SUMMARY AND ANALYSIS OF COMMENTS
ON THE
NOTICE OF PROPOSED RULEMAKING
FOR
HIGH-ALTITUDE EMISSION STANDARDS FOR 1982 AND 1983 MODEL YEAR LIGHT-DUTY MOTOR VEHICLES

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR, NOISE, AND RADIATION
OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL

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IMPORTANT NOTICE

EPA has recently decided to delay the implementation of more stringent low-altitude standards for light-duty trucks (LDTs) from 1983 to 1984. Since the high-altitude LDT standards are based on the levels of the applicable low-altitude standards, this decision also affects the stringency of the 1983 high-altitude standards. This Summary and Analysis of Comments was completed prior to the postponement; therefore, the analyses presented here were done under the assumption that LDTs would comply with more stringent standards in 1983. Although the LDT high-altitude standards which were originally proposed for 1982 will now also be applicable in 1983, the conclusions contained in this document remain valid and EPA has chosen not to revise the analyses in order to prevent an unnecessary delay in promulgating the interim high-altitude standards.

Commenters and Speakers on the Proposed High-Altitude Motor Vehicle Standards

Congressman Alan Simpson
Congressman Gary Hart
Recreation Vehicle Industry Association
Ford Motor Company
General Motors Corporation
Motor Vehicle Manufacturers Association
Chrysler Corporation
Renault, USA
Colorado Department of Highways
Subaru of America, Inc.
Colorado Open Space Council
National Automobile Dealers Association
Welling Ford Sales, Inc.
Nissan Motor Company
Jaguar Rover Triumph, Inc.
U.S. Technical Research Company
Colorado Department of Health
Toyota Motor Company
Mr. B. Jay Welling
South Dakota Department of Health
Congressman Timothy Wirth
Congresswoman Patricia Schroeder
Volkswagen of America, Inc.
American Motors Corporation
International Harvester
Mr. Steve Schweitzberger
Mr. Richard Becker
Utah Department of Health
Honda Motor Company
Ray Shellabarger, Chevrolet, Inc.
Zeiger Enterprises

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A. Issue: Standards

Summary of Issue

1. Light-Duty Vehicle. EPA derived the light-duty vehicle standard (which called for a maximum 90 percent reduction from a 1970 high altitude baseline fleet) from a limited sample of high mileage vehicles tested by the MVMA. Because this limited and older sample could not be construed to have equal results with a true 1970 high-altitude baseline, certain controversial mathematical procedures were used on this data to obtain an estimate of the true baseline figure. Also, EPA did not propose any high-altitude counterpart to the 1982 CO and NOx waivers for low altitude.

2. Light-Duty Truck. EPA derived the light-duty truck standard beginning with 1969 low-altitude fleet data and used the MVMA light-duty vehicle test data to estimate the altitude effect. While this approach was recognized to be far from ideal, it seemed the only rational method given the dearth of data available at the time.

Summary of Comments

The industry collectively disputed the procedures used in the derivation of the LDV and LDT standards. The criticism of the LDV derivation involved the question of the proper manipulation of the data; the criticism of the LDT derivation also included a challenge of the propriety of the assorted data which were used.

Major Subissues

1. Light-Duty Vehicle. Most of the manufacturers who commented on the subject supported the position of the MVMA who criticized EPA's "misapplication" of their data. Specifically, MVMA argued that their fleet was statistically representative (something about which EPA had earlier doubts), but that EPA should have multiplied the ratio of the high-to-low altitude emissions found from the test data by the low-altitude baseline which hopefully would provide an estimate of the true high-altitude baseline. A 90 percent reduction then yields the high-altitude standard. Rather, EPA "erroneously" added the absolute difference of the high- and low-altitude data to the true low-altitude baseline.

MVMA, as well as several manufacturers (AMC, Toyota, Peugeot, and Jaguar), also pointed out that EPA had not proposed any CO or NOx waiver standards to parallel those permitted by the CAA. Not to do so would contravene the act. Peugeot also complained that the evaporative emission standard was too tough and that the MVMA fleet itself was unrepresentative because it contained no diesel vehicles.

2. Light-Duty Truck. Again the industry as a whole echoed

the MVMA criticisms. MVMA had four major complaints with the EPA methodology. First, as with the LDV, they felt that EPA should have used a ratio approach rather than an absolute difference in extrapolating the low-altitude baseline to high altitude. Second, they objected to EPA's use of a 1969 instead of 1970 baseline fleet which was not even representative of the LDT sizes. Third, they objected to the use of the LDV data from their study to extrapolate the baseline from low altitude to high altitude. Fourth, they capped off their criticism by claiming that EPA's formula gave nonsensical results.

Ford and Chrysler went on to recommend that EPA abandon the LDT standard until such time as it had a representative 1970 fleet from which to obtain high- and low-altitude comparison data. Chrysler also questioned if EPA's use of LDV data to derive the LDT standard was legal in view of the U.S. Court of Appeals ruling in International Harvester vs. Ruckelshaus in which the court forbad EPA from treating LDT the same as LDV and thus giving them the same standards.

Analysis of Comments

1. Light-Duty Vehicle. Certain criticisms can be dismissed at once; others require greater analysis. First, Peugeot claimed that the evaporative emission standard was "too tough." Perhaps it is for Peugeot, but it is nonetheless correct. The MVMA study verified the EPA theoretical prediction for the evaporative emission baseline at high altitude1/ and subsequently supported the 2.6 g/test SHED requirement. With EPA's prediction thus substantiated by an experimental program conducted by industry, little attention need be paid to Peugeot unsupported claim.

Peugeot also claimed that the 1970 baseline fleet that was used was not representative because it did not contain a diesel vehicle. This is wrong. In 1970, less than one-tenth of one percent of the LDVs sold were diesel. Hence, they represent a negligible influence on the baseline and even one vehicle in the MVMA fleet of 25 would grossly over-represent diesels.

Several manufacturers and MVMA pointed out EPA's failure to provide CO and NOx waiver standards for 1982 to parallel those for the statutory low-altitude standards. This is an excellent point. This final rule will include waiver standards. The exact levels of the standards will be discussed along with EPA's rebuttal to the industry objections to EPA's approach to the derivation of the standards.

For the LDV standard, the single remaining complaint is that the EPA applied an additive correction for altitude to the recognized 1970 fleet baseline rather than applying a multiplicative factor to get an estimate of the 1970 high-altitude baseline which is not available from data. The Clean Air Act (202(f)) requires that the high-altitude emissions reduction from the 1970 high-altitude emission level be no greater than that required at low altitude. Inasmuch as the corresponding low-altitude regulations for LDV (202(b)) require a 90 percent reduction from the 1970 baseline, this same reduction (or less) is also required for high altitude LDV standards. The basic information which is required is a high-altitude emissions baseline from a certification fleet of 1970 vehicles using the 1975 FTP. Such information is not available.

However, data do exist which allow the high-altitude baseline to be estimated and thus the standards to be found. These estimates can be obtained in two ways: 1) by obtaining a well-tuned 1970 vehicle high-altitude baseline and applying a 90 percent reduction to these emissions to establish the 1982-83 standards, and 2) by generating a high-to-low altitude correlation and using this to adjust the generally recognized low-altitude baseline to a high-altitude equivalent. The former approach is most similar to the ideal method if confidence can be gained that the test fleet (1) is representative, (2) is in compliance with the corresponding 1970 low-altitude standards, (3) properly accounts for deterioration, and (4) is tested with the relevant (1975) FTP. If these conditions cannot be met, then the latter procedure may offer greater confidence.

These alternatives were first discussed by Miriam Torres in a memorandum to R. Maxwell on July 24, 1978.* On the basis of the data available to her at the time, she recommended the latter approach which, as she saw it, involved the use of a ratio of high-to-low altitude emission performance which would be applied to the low-altitude baseline to establish a high altitude baseline. There are other possibilities, of course, including the procedure used by EPA in determining the proposed standards. Ms. Torres' preference for the high-to-low altitude correlation rests largely in the lack of confidence that the high-altitude data available then was adequate and appropriate (being based upon the obsolete 1970 FTP and untuned, less than new condition vehicles):

> The most important reason for preferring the ratio method (i.e., a high-to-low altitude correlation) is that it is not necessary to determine what high-altitude emission levels would correspond to the low-altitude emissions that were determined for the 1970 model year baseline under the CVS-CH procedure. This correspondence would be necessary in order to meet the Clean Air Act requirement that the high-altitude emissions reduction be no greater than that required at low altitude. No study has been conducted where the same set of

* This document was referred to several times in the comments as evidence that EPA officially supported a ratio approach. However, a memorandum from a branch member to the branch chief does not constitute agency policy.

