage of treating each pollutant independently is that the computational procedures are relatively simple. Computational procedures become extremely complex when all pollutants are grouped together and trade-offs must then be made of the relative health effects of each pollutant so that it can be given its factor of importance. Moreover, air quality decisions have historically tended to be made based on individual control of each pollutant. The disadvantage of considering each pollutant separately is that the true vehicle commission error is not immediately known. The true error rate can only be determined by examining each vehicle separately, i.e. if the vehicle is a commission error for HC and fails CO then it is not a true commission error. The converse is also true. The only way that the true commission error rate can go higher than the rate set by individual pollutants is when all pollutants on the same vehicle are errors of commission or correct passes. The net effect is that true commission errors are usually lower than individual pollutant errors because "bad" vehicles tend to truly fail (fail the ST) on more than one pollutant. While each group could have equivalent commission errors on individual pollutants, the group-to-group composite error rates could differ significantly. A group manufacturer is only concerned with his true commission error rate taken over all pollutants.

In order to treat the pollutants jointly, there must be a method for combining errors and failures across pollutants as referenced above. Several methods could be used. A total percentage of commission errors could be equally divided between the two or three pollutants and a commission error on a single pollutant would only be considered a commission error if it remained a commission error when all pollutants were considered. A second method would be to weight the allowable individual pollutant commission errors according to some other factor such as failure rate or ambient air quality level in a specific region divided by ambient air quality standard. Two examples can be given. First, assume the true commission errors are to be controlled to five percent and the test sample of vehicles indicates that 45% of the vehicles fail CO and 30% fail HC. Then, the commission errors could be divided so that 3% of the commission errors were a result of incorrect CO failures and 2% of the commission errors were a result of incorrect HC errors. Second, assume a given AQCR has an HC ambient level of .16 ppm and a CO ambient level of 13.5 ppm. Thus, HC exceeds the standard by a factor of 2 and CO exceeds the standard by a factor of 1.5. The commission errors could be apportioned so that 2.9 percent of the errors were HC errors and 2.1 percent were CO errors. This approach would tend to result in higher 207(b) failure rates for HC and thus, HC air quality benefits would be weighted to account for the greater ambient problem.

Cutpoints used in this paper were selected based on each pollutant independently. Preliminary analysis based on 1973-1975 vehicles tested in the emission factor program indicates that the overall commission error rate would be expected to be, at most, the same as the individual pollutant error rates and it could be considerably less. This is shown in Table XXIII.

Commission Errors Combine Across Pollutants

Combined Failure rate	Commission Errors: 1975 Model HC	1975 Model CO	1975 Model Both HC & CO	1973-1974 Models HC	1973-1974 Models CO	1973-1974 Models Both HC & CO
20%	1	2	2	1	3	4
30%	4	3	4	2	6	6
40%	7	6	7	3	8	7
50%	13	8	10	5	11	10

TABLE XXIII

Table XXIII shows the results when the respective fleets are treated as a whole. Because of technological differences in vehicles and because of varying effects of production tolerances, it is reasonable to expect that the true error of commission rate will vary between manufacturers and between groups. This effect needs to be further evaluated based on existing data.

6.2.5 Is there a need to perform more than one cutpoint program for a given model year of vehicles?

Response: If the contingency table relationship between the FTP and the short test is mileage dependent, i.e. the correlation is mileage dependent, then the cutpoints would have to be changed as the vehicles accumulated mileage. There is no basis in engineering to support the argument that the correlation between the short tests and the FTP is mileage dependent.

As the vehicles age, and their emissions controls deteriorate but are not repaired, then a greater number of vehicles will fail the short test, and rightly so. The ability of the short tests to perform the function of detecting component failures can be seen in the increased correlation indices of the defects fleet vs. the correlation indices of the CEV fleet as shown in Tables I, II and III. In this case, the short test cutpoints developed for the CEV fleet were applied to the defects fleet with the result that more vehicles failed the short tests, thereby supporting the conclusion that correlation is not mileage dependent.

Additional support for the argument for not changing cutpoints with mileage was obtained from available 1975 model year data which has been analyzed. While only two distinct mileage categories have sufficient data, these categories indicate no statistical difference in cutpoint would be obtained. Analysis is ongoing to extend this work to pre-1975 vehicles since the available data base is larger.