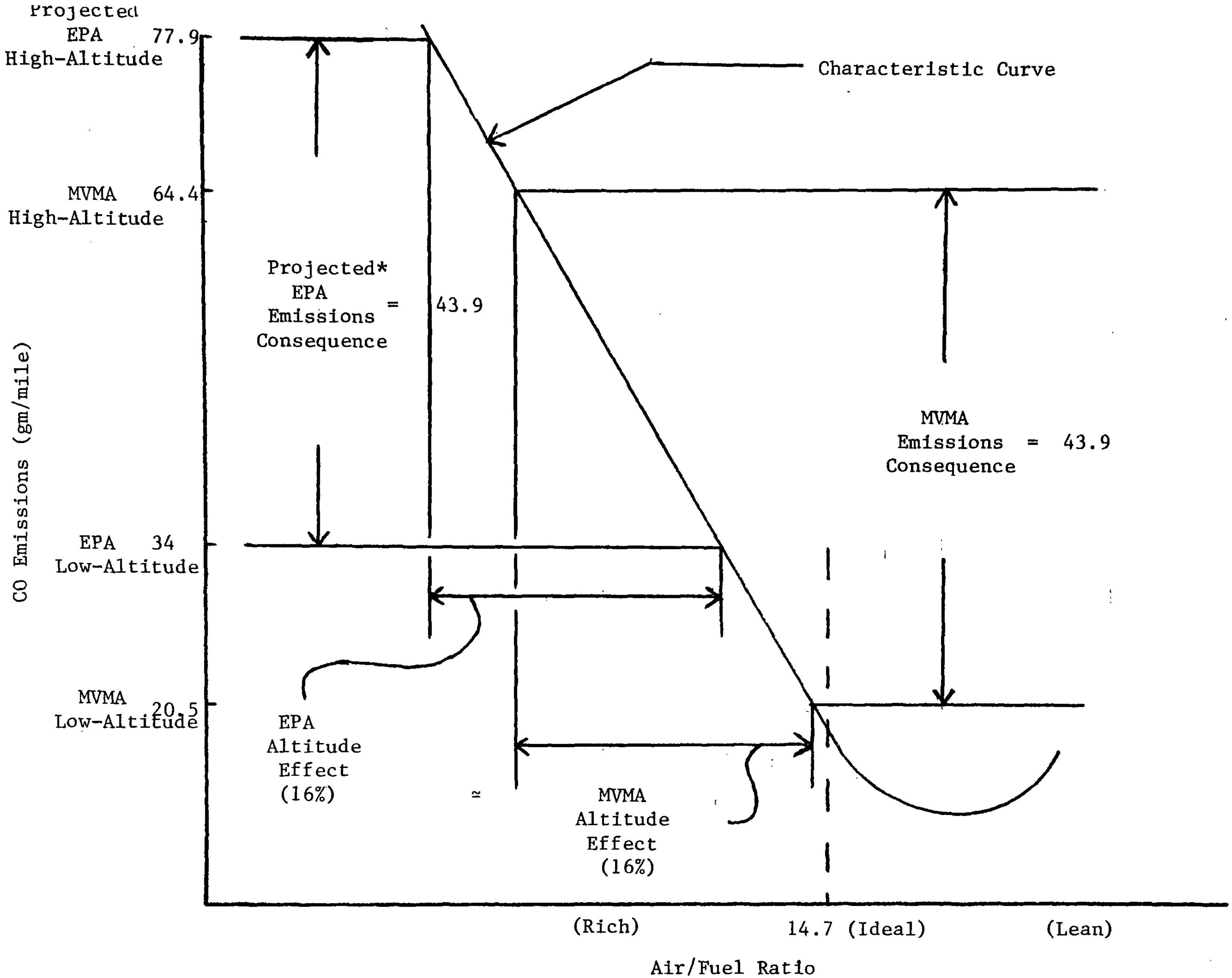
vehicles was tested in both high- and low-altitude cities and, therefore, there is no assurance that a proportional emissions reduction would be achieved (emphasis added).

With the advent of the recent MVMA data, this concern is largely overcome if that data can be accepted (1) as representative, (2) in compliance with the corresponding low-altitude standards, (3) with deterioration properly accounted for, and (4) with the relevant (1975) FTP used. Indeed MVMA presents strong arguments that their data are indeed valid and representative. If so, then a 90 percent reduction would lead to high-altitude standards of 0.3 gm/mile HC and 2.1 gm/mile CO, which are far below the proposed values. Hence, the proposed standards apparently represent a less severe criterion than the corresponding low-altitude standard. The uncertainties in the baseline nonetheless weigh against the imposition of these values. For instance, MVMA attempted to validate the test data by comparing the low-altitude portion with the original low-altitude certification data. This led to only marginal agreement with HC, the two numbers being about one standard deviation apart. Thus, the MVMA HC result appears genuinely low at least at low altitude for which the comparison was made. But if the high-altitude data is considered to be a roughly correct baseline (but because of small sample size, partially deteriorated or worn condition of the vehicles, etc., an element of uncertainty exists), how then to adjust the above result in a reasonable manner, recognizing that excessive conservation will result in a standard too lax?

The MVMA data can be utilized to adjust the baseline using a correlation method (method 2). The idea here is to find a correction for altitude (i.e., the correlation) and apply it to the generally accepted low-altitude values which are higher than the MVMA values. This would result in a new baseline for high altitude that is above the raw MVMA value.

One correlation method, and the one that was used by EPA in deriving the proposed standards, applies an additive constant to the generally recognized low-altitude baseline values (the 1970 standards corrected to account for the effects of the current, 1975 FTP) to arrive at the high-altitude baseline. This additive constant is obtained from the difference in the high- and low-altitude data.

The other correlation method is the use of ratios (high-altitude data/low-altitude data) as advocated by Miriam Torres and MVMA. MVMA supported their position by heavy reference to Ms. Torres' work. Ms. Torres, in turn, supported her position with two observations: (1) ratios vary less than the emissions themselves and (2) deterioration and maladjustment have less effect on ratios than on emissions. The second of these is irrelevant to the MVMA data as that fleet was carefully tuned and, indeed, partially renovated. The first proves incorrect for the MVMA data as the following summary of that data shows.



* Necessarily equal to the MVMA emissions consequence (= 64.4 - 20.5 or 43.9 gm/mile) if the EPA altitude effect is taken to be equal to the MVMA altitude effect (very nearly true for the 16 percent change due to altitude over the plausible range of air/fuel ratios).

Method	Mean		(Std. Deviation / Mean)	
	HC	CO	HC	CO
1. Ratio	1.60	3.47	0.19	0.45
2. High-altitude absolute level	4.47	64.45	0.21	0.37
3. Low-altitude absolute level	2.851	20.45	0.24	0.40

The differences in the normalized standard deviations do not appear significant. The ratio method operates with a marginally better variation in HC, but worse variation in CO than does the absolute difference method which utilizes the data in rows 2 and 3 in the table. Thus, while these two methods for correlation obviously result in different high-altitude baselines and, hence, standards, they cannot so easily be criticized on the basis of variability.

Finally, MVMA submitted to EPA some late data (having asked for an extension of the comment period) which by the ratio method again, they attempt to demonstrate how actual, more or less currently controlled vehicles (1976, 1978) change with altitude differently than the EPA high-altitude standards require them to do. EPA finds these data unpersuasive. The issue is to determine a 1970 baseline and, therefore, it is necessary to see how 1970 vehicles vary with altitude, since vehicles produced in different model years have different emission characteristics. In fact, these MVMA data are also irrelevant with regard to the issue of technical ability to achieve the standards because the vehicles tested were under no requirement to reduce high-altitude emissions. The 1977 model year was specifically avoided.

EPA's decision to use the absolute difference method is based upon a recognition that a multiplicative approach, such as the ratio method, tends to exaggerate an otherwise modest error in the high-to-low altitude correlation which might appear as a result of the use of a fairly small sample (25 vehicles). The additive approach ought to avoid this concern.

A further argument, based upon a consideration of the chemistry involved, independently supports the additive approach. The argument will be presented for CO, the pollutant of greatest concern to the manufacturers; it is equally valid for HC. The slope of CO vs. air/fuel ratio is very linear on the rich side of stoichiometry, the typical running regime of weakly controlled vehicles (i.e., 1970). This is shown in Figure 1. The generally recognized CO emissions factor for the 1970 low-altitude fleet is 34 gm/mile. The MVMA fleet obtained 20.5 gm/mile at low altitude and 64.4 gm/mile at high altitude. These are also shown in Figure

1. The air/fuel ratios between the MVMA data points must differ by 16 percent due to the altitude effect on air density. The actual low altitude air/fuel ratios for the general fleet and the MVMA fleet are not known; however, the MVMA fleet as seen in Figure 1 is necessarily more lean than the general fleet at each altitude.

From the figure, it is apparent that a change in stoichiometry due to altitude leads to a nearly constant change in the emissions regardless of the initial value. That is, for a given altitude effect (i.e., change in air/fuel ratio), there is a constant change in the emissions consequence, regardless of the starting point. Thus, the emissions effect is clearly additive.

Criticism that EPA failed to account for the CO and NOx waiver portions of the standards is well founded. Again, the question arises how best to account for this. At low altitude the waiver granted under 202(b)(5) permits the governing CO standard to go from 3.4 gm/mile to 7.0 gm/mile during MY 1981-82. Once again, the derivation of a high-altitude analogue requires a decision on the choice of methodology. Similar reasoning to the preceeding dictates the utilization of the absolute difference approach. Hence, the CO waiver standard should be 7.8 + (7.0 - 3.4) = 11.4 gm/mile, or, rounding to two significant figures, 11 gm/mile. The NOx waiver from 1.0 gm/mile to 1.5 gm/mile for MY 1981-1984 diesel vehicles which may be granted under 202(b)(6) of the Clean Air Act as amended (1977) will also be available for high-altitude vehicles. Even though NOx emissions for a particular vehicle are generally lower at high altitudes, the Clean Air Act prohibits EPA from establishing high-altitude standards which are numerically lower than corresponding low-altitude standards. The diesel NOx waivers have been determined on an engine family basis, and thus any engine family which is granted the NOx waiver at low altitude will also have the waiver at high altitude.

2. Light-Duty Truck. MVMA's complaints about the proposed LDT standard fall into two general categories: first, they challenge the equation, claiming by example that it gives "nonsensical" results. Thus, no matter how excellent the data may be, the standard would be incorrect, they insist. Second, they point out several alleged deficiencies in the data base that results from EPA's use of certain assumptions and approximations they claim are inappropriate or outright wrong.

Taking these points one at a time, EPA rejects MVMA's contention that the equation used to derive the standards is nonsensical. The behavior of the equation demonstrated by MVMA in its examples is consistent and rational. One example:*

> EPA proposed the following equation for calculation of the LDT standard at altitude.

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* From submittal at the time of the Public Hearing, March 30, 1980.

$$\text{Standard at Altitude} = \left(\text{LDT baseline at low altitude} + \text{Change in LDV Emissions}\right) \times \frac{\text{LDT low-altitude std.}}{\text{LDT low altitude baseline}}$$

When this equation is used to calculate the 1982 HC high-altitude standard, the following result, which was also shown in the NPRM, is obtained:

$$\text{High-Altitude HC Standard} = (8 + 1.6)\,\frac{1.7}{8} = 2.0\ \text{g/mi}$$

Now, consider what happens if the value of the low-altitude baseline, (i.e., 8 g/mi HC) is, in fact, high since it was obtained with vehicles which were both uncontrolled and heavier than average for vehicles in the present LDT weight class. EPA recognized that this was, in fact, likely to be the case. Suppose the high-altitude baseline value were 5 g/mi HC instead of 8 g/mi HC. Then, substituting this value in the equation in the EPA methodology gives the following result:

$$\text{High-Altitude HC Standard} = (5 + 1.6)\,\frac{1.7}{5} = 2.24\ \text{g/mi}$$

This is indeed surprising. Contrary to the EPA reasoning and expectations, a high value for the low-altitude baseline gives a more stringent rather than a less stringent high altitude emission standard. Obviously, the methodology contains a flaw.

Deeper consideration of this example will corroborate the result and serve to support the equation. The significant point to observe is that the stringency of the standard (i.e., the fractional reduction from the baseline) changes as the baseline changes. Thus, if the low-altitude baseline is 5 (as in the second scenario), then the standard (1.7) represents something less stringent than in the first scenario. Because the standard is a proportional standard (i.e., it requires the same percentage reduction from the appropriate baseline at both high and low altitude), this less stringent low-altitude standard yields also a proportionally less strict high-altitude standard, too.

This does, however, disprove the logic behind EPA's assumption, namely that while the two pieces of available data were not directly applicable, their errors would be in the opposite direction and, therefore, would tend to cancel, hopefully to large degree. It is evident that the use of this equation shows that as the baseline is reduced, the standard increases slowly to reflect the fact that the stringency of the standard (low-altitude standard/low-altitude base) is lessening at a slightly faster rate than the <u>high-altitude</u> baseline is dropping. This is due to the additive nature of the altitude correction. A multiplicative altitude correction would not display this behavior, as pointed out by MVMA, but that cannot be construed as an endorsement of that approach. EPA remains convinced that the additive nature of altitude effects is correct and amply defended its position in the LDV discussion.

However, because the errors in the data base compound each other rather than cancel, EPA must take care to see that these errors are minimized, if not removed altogether. A careful reconsideration of the overall derivation of the standards provides some useful insight into the problem at hand. The basic equation upon which the standards are based is:

$$\text{High-Altitude Standard} = \left(\begin{matrix}\text{high-altitude} \\ \text{baseline}\end{matrix}\right) \times \left(\begin{matrix}\text{1-fractional reduction} \\ \text{from the baseline demanded}\end{matrix}\right)$$

Guidelines for the numbers to be used in the terms within the parentheses are found in section 202(f)(2) of the CAA(1977):

> "Any such future regulation applicable to high-altitude vehicles or engines shall not require a percentage of reduction in the emissions of such vehicles which is greater than the required percentage of reduction in emissions from motor vehicles as set forth in section 202(b). This percentage reduction shall be determined by comparing any proposed high-altitude emission standards to high-altitude emissions from vehicles manufactured during model year 1970."

Section 202(b) refers to the LDV standards for 1982 and 1983 among other years. The LDV standards for these years reflect a 90 percent reduction from the baseline year 1970 which was also the basis for the high-altitude LDV standards. Thus, the fractional reduction permitted by the CAA to be used for the derivation of these LDT standards is also 90 percent, not the various lesser reductions used in the derivation of the proposed standards. Section 202(f)(2) also requires this 90 percent reduction to be taken from a 1970 baseline.

The 1970 model year saw the present LDT class divided into two groups: those up to 6,000 lbs. GVW which were classified as LDVs and subject to those standards and those of 6,000-8,500 lbs. GVW which were classified as HDTs and subject to those standards. The lighter weight group constituted 84 percent of sales, the heavier, 16 percent of sales. Thus, a composite baseline of these groups can be expressed by:

$$\text{Low-Altitude Baseline} = 0.16(\text{LDV baseline}) + 0.84(\text{HDV baseline})$$

However, this is not useful because the 1970 HDV baseline cannot be approximated by its standard and converted to an equivalent number for the current test procedure based upon the generally recognized conversion factors.2/ Unfortunately, the HDV standard was not based upon the LDV cycle and, in fact, is not even expressed in terms of gm/mi. Thus, there is no recognized conversion.

Barring the use of a 1970 low-altitude baseline, the available 1969 low-altitude baseline must be considered. This will be highly favorable to the industry as the HDVs (i.e., those 6,000-8,500 lbs. GVW) are totally uncontrolled and the LDVs (i.e., trucks less than 6,000 lbs. GVW) are less controlled than in 1970. Furthermore, because 1969 LDV data (or appropriate standards) are not available, it becomes necessary to put this 1969 baseline completely in terms of the 6,000-8,500 lbs. GVW vehicles, thus raising the baseline further. The values for this baseline used in the NPRM were found to be erroneous and were later corrected by retesting. The correct values are:3/

HC 6.46 gm/mi
CO 76.02 gm/mi

These values are higher by an unknown, but nonetheless, substantial amount than the proper 1970 baseline fleet of sales-weighted 0-8,500 lb. GVW LDTs.

The correct low-altitude baseline, as referenced above, must be corrected to a high-altitude baseline, so to it must be added the high-altitude increment (following the LDV procedure which was amply justified in the earlier discussion). For the LDT increment, EPA used the LDV increment because no proper LDT high-altitude data existed then, nor exists now. While EPA recognized that this value was probably low, it concluded that the value cannot be too erroneous because the increase in emissions with altitude is largely due to the enriching of the fuel-air mixture of the carburetor and is not significantly affected by the differences in weight or road load between the two categories of vehicles. What little error there may be (a value too low and therefore unfavorable to industry) will have a smaller effect than the advantage given to industry by the use of the uncontrolled 1969 low-altitude baseline. Also, in its final submittal, MVMA presented additional data which followed, to a degree, the format of its earlier LDV study. It presented the results of 5 LDTs (all GM) tested at both low and high altitude with which it concluded that EPA grossly underestimated the degradation of emissions with altitude by using the LDV data additively. It did this by comparing those high-to-low altitude ratios to that implicit in the proposed standards. EPA rejects the data and, hence, the argument. The data are irrelevant because they come from vehicles designed to meet the 1978 California standards. The behavior with altitude of these strongly controlled vehicles is irrelevant to the estimation of altitude effects in a very weakly controlled 1970 baseline fleet: variation with altitude could be vastly different due to vastly different control technologies. Furthermore, EPA has already rejected the use of the ratio method and, hence, finds an argument based upon the comparison of two computed ratios to be pointless.

Thus, the high-altitude baseline is taken to be:

HC 6.5 + 1.6 = 8.1 gm/mi
CO 76 + 44 = 120 gm/mi

Taking then 10 percent of this baseline, as permitted by Sections 202(f)(2) and 202(b) of the CAA(1977), yields potential standards for 1982-83 of 0.8 gm/mi for HC and 12 gm/mi for CO. These values still are higher than that allowed because of the generous baseline used (the only supportable one, however, at this time). They are, however, less than the 1982 and 1983 standards proposed by EPA on January 24, 1980 and debated here. Unfortunately, while the CAA permits these lower standards, to use them at this point would suggest a reproposal which would delay the truck standards, at least to 1983. EPA judges that it would be preferable from an air quality perspective to promulgate the proposed rules, thereby obtaining some control, although not the maximum, in 1982.

Recommendation

The standards are acceptable as proposed except for the need to include waiver standards for CO and NOx. The waiver standards should be, for qualifying vehicles, CO = 11 gms/mile and NOx = 1.5 gms/ mile.

References

1/ Michael W. Leiferman, "Effect of Altitude on Non-Controlled Evaporative Emissions from Gasoline-Fueled Vehicles," U.S. Environmental Protection Agency, Emission Control Technology Division, Ann Arbor, Michigan, January, 1979.

2/ Thomas A. Huls, "Evolution of Federal Light-Duty Mass Emissions Regulations," Society of Automotive Engineers paper 730554, 1973.

3/ Larry Ragsdale, "Final 1969 LDT Baseline Emission Results," U.S. EPA, Memorandum to the Record, March 21, 1980.

B. Issue: Technical Feasibility

Summary of Issue

In the NPRM, EPA predicted that it would be technically feasible for all light-duty vehicles and light-duty trucks to comply with the proposed high-altitude standards.

Summary of Comments

Most of the manufacturers commended that the proposed standards were not feasible for the 1982 model year, for either light-duty vehicles or light-duty trucks.