Work also needs to be performed to address the question of what the confidence interval is around the cutpoint that was determined from the 5% commission error criteria. (If a decision is made to use another cutpoint methodology, that confidence interval will also have to be developed). The development of the confidence interval is ongoing. It is a complex statistical problem, depending on the sample size, total short test failure rate and total FTP failure rate. The work is expected to be completed prior to final rulemaking so that decisions can be made as to what magnitude of differences in the two cutpoints is statistically significant.

6.3 Other Technical Issues

6.3.1 Are garage type instruments adequate to implement 207(b)?

Response: The answer to this question is clearly yes for HC and CO instruments when the results given below in Table XXIV are compared. These results were obtained using Pearson regression analysis on the CEV fleet. The question cannot be clearly answered for NOx at this time as data have not been collected using garage caliber NOx instruments since these instruments were not available at the time of the correlation investigated.

Short Test	Mode	Correlation Coefficient HC	CO
Clayton Key Mode			
(Laboratory Instruments)	Hi	0.61	0.26
	low	0.53	0.39
	idle	0.92	0.54
(Garage Instruments)	Hi	0.73	0.37
	low	0.73	0.21
	idle	0.88	0.52
Federal 3 Mode			
(Laboratory Instruments)	Hi	0.87	0.08
	low	0.79	0.22
	idle	0.80	0.48
(Garage Instruments)	Hi	0.76	0.24
	low	0.73	0.21
	idle	0.78	0.52

TABLE XXIV

The answer to this question is not as clearly yes when the results given in Table XXV are compared. These results were obtained from the 1974 MY fleet of vehicles.

Short Test	Mode	Correlation Coefficient HC	CO
Clayton Key Mode (Laboratory)	idle		
all vehicles		0.793	0.739
Chrysler Corp.		0.723	0.704
Ford Motor Co.		0.825	0.650
Chevrolet (GM)		0.460	0.757
(Garage)	idle		
all vehicles		0.455	0.470
Chrysler Corp.		0.245	0.372
Ford Motor Co.		0.692	0.560
Chevrolet (GM)		0.100	0.229
Federal 3 Mode (Laboratory)	idle		
all vehicles		0.803	0.734
Chrysler Corp.		0.709	0.724
Ford Motor Co.		0.851	0.622
Chevrolet (GM)		0.252	0.733
(Garage)	idle		
all vehicles		0.632	0.476
Chrysler Corp.		0.660	0.397
Ford Motor Co.		0.717	0.550
Chevrolet (GM)		-0.060	0.392

TABLE XXV

Sensitivity to instrumentation was noted in the results from the 1974 model year fleet. When all of the vehicles were treated as a group, the laboratory instruments show a superiority over the garage instruments. When the data are analyzed by vehicle group, this superiority of laboratory instruments over garage instruments holds for the Chrysler Corporation cars in the Clayton Key Mode test but almost disappears in the Federal 3 Mode Test. In the case of the Chevrolets, where the correlation is very poor for both classes of instruments, the laboratory instruments are clearly better. In the case of the data obtained from the Ford Motor Company vehicles, the differences between laboratory instruments and garage instruments diminishes substantially. The CEV fleet were also Ford Motor Company vehicles.

The following conclusions are based on all of the data collected to date:

1. Laboratory instruments show a superiority over garage instruments on some vehicles.

2. Garage instruments almost never show a superiority over laboratory nstruments.

3. Approximate equivalence between garage and laboratory instruments has been noticed on two different groups of Ford Motor Company vehicles. These vehicles were the low emitting, catalyst fleet vehicles, which were full size Fords, and the Pintos in the 1974 model year fleet.

4. The laboratory instruments were clearly superior for the 1974 MY Chevrolet vehicles.

The magnitude of this problem, if it continues, will be placed in perspective when the data from the Portland test program becomes available. Moreover, it will be necessary to recalculate these correlation coefficients based on the contingency table technique rather than Pearson correlation.

It is important to realize, however, that the effect of garage instrumentation will automatically be factored into the short test pass/fail levels. Thus, although some potential air quality benefit may be lost by the non-use of laboratory instrumentation, the commission errors will not increase.

Approximate costs for one set of test equipment in each instrument class, including all equipment necessary for measuring exhaust emissions are $80 K to $120 K for laboratory instruments and $12 K to $18 K for garage instruments.