Major Subissues

1. Technical Feasibility for Gasoline-Fueled Light-Duty Vehicles.

2. Technical Feasibility for Gasoline-Fueled Light-Duty Trucks.

3. Technical Feasibility for Diesel-Fueled Light-Duty Vehicles and Trucks Analysis of Comments.

Analysis of Comments

1. Technical Feasibility for Light-Duty Vehicles. The light-duty vehicle high-altitude standards which EPA proposed, and which EPA is promulgating in the final rule, are 0.57 g/mi HC, 7.8 g/mi CO, and 1.0 g/mi NOx. There are several exceptions to these standards, however. Several engine families have received CO waivers for the 1982 model year at low altitude. Accordingly, these engine families will only have to meet a high-altitude CO standard of 11 g/mi in 1982 rather than 7.8 g/mi. These engine families are listed in Table 1.

In addition, American Motors must only comply to a 2.0 g/mi low-altitude NOx standard in 1982; accordingly, American Motors will have a 2.0 g/mi high-altitude NOx standard in 1982 as well. Finally, several light-duty diesel engine families have received low-altitude NOx waivers for 1982; these engine families will have high-altitude NOx standards equivalent to the low-altitude NOx standard levels for 1982. These engine families and their 1982 waiver levels are listed in Table 2.

The analysis of the feasibility of the 1982-83 high-altitude interim standards has not been an easy task. Many of the manufacturers submitted little or no high-altitude test data for the emission control systems they plan to use in the 1982 and 1983 model years. Many manufacturers did not even submit relevant low-altitude data or data which would be helpful in determining appropriate high-altitude/low-altitude emission factors. Due to

Table 1

Engines with CO Waivers for the 1982 Model Year

Manufacturer	Engine
American Motors	258 CID
Chrysler	1.7 L 3.7 L 5.2 L-4V
General Motors	2.8 L/173 CID-2V 3.8 L/231 CID-2V
Jaguar-Rover-Triumph	215 CID 326 CID
Toyota	88.6 CID

Table 2

Diesel Engines with NOx Waivers for the 1982 Model Year

Manufacturer	Engine Family	1982 NOx Standard
Daimler-Benz	2.4 L	1.25
	3.0 L-NA	1.5
	3.0 L-TC	1.5
General Motors	5.7 L	1.5
Peugeot	2.3 L-TC-XD2S	1.5
Volkswagen	1.6 L-NA-2375IW	1.3
	2.0 L-NA-3250IW	1.5
	1.6 L-TC-2375IW	1.3
	1.6 L-TC-2625IW	1.4
	2.0 L-TC-3250IW	1.5
Volvo	2.4 L-NA	1.5

the scarcity of relevant data, our technical evaluation has not been based on as broad a data base as EPA would prefer to use in its technical assessments.

Nevertheless, despite the limitations imposed by the lack of a broad data base, EPA's technical staff has performed a comprehensive feasibility analysis for all the manufacturers which commented on the technical feasibility of the proposed standards. It is entitled "Technical Feasibility of the Proposed 1982-1983 High Altitude Standards for Light-Duty Vehicles and Light-Duty Trucks" by Robert J. Bruetsch, John J. McFadden, and William M. Pidgeon, dated August, 1980. This Technical Report has been placed in the docket and is publicly available as CTAB/TA/80-3. This chapter will only summarize the methodology and results of this analysis, anyone wishing further detail should consult the above report.

The basic methodology used by EPA's technical staff to determine the feasibility of the high-altitude standards was to make pass/fail judgments on the manufacturers' technical ability to comply with the standards. The following four methods were used in making the pass/fail judgments.

1. The first method used high-altitude data for emission control systems which the EPA technical staff predicted would be used by the manufacturers for the 1982-1983 model years. These data were averaged for each engine group. The averages were then multiplied by deterioration factors (dfs) taken from 1981 certification data for that manufacturer. The calculated results were then compared to the standards.

2. The second method utilized 1981 certification test data from emission data vehicles and deterioration factors from 1981 certification durability vehicles. Factors were developed to reflect the change in emissions based on tests at high and low altitudes. These three data sets were multiplied to calculate the predicted high-altitude emissions at 50,000 miles. These predicted levels were then compared to the standards.

3. The third method is the same as method 2, but instead of emission data vehicle results, 4,000-mile extrapolated emission results from the 1981 certification durability vehicles were substituted. Therefore, the dfs and 4,000-mile emissions were from the same vehicles.

4. The fourth method utilized technical knowledge of the emission control system's ability to compensate for altitude. This was used for situations where data were unavailable or to specifically address issues raised by the particular manufacturer being evaluated.

Before using any of the four methods it was necessary for EPA to predict the engine displacements and emission control technology to be used by each manufacturer. In most cases these judgments were based on information from four sources; a) 1981 certification data, b) CO waiver applications, c) testimony from the 1982-1983 high-altitude hearings, and comments on the 1982-1983 high-altitude NPRM, and d) written responses to questions from the high-altitude hearing panel. Of these four sources, only the 1981 certification data were not yet publicly available. While certification data were considered in this analysis, data which were unavailable from the other sources cannot be divulged in our analysis. In such cases, the engine displacement was replaced by a letter designation and the emission control system description was replaced by a number.

Where the manufacturer has historically grouped more than one engine displacement in an engine family, or where the EPA technical staff judged that several engine displacements were equipped with similar emission control systems, these engines were evaluated as a group in order to expedite the analysis. Several engine displacements were available with more than one emission control system. The prime concern was to evaluate whether the manufacturer had the technology for each engine group to comply with the standards. It was not possible for this analysis to determine whether every combination of engine displacement and emission control system which the manufacturer had available could comply with the standards. Therefore, in most cases, only one such combination was evaluated.

In methods 1 thru 3, four different data sets were used. The 1981 certification dfs comprised one of the data sets. The dfs were taken from the EPA Certification Status Report of July 11, 1980 and averaged for each engine group. Deterioration factors were only calculated for vehicles with at least three valid tests and a 15,000-mile test. Vehicles which were line crossing* were not included in the average.

Because manufacturers have historically generated dfs for more engine families than they actually market, a second set of dfs was also used. In many cases, a manufacturer will actually market only those engine families whose durability vehicles achieved the lowest deterioration factors. In order to reflect these practices, EPA selected the durability data within the engine group which had the best combination of results when considered with the altitude factors and the 4,000-mile data. The best combination results would give the engine group the highest probability of passing the standards. These deterioration factors are referred to as the "lowest dfs." It should be noted that the dfs from the single durability vehicle with the best combination results was chosen,

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* A durability vehicle is considered to be line crossing when the results from one or more valid tests are above the 1982-1983 model year low-altitude standards, and either the extrapolated 4K or extrapolated 50K results are also above the same standards.

and not the lowest dfs from among all the individual vehicles within the engine group. The selected vehicle's dfs were then used in the calculations.

The second data set used in methods 1, 2 and 3 were low mileage test results. In method 1, low mileage high-altitude test results were used along with certification dfs in order to predict 50,000-mile emissions at high altitude. Due to the scarcity of high-altitude test data, method 1 was infrequently used.

In method 2, the low mileage test results were the 4,000-mile certification results from 1981 emission data vehicles which had been assigned a certification disposition of passing. The cutoff date for this data was July 15, 1980 for light-duty vehicles, and July 23, 1980 for light-duty trucks. These data were then averaged for each engine group.

Because the 1981 Federal CO standard for light-duty vehicles is more stringent than the California standard, where possible, only emission data vehicles calibrated for sale in 49-states or 50-states were included in 4,000 test averages. For light-duty trucks, the opposite is true. The California standards are more stringent. In this case California trucks and 50-state trucks were used in the 4,000-mile test averages.

Durability vehicles were selected by emission control system only. Sales location was not a criterion in their selection. All durability vehicles with at least three valid tests, a 15,000-mile test, and which were not considered to be line crossing, were used for the df averages and the extrapolated 4,000-mile results.

The third data set was used when 4,000-mile emission data vehicle test results with a certification disposition of passing were not available. Instead, extrapolated 4,000-mile results from the durability vehicles within the EPA designated engine group were averaged and used. Only those vehicles which met the criteria to be included in the df average were included in the 4,000-mile average. These data were gathered on July 17, 1980, and used in method 3.

The fourth set of data used in methods 2 and 3 were factors reflecting the change in emissions for a vehicle tested at high and low altitudes. The primary reason for emissions problems at high altitude is the fact that as altitude increases, the air density decreases. This causes the air/fuel ratio of non-altitude compensated fuel metering systems to enrich as altitude increases. Attendant with richer mixtures are increases in HC and CO emissions. Therefore, in order to prevent or limit increases in HC and CO emissions with increases in altitude, the air/fuel ratio enrichment has to be limited, and/or the emission control aftertreatment system has to be modified to increase its effectiveness in converting the increased engine-out emissions. The methods of achieving those objectives vary with the type of emission control system. Multiplicative high-altitude to low-altitude emission factors were developed for four generic emission control systems:

1. Pulse or aspirator type air injection systems (PAIR), oxidation catalysts (OC), and exhaust gas recirculation (EGR) with altitude compensating carburetors.

2. Air injection systems using air pumps (AIR), OC, and EGR with altitude compensating carburetors.

3. Feedback carburation (FBC), three-way catalysts (3W), AIR, OC, and EGR.

4. Closed-loop electronic fuel injection (CLEFI), 3W, and EGR.

These factors were developed from light-duty vehicle data submitted by various manufacturers. They are summarized in Table 3.

For further detail on the calculation of these factors, see the aforementioned EPA Technical Report CTAB/TA/80-3.

With this basic methodology, we will now briefly summarize the analyses for each light-duty vehicle manufacturer.

American Motors - In their final written comments, American Motors (AMC) did not "dispute the basic feasibility of the proposed standards." They considered the issue more one of leadtime and resource prioritization. Table 4 summarizes EPA's technical analysis of AMC's position. Based on the above quote from AMC, the advanced nature of the GM emission control system that AMC uses, and the dearth of any data to the contrary, EPA concludes that AMC will be able to comply with the high-altitude standards.

Chrysler - Table 5 summarizes EPA's technical feasibility analysis for Chrysler. Based on the conclusions reached in Table 5 and EPA's latest discussions with Chrysler representatives, it is clear that Chrysler will have no problems meeting the high-altitude standards in 1982-1983.

Ford - Table 6 summarizes EPA's technical feasibility analysis for Ford. As can be seen from Table 6, EPA cannot show that Ford can comply with the high-altitude standards. This is primarily due to a lack of relevant data. However, the following statement from a letter from D.A. Jensen of Ford to EPA (dated April 30, 1980) clarifies Ford's current position:

> "The data in Table 2 indicates that Ford's current 'altitude compensated electronic calibrations' are capable of achieving the standards EPA has proposed at altitude. The test results on Vehicle #4 indicate that less costly 'aneroid compensated nonelectronic calibrations also comply'."

Table 3

High-Altitude to Low-Altitude Emission Factors for Genenic Emission Control Systems

Emission Control System	Data Base	Applicable Manufacturers	HC	CO	NOx
PAIR/OC/EGR + aneroid carburetor	Nissan	Nissan	1.10	1.76	--
PAIR/OC/EGR + aneroid carburetor	Nissan	All Others	1.70	1.80	--
AIR/OC/EGR + aneroid carburetor	Ford	All	1.65	1.73	1.03
FBC/AIR/3W/OC/EGR	Chrysler	Chrysler	1.55	2.65	1.00
FBC/AIR/3W/OC/EGR	Ford	Ford	1.12	2.56	0.97
FBC/AIR/3W/OC/EGR	Chrysler, Ford	All Others	1.47	2.63	1.00
CLEFI/3W/EGR	Nissan	All	1.68	2.57	0.74

Table 4

Technical Feasibility for American Motors

Engine	Year	Emission Control System	Conclusion	Basis
151 CID	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 1 Analysis Using GM Data and Lowest DFs.
258 CID	1982	1	Not Enough Data	--
258 CID	1983	FBC/AIR/3W/OC/EGR	Not Enough Data	--

Table 5

Technical Feasibility for Chrysler

Engine	Year	Emission Control System	Conclusion	Basis
1.7 L	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 2 Analysis
2.2 L	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 2 Analysis
2.6 L	1982-83	PAIR/OC/EGR	Pass	Method 2 Analysis
3.7 L	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 2 Analysis

Table 6

Technical Feasibility for Ford

Engine	Year	Emission Control System	Conclusion	Basis
1.3/1.6 L	1982-83	Open-loop/AIR/3W/OC/EGR	Not enough data	--
2.3 L	1982-83	FBC/AIR/3W/OC/EGR or	Pass	Method 3 analysis
		Open-loop/AIR/3W/OC/EGR	Not enough data	--
2.3 L/TC	1982	FBC/AIR/3W/OC/EGR or	Not enough data	--
		Open-loop/AIR/3W/OC/EGR	Not enough data	--
	1983	EFI	Not enough data	--
3.3 L	1982-83	FBC/AIR/3W/OC/EGR or	Not enough data	--
		Open-loop/AIR/3W/OC/EGR	Not enough data	--
			Pass	Method 2 analysis
4.2/5.0/	1982-83	Open-loop/AIR/3W/OC/EGR	Not enough data	--
5.8L		FBC/AIR/3W/OC/EGR	Fail (NOx)	Method 1 analysis
		CFI/AIR/3W/OC/EGR	Pass	Method 1 analysis

Thus, there seems to be little question that Ford can meet the high-altitude standards.

General Motors - Table 7 summarizes EPA's analysis of General Motors' technical position.

GM did not make technical feasibility an issue in their comments on the NPRM. They provided more extensive high-altitude test data than any other manufacturer. This allowed EPA to use method 1 analyses, which give conclusions with higher confidence than methods 2, 3, or 4. As Table 7 shows, we have concluded that most of the engine groups for which GM Provided high-altitude test data will comply with the high-altitude standards. Two factors must be noted with respect to Table 7. First, there are four engine groups for which we could not show compliance. GM did provide high-altitude data on these vehicles, and EPA's technical analsyis showed these vehicles to fail the high-altitude standards. But in each of these four instances, there have been extenuating circumstances that lead us to the conclusion that we do not have sufficient information to make a conclusion (for example, in the case of the 4.4-liter engine GM has expanded the feedback carburetion range of authority and they expect the engine to meet high-altitude requirements). Secondly, the technical staff did not attempt to analyze every engine displacement and emission control system which GM might use for the 1982-83 model years. GM characterized the data they presented as "representing the broad spectrum of General Motors passenger cars," and EPA concluded that analyses covering these data would be representative of GM's capabilities in complying with the high-altitude standards, based on Table 7, then, we conclude that GM will be able to comply with the high-altitude standards.

Honda - We have assumed that Honda will market engines A, B, and C with emission control systems 1, 2, and 3 for model years 1982 and 1983. Honda has used an "air jet controller" (aneroid) modification to the carburetor assembly for air/fuel ratio control on high-altitude vehicles since 1977. The potential effectiveness of this control, as demonstrated on the 1.8-liter, 49-state vehicle adjusted for deterioration, is shown in Table 8.

It can be seen that the high-altitude emissions in Table 8 are well under the standards. The air jet control technology is considered to be transferable to other Honda engines allowing compliance with the 1982-83 high-altitude standards.

Jaguar-Rover-Triumph - Table 9 summarizes Jaguar-Rover-Triumph (JTR) technical position.

JRT submitted no high-altitude data for any of their engines. This has made our technical analysis very difficult. JRT uses a Lucas/Bosch electronically-controlled fuel njection system on its vehicles. It is an air flow sensitive, pulsed, port injection system with one injector per engine cylinder. The air/fuel ratio

Table 7

Technical Feasibility for General Motors

Engine	Year	Emission Control System	Conclusion	Basis
1.6 L	1982-83	FBC/AIR/3W/OC/EGR	Not enough data	--
2.5 L	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 1 analysis using lowest dfs.
3.8 L	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 1 analysis
4.3 L	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 1 analysis
4.4 L	1982-83	FBC/AIR/3W/OC/EGR	Not enough data	--
4.9 L (standard)	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 1 analysis
4.9 L (high performance)	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 1 analysis
4.9 L/TC	1982-83	FBC/AIR/3W/OC/EGR	Not enough data	--
5.0/5.7L	1982-83	FBC/AIR/3W/OC/EGR	Pass	Method 1 analysis
6.0 L	1982-83	FBC/AIR/3W/OC/EGR	Not enough data	--

Table 8

Honda High-Altitude Emission Characteristics Using Air Jet Controller

Vehicle	Test Location	HC	CO	NOx
1.8 L 49-states 5MT	Low altitude	0.17	2.51	0.68
	High altitude*	0.28	5.8	0.45
1.8 L 49-states 3AT	Low altitude	0.13	3.40	0.56
	High altiude*	0.18	5.10	0.60

* WIth Air Jet Controller

Table 9

Technical Feasibility for Jaguar-Rover-Triumph

Engine	Year	Emission Control System	Conclusion	Basis
122 CID	1982-83	CLEFI/3W	Pass	Method 3 Analysis
215 CID	1982-83	CLEFI/3W/EGR	Not enough data	--
258 CID	1982-83	AIR/CLEFI/3W or CLEFI/3W	Not enough data	--
326 CID	1982-83	CLEFI/3W/3W	Not enough data	--

is controlled near stoichiometry by the use of oxygen sensors in the exhaust down pipes. Bosch has claimed that this control system is self-compensating up to 8,200 feet. Thus, despite the lack of relevant data, we have concluded that JRT will be able to comply with the high-altitude standards.

Nissan - Table 10 summarizes our technical analysis for Nissan.

Based on the technical analysis, EPA concludes that Nissan will be able to comply with the high-altitude standards.

Peugeot - EPA assumes that Peugeot will market engine A with emission control system 5 in model years 1982 and 1983. Data were not available to fully utilize methods 1, 2, and 3. We did have some limited data analysis of this along with engineering judgment led us to predict the following results for the Peugeot engine at high altitude: 0.38 g/mi HC, 7.0 g/mi CO, and 0.58 g/mi NOx. These results are less than the high-altitude standards.

Toyota - Table 11 summarizes Toyota's position.

As shown in Table 11, EPA concludes that Toyota will achieve compliance with the high-altitude standards.

Volkswagen - Volkswagen intends to use the Bosch K-Jetronic fuel injection system. Although this system is able to compensate for changes in air density, VW expressed some doubt that it would compensate sufficiently to meet the high-altitude standards. Bosch has stated that the system compensates for altitude up to 8,200 feet. In addition, Volvo test data has shown that the same K-Jetronic fuel injection system produced emissions results well under the high-altitude standards. In view of these facts, and lacking any VW data to prove otherwise, the EPA technical staff's judgment is that VW will be able to comply with the high-altitude standards. For a more complete discussion of VW, see EPA Technical Report CTAB-TA/80-3.