Differences in the costs of dynamometers center on the requirements of the test to be performed. If the test requires a simple dynamometer which only has to simulate steady speed conditions then the cost will vary between $2,000 and $3,000. If the dynamometer has to simulate transient vehicle conditions, i.e., inertia, then the cost will vary between $9,000 and $11,000.

6.3.2 What effect will real world conditions have on short test correlation?

Response: There are presently no data on the impact of real world variables such as inspector errors resulting from job routine, ambient variations, the waiting period of the vehicle which precedes the short test, etc. on short test to FTP correlation.

Human errors, such as those caused by a routine type of job, inaccuracies in following a driving trace if used, misreading an instrument or misidentifying the engine which is in a vehicle, must be expected, and accounted for, in a vehicle inspection program. Evaluation of the magnitude of this problem is not presently possible because of a lack of data. The data necessary for making this quantification will be obtained in the Portland project.

Evaluation of the effects of ambient variations and the time that the vehicle waits to be tested will be accomplished on the basis of the Portland project. Ambient effects will be evaluated through the comparison of data taken during cold, moderate and hot weather conditions. Vehicles participating in the project will be subject to the same variations in the waiting period as vehicles not in the project. The waiting period of each vehicle will be recorded and short test results will be evaluated, if possible, to determine the effects on emissions of delays which occur before testing.

Since the short test pass/fail levels are determined by a set error of commission rate (or possibly some other set efficiency measurements) and as the short test data which will be used for setting the actual pass/fail levels will be collected under real world conditions, the effects of these variables will automatically be factored into the short test pass/fail values.

6.3.3 Will changes in technology obsolete one or more of the currently correlatable short tests?

Response: As manufacturers develop sophisticated computerized engine control systems, it is possible that current correlatable short cycles would become less correlatable. That is, the potential always exists for a manufacturer to design around a specific emission test. A similar problem could occur if EPA were to go to a non-methane hydrocarbon standard. The methane hydrocarbon fraction may be mode dependent and may lessen the correlation presently achieved based on total hydrocarbons for the FTP and the C_6 equivalent as measured by the garage instruments.

In order to keep abreast of potential changes in short test correlatability, all prototype vehicles obtained in the laboratory for technical evaluation will be tested on the 207(b) short tests. Large numbers of these vehicles will also be tested using continuous measurement techniques. Thus, data will be available to indicate whether potential problems exist with current short tests and, if necessary, these data will form a base for developing new short tests.

An additional source of data could come from the prototype certification vehicles. Manufacturers will be asked to comment in the NPRM as to any problems which would be incurred by including 207(b) short tests on all certification tests performed in the EPA lab and/or at manufacturer facilities.

6.3.4 Will the implementation of 207(b) affect manufacturer's recommended service intervals?

Response: Manufacturers recommended service intervals are presently based on "average" vehicle use. When manufacturers have to warrant emission levels for all vehicles up to their useful life mileage levels, they may want to reduce the scheduled service intervals. A decision on how to set these service intervals may depend on an assessment of the difference in emissions/maintenance between the average car and the car used in severe service. Manufacturers will be asked to comment on this issue in the NPRM. Also, it may be possible to obtain service related data from some severe service fleets such as taxi cabs, rental fleets, etc. This information will be obtained, to the extent possible, before final rulemaking.

6.4 Policy Issues

6.4.1 What is an acceptable level for reasonable correlation?

Response: This is strictly a policy issue although the acceptable level of commission errors could be expected to be related to the total failure rate. After the August 19, 1976 briefing for Mr. Quarles, he indicated that a level of E_c equal to 5 percent was not unreasonable given that the total failures were between 30 and 40 percent. Also, the level established during the first year of vehicle use may decrease as vehicles accumulate mileage. The decrease would not occur because of a change in the FTP/short test relationship. Rather, it would occur because larger percentages of vehicles fail and fail at higher FTP levels.