2. Technical Feasibility for Gasoline-Fueled Light-Duty Trucks. Light-duty trucks have higher numerical standards at low altitude than do light-duty vehicles. Similarly, light-duty trucks will have numerically less stringent standards at high-altitudes as well. In 1982, light-duty trucks will have high-altitude standards of 2.0 gpm HC, 2b gpm CO, and 2.3 gpm NOx. In 1983, the high-altitude standards will be 1.0 gpm HC, 14 gpm CO, and 2.3 gpm NOx.

Basically, the methodology used by the EPA technical staff to determine the technical feasibility for light-duty truck manufacturers was the same as that used in the previous subissue for light-duty vehicles. One issue in this regard was the validity of using the high altitude to low altitude emission factors in Table 3 (calculated from light-duty vehicle data) in assessing the techni-

Table 10

Technical Feasibility for Nissan

Engine	Year	Emission Control System	Conclusion	Basis
1.2/1.4/ 1/5L	1982-83	PAIR/OC/EGR	Pass	Method 3 Analysis
2.0 L	1982-83	"Fast Burn"/CLEFI/ 3W/EGR	Pass	Method 3 Analysis
2.8 L	1982-83	CLEFI/3W/EGR	Pass	Method 1 Analysis

Table 11

Technical Feasibility for Toyota

Engine	Year	Emission Control System	Conclusion	Basis
78.7 CID	1982-83	PAIR/OC/EGR	Pass	Method 3 Analysis
88.6 CID	1982-83	PAIR/OC/EGR	Pass	Method 3 Analysis
108 CID	1982-83	Closed Loop AIR/3W/EGR	Pass	Method 4 Analysis
134/ 144.4 CID	1982-83	Closed Loop AIR/3W/EGR	Pass	Method 3 Analysis
156.4/ 168.4 CID	1982-83	CLEFI/3W/EGR	Pass	Method 3 Analysis

cal feasibility for light-duty trucks. This issue is discussed in some depth in the EPA Technical Report CTAB/TA/80-3 discussed above. EPA did use the emission factors in Table 3 for light-duty trucks, but did so with the understanding that there were questions about doing so.

We will now summarize the technical feasibility of each light-duty truck manufacturer that commented on the issue.

American Motors - The summary of AMC's technical position is listed in Table 12.

Table 12 indicates that AMC can comply with the 1982 high-altitude light-duty truck standards but can not now show compliance with the 1983 standards. There will be an extra full year of leadtime for 1983 and EPA believes this to be sufficient for the development of a light-duty truck package to meet the 1983 standards.

Chrysler - Table 13 summarizes our analysis of Chryslers light-duty trucks.

EPA anticipates that Chrysler will have no problems meeting the high-altitude light-duty truck standards.

Ford - Our analysis of Ford's light-duty situation is highlighted in Table 14.

As shown in Table 14, the only engine groupings which failed were engines A-1 and B/C/D-1, both for the 1983 model year. Two factors must be noted. One, both of these engines involved emission control systems which were calibrated to meet the 49-state HC standard of 1.7 gpm, thus it is not surprising that these vehicles would fail to meet the 1983 high-altitude HC standard of 1.0 gpm. Given a year of development time and the lower standard it is quite likely that compliance can be achieved. Second, both the A and B/C/D engines were able to show compliance with the 1983 high-altitude standards with emission control system 2. Thus we conclude that Ford will be able to meet the high-altitude standards.

General Motors - Our summary of GM's light-duty truck situation is given in Table 15.

As Table 15 shows, GM should be able to meet the high-altitude light-duty truck standards.

International Harvester - The only high-altitude data which IH provided to EPA were two series of tests of 1977 Scout Travelers with 345 CID engines. Both vehicles showed high-altitude emissions consistently below the 1983 high-altitude standards. Since IH demonstrated ability to meet the 1983 standards at high-altitude with a relatively large vehicle (5000 pounds inertia weight) and large engine (345 CID), EPA is confident that the technology can be

Table 12

LDT Technical Feasibility for American Motors

Engine	Year	Emission Control System	Conclusion	Basis
A	1982-83	1	Pass	Method 4 Analysis
B	1982	2	Pass	Method 2 Analysis
B	1983	2	Fail	Method 2 Analysis
C	1982	2	Pass	Method 2 Analysis
C	1983	2	Fail	Method 2 Analysis
D	1982	2	Pass	Method 2 Analysis
D	1983	2	Fail	Method 2 Analysis

Table 13

LDT Technical Feasibility for Chrysler

Engine	Year	Emission Control System	Conclusion	Basis
A	1982-83	1	Pass	Method 2 Analysis
B/C	1982-83	1	Pass	Method 3 Analysis

Table 14

LDT Technical Feasibility for Ford

Engine	Year	Emission Control System	Conclusion	Basis
A	1982	1	Pass	Method 2 Analysis
A	1983	1	Fail	Method 2 Analysis
A	1982-83	2	Pass	Method 2 Analysis
B/C/D	1982	1	Pass	Method 2 Analysis
B/C/D	1983	1	Fail	Method 2 Analysis
B/C/D	1982-83	2	Pass	Method 2 Analysis

Table 15

LDT Technical Feasibility for General Motors

Engine	Year	Emission Control System	Conclusion	Basis
A	1982-83	1	Pass	Method 4 Analysis
B	1982-83	3	Pass	Method 2 Analysis
C/D	1982-83	3	Pass	Method 2 Analysis

Table 16

LDT Technical Feasibility for General Motors

Engine	Year	Emission Control System	Conclusion	Basis
A	1982-83	1	Pass	Method 4 Analysis
B	1982-83	2	Pass	Method 4 Analysis

transferred to smaller displacement engines and lighter vehicles. In addition, three years time has elapsed yielding IH much time to resolve any possible problems in transferring the technology.

Nissan - Nissan is expected to market only one light-duty gasoline engine for light-duty trucks in 1982-83. The Nissan A engine is expected to be available with emission control system 1. A method 2 analysis was performed which indicated that this engine easily complies with the 1982 and 1983 high-altitude standards.

Toyota - Table 16 summarizes our analysis of Toyota's feasibility in meeting the light-duty truck standards.

Based on Table 16, Toyota should be able to comply with the high-altitude light-duty truck standards.

3. Technical Feasibility for Diesel-Fueled Light-Duty Vehicles and Trucks

Light-Duty Vehicles

General Motors, Peugeot, Volkswagen, Mercedes Benz, Volvo, Audi, and International Harvester offer diesel-fueled vehicles in their product mix for light-duty vehicle and/or light-duty truck applications. The diesel combustion process tends to produce low HC and CO emissions, and the technical staff's judgement is that the interim high-altitude standards should not pose a problen for this category of engines. There were not many comments from the manufacturers concerning this issue. General Motors did comment that:

> "For diesel engines, adjustments have a much smaller effect on HC, CO and NOx compared to gasoline engines, but can reduce exhaust smoke."

In order to assess the ability of diesel engines to comply with the standards, the technical staff developed high/low altitude emission factors from two sources. Data from an EPA report entitled "1977 EPA-Industry Light-Duty Diesel Correlation Program," April 1978, showed that HC, CO and NOx emissions were lower for a Mercedes Benz 300D at high altitude than at low altitude. This is explainable since this engine was apparently equipped with an intake-air density compensator. The high-altitude/low-altitude emission factors were 0.98, 0.94, and 0.92 for HC, CO, and NOx, respectively. The same report determined altitude factors for a GM Oldsmobile diesel as well. Its high-altitude/low-altitude factors were 1.31, 1.21, and 0.79 for HC, CO, and NOx, respectively. Comparing these altitude factors to factors for the high-to-low altitude standards (high/low altitude standard) of 1.89 HC, 2.3 CO, and 1.0 NOx, would indicate that diesel LDVs can comply with the proposed standards without the need for adjustments.

Other FTP data more recently developed, for five diesel LDVs (two Oldsmobiles, VW, Peugeot, Mercedes) tested at both EPA (for low-altitude environment) and at the Automotive Testing Laboratory (ATL) at Auroram Colorado (5480 feet), averaged high/low-altitude emission factors of 2.27, 1.87, and 1.02 for HC, CO, and NOx, respectively.

These factors show some upward pressure on HC and CO emissions and negligible effect on NOx emissions. However, the CO factor of 1.85 is offset by the higher standard of 7.8 g/mi at high altitude, which is calculated to be 2.3 times the low-altitude standard of 3.4 g/mi. Those LDV diesels certifying (low altitude) at 0.25 g/mi HC or below should comply with the interim HC high-altitude standard. Otherwise, aneroids, other fuel limiting devices, fuel rack adjustments, or injection timing modification options are available to the manufacturers.

In order to test this assumption that diesel LDVs can comply with the interim high-altitude standards for 1982 and 1983, with only minor adjustments, the technical staff applied the more conservative high/low altitude factors of 2.27 HC, 1.85 CO, and 1.02 NOx to low altitude 1980 4K certification, average test results on the GMC, Mercedes, Peugeot, VW, Audi, and Volvo vehicles. The predicted results are listed in Table 17.

These results confirm that there could be some upward pressure on HC from diesel LDVs at high altitude, and that some minor injection timing or maximum fuel adjustments may be required to meet the high-altitude standard of 0.57 g/mi. The conservative high/low altitude factor of 1.02 NOx indicates that the manufacturers that certify at low altitude should also conform to high-altitude standards. The higher NOx values shown here are to be expected since the NOx standard for 1980 MY vehicles was 2.0 g/mi. Although the 1981 statutory NOx standard is 1.0 g/mi, wiavers to 1.5 g/mi NOx are available for manufacturers whom fulfúll the statutory criteria under Section 202(b)(b)(B) of the Clean Air Act for model years 1981 through 1984.

Light-Duty Trucks

With respect to the LDT standards for 1982 and 1983, Nissan, who has supplied diesel engines to International Harvester, provided the following statement:

> "Because the amount of inlet air is reduced at high altitude and excessive air cannor be obtained, an altitude compensator (aneroid type compensator) will be required for the fuel injection system at WOR operation. Furthermore, our simulation test data indicates that HC and CO emissions are likely to increase with altitude even at partial load operation. (The HC and CO emissions during FTP increases 2.2 and 1.4 times respectively.) Therefore, in order to control HC and Co emissions at high altitude, it is considered that using only a

Table 17

Predicted High-Altitude Diesel LDV Emissions Using Conservative Altitude Factors and 1980 Certification Results

	GMC	Mercedes (49 states)		Peugeot		VW	Audi	Volvo
	(NA)	(NA)	(TC)	(NA)	(TC)	(NA)	(NA)	(NA)
HC	0.71	0.72	0.54	0.72	0.49	0.82	0.91	0.66
CO	3.86	1.98	1.98	2.4	2.5	2.22	2.40	2.53
NOx	1.68	1.50	1.49	1.46	1.0	1.27	1.73	1.70

Table 18

Predicted High-Altitude Diesel LDT Emissions Using Conservative Altitude Factors and 1980 Certification Results

	Nissan/IH	GMC	VW
HC	0.95	2.0	0.73
CO	3.51	4.01	1.85
NOx	1.53	2.14	2.18

compensator is not enough, and recalibration of injection timing and EGR will be necessary."

International Harvester has used a turbocharged engine for LDT applications. This engine does have the capability to provide excess air, and the statement by Nissan that "excess air cannot be obtained" does not apply. Furthermore, it is currently accepted practice to install aneroid controls on turbocharged engines for the sole purpose of preventing excess smoke during acceleration modes. This aneroid could also automatically correct the maximum fuel setting for high-altitude conditions.

Nissan, in their submission, considered emission factors of 2.2 and 1.4 for HC and CO, respectively, for high altitude. The EPA technical staff used the more conservative LDV factors of 2.27 and 1.85 for HC and CO in establishing whether this engine would comply with the high altitude standards. Application of these factors to 1980 MY certification test results provided the results in Table 18.

Since the 1983 high-altitude LDT standards are 1.0 g/mi HC, 14.0 g/mi CO, and 2.3 g/mi NOx, both the VW Diesel and the Nissan 198TC Diesel, as used by International Harvester, are considered by the technical staff to be capable of meeting the high-altitude standards for the 1982 and 1983 model years. Because of upward pressure on HC, the GMC trucks will probably require modifications which may include adjustments of injection timing or the maximum fuel setting in order to comply with 1983 MY standards.

Particulate emissions were not considered in this determination, but there is no high-altitude particulate standard for the 1982 and 1983 model years. Thus, it is the determination of the technical staff that both light-duty vehicles and light-duty trucks powered by diesel engines can comply with the high-altitude standards with minor adjustments or, effectively, by addition of aneroid type controls.

Recommendation

The interim high-altitude standards appear to be technically feasible after a careful analysis of the available information. Therefore, the levels of the standards should not be changed in the final rule.

C. Issue: Adequacy of Existing High-Altitude Test Facilities

Summary of the Issue

The proposed regulations would necessitate the use of testing facilities located at high altitude (HA) or testing facilities with the capability of simulating HA conditions. These HA test facilities would be needed for research and development (R & D) work, certification testing, and Selective Enforcement Audits as well as continued EPA in-use surveillance testing. The proposal assumed that existing HA test facilities would be sufficient to develop and certify the low-altitude light-duty fleet to the proposed 1982 and 1983 HA standard.

Summary of the Comments

The major comment by the manufacturers was that existing commercial HA test facilities might not have adequate test capacity to meet the needs of the manufacturers. MVMA stated that they questioned if HA test facilities would be adequate but they didn't give any analysis of this suspicion. Ford stated that they probably would require expansion of their HA facility. However, further details were not given. AMC claimed that HA test facilities were already scheduled to capacity and Fuji/Subaru was concerned that the Denver commercial labs could not guarantee test time due to limited testing capacity. VW claimed that since HA facilities would be fully utilized for development work, Selective Enforcement Audits could not be done.

Analysis of Comments

The following discussion and analysis of high-altitude test facilities is divided into two parts. First, a review of existing facilities both commercial and private is presented. This information was obtained from the various manufacturers at the request of EPA. EPA's letter and the manufacturer's responses can be found in the public docket for this rulemaking. The two commercial testing facilities also submitted information in response to an EPA request and their letters can be found in the public docket as well.

After discussing existing facilities, the need for high-altitude test facilities will be presented. Estimates of each manufacturer's research and development (R&D), certification, and Selective Enforcement Audit (SEA) burdens are made. Then the previously developed information on existing facilities is combined with the need for facilities to resolve the issue of whether or not there are adequate high-altitude test facilities to implement the proposed rule.

1. Existing Facilities. Currently, there are two commercial high-altitude test facilities in the Denver area. EPA is not aware

of any other commercial facilities capable of performing HA testing. The two facilities are Automotive Testing Laboratories (ATL) and Environmental Testing Corporation (ETC). Both facilities have the capability of performing the full Federal Test Procedure (FTP) for light-duty vehicles (LDVs) and light-duty trucks (LDTs) including evaporative emission testing. Both facilities have considerable amounts of testing capacity still available at the time of this writing and both facilities doubt that the proposed rule will necessitate full utilization of their respective testing capacities.

ETC is located in Aurora, Colorado, a suburb of Denver. This commercial testing facility has two chassis dynanometers and one LDV evaporative emission enclosure or SHED. ETC states that by running at full capacity they could conduct 252 tests per week if evaporative testing is not included (i.e., 2 test sites x 3 shifts per day x 6 tests per test site per shift x 7 days per week). If each test included evaporative emission testing, ETC could then conduct 63 tests per week (i.e., 3 tests per test site per shift x 1 test site x 3 shifts per day x 7 days per week). However, ETC states that they could have another LDV SHED operational within six months should they perceive a need. This would effectively double their evaporative emission testing capability to 126 tests per week.

The above test rates are for non-certification testing. These rates would be appropriate for R & D testing but not for actual certification testing. Tests conducted for R&D purposes do not have to meet any EPA specifications. For example, R&D tests could be conducted with an ambient temperature of 50°F. This would still be a useful test for R&D purposes but would not be acceptable from a certification point of view. Because there are a number of specifications which must be met in order to have a valid certification test, a void rate should be applied to the above testing rates if the testing has to be of certification quality. ETC estimated their void rate as 20 percent at maximum. This would reduce the above test rates to 202 tests per week not including evaporative testing and 101 tests per week including evaporative testing (2 SHEDs).

The other commercial high-altitude testing laboratory, Automotive Testing Laboratories, Inc. (ATL), is also located in Aurora, Colorado. This facility currently has one test cell in operation and floor space for another. A second test cell will be operational by November 1, 1980, which is the date that this analysis will use as the starting point of the manufacturers' development effort. November 1, 1980 will be used as the starting date even though we know that significant development effort has already occurred. In fact, conversations with ATL indicate that a number of manufacturers have been testing since the spring of this year and testing is continuing to be scheduled from now through the November 1 starting point of this analysis. ATL does not expect to fully utilize their testing capacity at any time in the next 12 months. Furthermore, conversations with Chrysler (see the public docket for this rulemaking) indicate that they have been running 4-5 tests/day since February 1, 1980. It is, however, difficult to quantify the amount of development work that will have been done by November 1, because ATL cannot provide the necessary details due to the proprietary nature of such information. Thus, this analysis is based on the very conservative assumption that no HA development testing will be done until November 1, 1980.

The test cell currently operating at ATL's high-altitude facility is staffed to operate 20 hours per day. The other four hours are used for calibration and maintenance. ATL submitted standard dynamometer test times which show that 112 FTPs without SHED could be conducted per 7-day week. With the addition of the second test cell 224 non-SHED FTPs could be conducted per 7-day week.

ATL's one operating test cell includes a SHED for evaporative emissions testing. ATL has another SHED and the necessary auxiliary equipment for evaporative emissions testing at the Aurora lab, however, it is not set up at the present time. This second evaporative emission test site could be assembled very quickly if the need presented itself. Therefore this analysis will assume that the second SHED is operational. It has not been assembled yet because ATL has no indication that it will be needed. With two operating SHEDs and two chassis dynos, ATL could conduct about 93 FTPs per week including SHED testing.

ATL did not include a void rate for certification quality testing so ETC's void rate of 20 percent will be used. ATL's capacity for certification quality testing is 179 FTPs per week excluding SHED testing and 74 FTPs per week including SHED testing.

To summarize the available commercial facilities, with current equipment ETC can run 252 non-SHED FTPs per week and ATL can run 224 non-SHED FTPs per week for a total of 476 tests per week. If evaporative emissions testing capabilities are included then ETC can run 63 FTP (with SHED) tests per week and ATL can run 93 FTP (with SHED) tests per week for a total of 156 tests per week. Additionally, if necessary ETC could double its capacity within six months to 126 FTP (with SHED) tests per week bringing the total for both facilities to 219 tests per week. Test rates for certification quality testing would be the above testing rates reduced by 20 percent.

The total number of non-SHED tests that could be made available between November 1, 1980 and June 30, 1981 is somewhat more than 16,000 of R&D quality. EPA expects that SHED testing will not be a limiting factor because it will be relatively easy to meet the HA evaporative emission standards. Therefore, the large majority of testing will be R&D quality, non-SHED test.