The vehicles which are identified as commission errors can be examined and their FTP emissions compared with vehicles which are identified as passed vehicles. In one small sample of vehicles, at a 3% E_c level, vehicles in the E_c cell have mean FTP emissions significantly above those which are classified into the PP cell, as given in Table XXVI. Thus, the cars identified as E_c cars could be expected to exceed Federal FTP standards within a year if they were not maintained and would fail at the second inspection. Therefore, they may not be real errors in the sense of a once a year inspection program. It must be stressed here, however, that all cars were examined by the same cutpoint, which is known not to be equitable. The picture will probably change extensively once vehicles are properly grouped and their appropriate cutpoints applied.

6.4.2 What is acceptable vehicle variability on the short tests and the FTP?

Mean and Percent of 1975 Model Year Vehicles
Classified Pass/Fail by the FTP and the Chicago Idle Test*

		FTP	
		Pass	Fail
Chicago Test	Pass	45%	28%
	Fail	3%	24%

		FTP	
		Pass	Fail
Chicago Test	Pass	HC = 0.67 CO = 9.30	HC = 1.44 CO =28.11
	Fail	HC = 1.14 CO =12.96	HC = 2.01 CO =44.79

TABLE XXVI

* based on 137 vehicles tested in the FY74 emission factor program.

Response: This is a difficult question to answer. It was brought up in the fuel economy regulations and was not resolved there. The data from the Portland experiment would permit an assessment of variability as a function of FTP level or average commission error level or average omission error level. It is improbable that the 3 cities data can provide a partial answer to these relationships. However, a decision on acceptable variability would require inputs from the manufacturers.

6.4.3 Should the annual cutpoint program be performed by the states or by EPA?

Response: The Clear Air Act directs the Agency to implement section 207(b). It does not specify, however, what the Agency's role is to be in the yearly selection of short test pass/fail levels, variations in the applicability of short tests with modifications in technology, etc. In light of the continuing changes in the vehicle emissions standards and modifications in the technology used to meet these standards, it is reasonable to expect that changes in the short test pass/fail levels must be made on a model year basis. These changes can be made by the agency from data collected from a single or at most two fleets of vehicles representing the national standards at high and low altitudes. If the states were to perform the work necessary to execute the changes, then each state would have to test a fleet of vehicles--a costly and inefficient procedure. It appears logical, therefore, for the agency to furnish each state with a yearly set of short test pass/fail levels so as to maintain national uniformity as well as to hold costs at an acceptable level.

In the August 19, 1976 Quarles briefing, Mr. Quarles commented that he did not believe that the states will have the resources to establish cutpoints and that EPA should plan to undertake the task with the understanding that states could develop more stringent cutpoints if they should desire.

6.4.4 Will the Federal 207(b) cutpoints pre-empt state I/M standards?

Response: States would have the option of setting higher or lower I/M pass/fail levels. The question of concern is whether states would be able to trigger the 207(b) warranty with more stringent I/M standards. This issue would seem to require a state to run their own cutpoint program to prove that reasonable correlation still exists. Or, the data collected by EPA in their cutpoint program could be analyzed for the proposed state cutpoint levels. The decision on reasonable correlation would be difficult to determine on a state by state basis.

6.4.5 Will final rulemaking include the results obtained in the Portland study?

Response: The present schedule for the Portland study is to have the contract signed by December, 1976. The 207(b) testing phase of this program would not be completed until June 1978, although preliminary results would be available throughout the year. The Portland study will provide insight into the number of cutpoint levels needed, the size of the yearly cutpoint program, the effect of real world variables on short test correlation and the effect of variability on correlation. The program is not expected to change the recommendations on which short tests are correlatable nor the methodology for selecting a cutpoint for a given vehicle group. Thus, final rulemaking can proceed prior to completion of the Portland study.

6.4.6 Are there other uses for the yearly cutpoint data?

Response: The yearly cutpoint program has the potential to be used to implement section 207(c) of the Clean Air Act, the recall provision. Sample sizes of individual groups will be relatively large, test vehicles will be properly maintained and used, testing will be performed early in the new model year, and testing will be performed using the FTP* as well as short tests. By performing a 207(c) program in conjunction with the 207(b) cutpoint program, owners of defective class vehicles will be protected in states with more stringent I/M standards.

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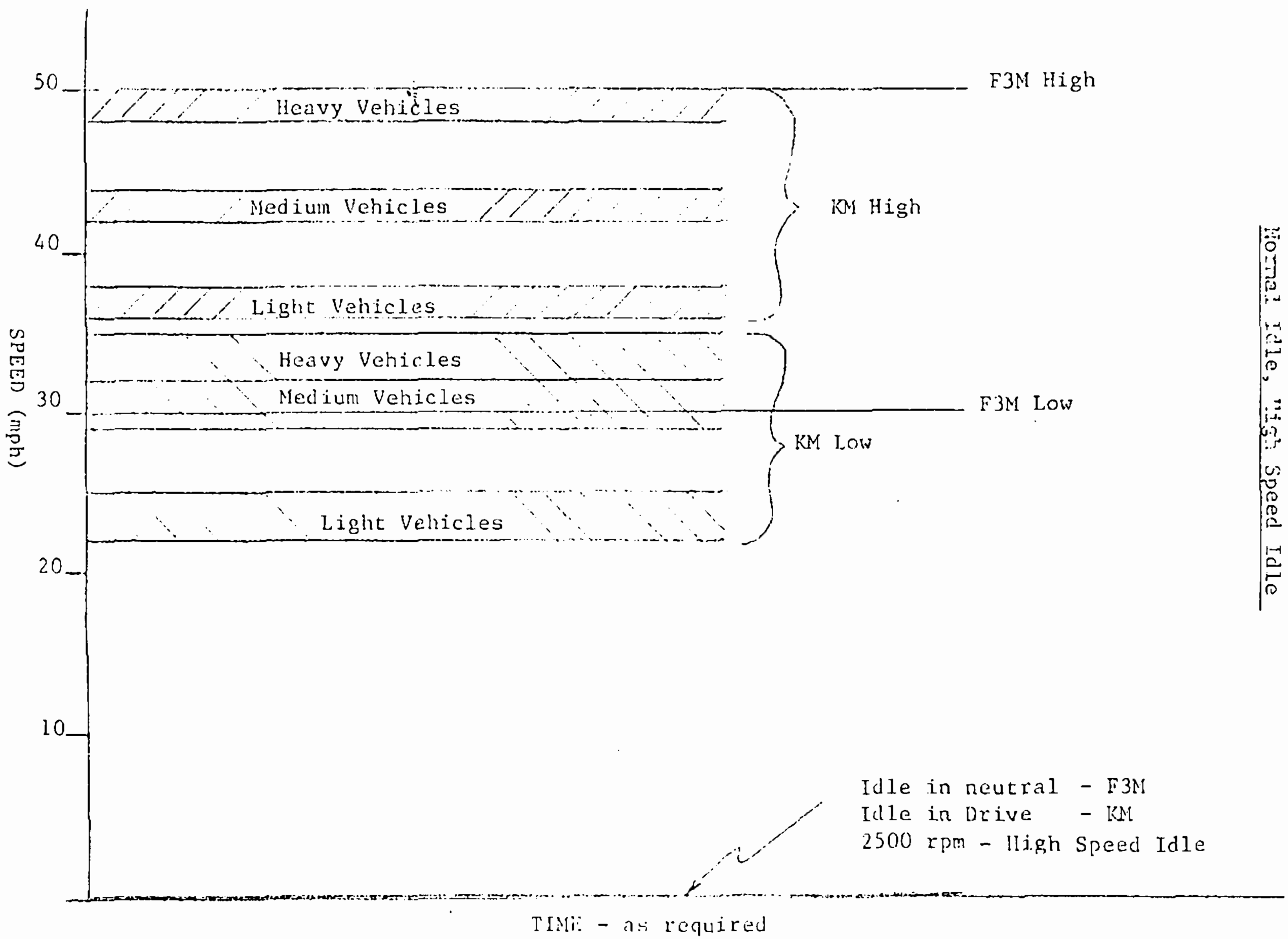
* Although some modifications may be incorporated in the FTP (ie: elimination of evaporative emissions tests and minor modification of the preconditioning cycle) the effects of these modifications on the requirement of reasonable correlation for 207(b) and the requirement of a substantial number of nonconforming vehicles for 207(c) are expected to be negligible. A test program will be initiated to investigate the effects of these test differences.

Appendix A

Graphical Descriptions of Short Tests

STEADY STATE MODAL TESTS AND IDLE TESTS

Federal 3 Mode, Clayton Key Mode, Normal Idle, High Speed Idle



TRANSIENT TESTS

Federal Short Cycle and NY/NJ Composite