Besides commercial test facilities there are many manufacturers that have facilities for high-altitude testing. General Motors, Ford, Honda, Mercedes Benz, and Fiat have testing facilities located at high altitude. Furthermore, General Motors, VW/Audi, Honda, Nissan, Mercedes Benz, Toyota, BMW, Mitsubishi, Mazda, Subaru, and Peugeot all either have a pressure chamber capable of simulating high-altitude conditions or have contracted to rent such a facility overseas. In this section a brief discussion of each manufacturer's high-altitude test facilities will be presented.

General Motors has an emissions laboratory in Denver, Colorado. It has three chassis dynamometers, two SHEDs, and covers 51,750 ft^2. General Motors also has a high-altitude test chamber at Milford, Michigan. The chamber has one chassis dynamometer only and was designed to achieve a pressure reduction of 4 inches of mercury below ambient atmospheric pressure.

Ford also has an emissions laboratory at Denver, Colorado. Ford's facility has four chassis dynamometers, one SHED and covers approximately 25,000 ft^2 which includes a soak area for 45 vehicles. Although Ford does not have an altitude test chamber at this time, the company is considering converting an engine dynamometer cell to accomodate simulated high-altitude conditions.

Chyrsler has no facilities of its own at high altitude nor any capable of simulating high-altitude conditions. However, Chrysler has contracted with ETC to rent two of their six testing shifts as of August, 1980.

Volkswagenwerk/Audi has a chamber capable of simulating high-altitude conditions which is located in Germany. The chamber is very close to being finished and some testing has been done. The chamber has one chassis dynamometer and one SHED plus area for soaking vehicles. Another chamber is planned.

Nissan has a high-altitude simulation chamber located in Japan. The chamber has two chassis dynamometers and one SHED. Nissan is currently studying whether or not to build a test facility at a high altitude location in the USA.

Toyota has a pressure controlled test room in Japan which has one chassis dynamometer and one SHED.

Mercedes Benz has both an emissions testing facility at a high-altitude location (Aurora, Colorado) and a chamber capable of simulating high-altitude conditions (in Germany). The facility at high-altitude has one chassis dynamometer, one SHED, and covers 10,300 ft^2. The high-altitude simulation chamber has two chassis dynamometers but they can't be used simultaneously. It has a SHED and particulate measuring equipment that will be installed by October.

Mitsubishi has neither a facility located at high-altitude nor a chamber capable of simulating high-altitude conditions. However, they do rent time from a laboratory in Japan which has high-altitude simulation capability. This facility has an engine dynamometer but no chassis dynamometer or SHED.

Toyo Kogyo/Mazda has a high-altitude simulation chamber in Japan. The chamber has one chassis dynamometer, one SHED and area for soaking vehicles.

Honda has a high-altitude emissions test facility in Denver, Colorado. The facility has one chassis dynamometer, one SHED, and covers approximately 19,000 ft^2. Honda also has a high-altitude simulation chamber located in Japan. This chamber has one engine dynamometer and covers approximately 2200 ft^2.

Subaru/Fuji has a facility capable of simulating high-altitude conditions and is located in Japan. This facility has one chassis dyno but no SHED. However, the company is planning to construct another facility capable of performing the full FTP including SHED in one of their plants.

Fiat has a laboratory located in Sestrier, Italy which is at an altitude of 6,691 ft. this facility has one chassis dynamometer, no SHED, and covers approximately 2100 ft^2.

Peugeot has built a pressure chamber in France. The chamber has one chassis dynamometer but SHED testing cannot be performed in accordance with Federal regulations.

BMW will be using an environmental chamber that is owned and operated by Industrieanlagen-Betriebsgesellschaft of West Germany. This facility has one chassis dynamometer and one SHED.

Renault is currently building a chamber for the simulation of high-altitude conditions in Lardy, France. It will include one dynamometer and one SHED and is scheduled to be ready for the 1982 model year.

AMC, IHC, Isuzu, Volvo and Alfa Romeo indicated they have no facilities at a high-altitude location nor do they have a chamber capable of simulating high-altitude conditions.

EPA did not obtain information from other companies such as Ferrari, Maserati, Lotus, Panther, Porsche, Jaguar/Rover/Triumph, Hyundai, Rolls Royce, or Aston Martin. These smaller companies represent less than 10 percent of the engine families that were certified in 1980. For the purposes of this analysis it will be assumed that these manufacturers have no high-altitude test capability.

2. Need for Facilities. High-altitude emissions test facilities are needed for four primary reasons. First, high-

altitude test facilities are needed for research and development (R&D) work. Some engine families will need some recalibration of either the carburetor or the feedback control system. Once the recalibration is made it must be tested to see if it meets the new high-altitude standards. As discussed later in this section, R&D is the only area of facility usage that even comes close to fully utilizing existing commercial high-altitude test facility capacity.

High-altitude test facilities will also be needed for certification testing. In order to produce a model the manufacturer must show to EPA that the model meets the emission standards. He does this by performing certification tests in the late spring and early summer before production is scheduled to begin (usually in August). If the vehicle representing the model passes the test (and it usually does) the manufacturer is issued a certificate which allows him to produce the model. The utilization of high-altitude test facilities for certification testing will be minor as discussed later in this section.

The third and fourth reasons that high-altitude test facilities will be needed relate to Selective Enforcement Audits (SEA) and potential in-use surveillance programs. SEA is EPA's method of checking to make sure that production vehicles from the assembly line actually meet the emission standards. In-use surveillance testing is used by EPA to help determine the level of emissions of vehicles that have been owned and operated by the public for various lengths of time. Both SEA and in-use surveillance are expected to utilize relatively minor amounts of high-altitude testing facilities as discussed later in this section.

a. <u>Research and Development Needs</u>. Of the four different reasons why HA commercial test facilities are needed for this proposed regulation (i.e., R&D, certification testing, SEA, and in-use surveillance), R&D is the only one that could approach full utilization of existing commercial test capacity. In order to meet the proposed HA standards some manufacturers will have to recalibrate their low altitude engine/ emission control systems. Some manufacturers may add new components for HA vehicles that will have to be optimized for emissions, fuel economy and driveability. Estimations of R&D efforts for the industry are, of course, difficult because each manufacturer's needs are different. Additionally, utilization of test facilities to meet a given R&D need can vary considerably depending on factors such as the engineering experience and skill, the priority that the manufacturer places on the project and the extent that theoretical evaluations can be substituted for trial and error FTP testing. The following discussion present EPA's estimation of HA commercial test facility utilization for R&D in which a "worst case" scenario is evaluated. The "worst case" is based on the assumption that manufacturers will not begin development work until November 1, 1980, the projected date for the final rule (this conservative assumption, which ignores the development work done prior to November 1, will be discussed later.

It is convenient to divide LDVs and LDTs into two groups according to expected engine/emission control strategies. Feedback control strategies are those where an oxygen sensor electronically communicates with the air/fuel metering system through a computer to provide a constant stoichiometric A:F ratio during most driving modes. This allows optimization among emissions, fuel economy, and driveability. The feedback control system was relatively rare prior to 1981 but with the stricter low-altitude NOx, HC and CO standards for 1981 this type of system is now in the majority and is expected to be the predominant type of system for 1982 and 1983. The other group of engine control systems are known as non-feedback. This group has air/fuel metering systems of the conventional type such as carburetion or fuel injection but has no oxygen sensor or associated micro-processor unit.

The feedback systems are the easier of the two groups to modify for compliance with the proposed HA standards. When a feedback system that has been developed for low-altitude use is operated at high altitudes, there will be some automatic compensation for the less dense air. The oxygen sensor will signal the air/fuel metering system that the A:F ratio is too rich. The mixture will be enleaned to either the correct mixture called for by the micro-processor unit (usually close to stoichiometric) or the leanest mixture that the system can deliver. If the leanest mixture is still to rich, the system's range of authority can be shifted so that proper A:F mixture is obtained. Shifting the range of authority is probably the simplest of the modifications that will be needed to meet the HA standards.

The optimization effort for non-feedback systems will include recalibration for cold start, power enrichment, and other driving modes. Proper engine and emission control system performance must be obtained at different cruising speeds, during accelerations and decelerations, and during transient operation. The development effort for non-feedback systems is expected to be more than the development effort for feedback systems.

In order to determine if the capacity of HA commercial test facilities is sufficient, the number of R&D tests which will be needed must be estimated. In the chapter entitled Economic Impact of the 1982-1983 High-Altitude Emission Standards (Chapter V) of the "Regulatory Analysis" of this rulemaking the number of R&D tests required to meet these HA standards is estimated. To summarize that discussion, all diesel engine families, whether car or truck, are expected to need 20 R&D tests each. Also, all gasoline-fueled LDT families are expected to need 150 tests per famliy. Gasoline-fueled LDV engine families are divided into two groups: those which need so few R&D tests as to be considered already meeting the standards (GM's C-4 system and Bosch's Jetronic system) and those others which EPA estimates will each need 150 R&D tests.

The number of LDV and LDT engine families to be certified for 1982 is, of course, unknown at this time. We have assumed that approximately the same number of engine families will be certified in 1982 as was certified in 1980. In 1980 there were 156 non-California LDV and LDT engine families certified. These include families for sale in either the 49 states, excluding California, or the 50 states, including California. Engine families which are certified for sale in California only have been excluded because these proposed regulations do not apply to those vehicles.

Since some manufacturers have their own facilities capable of performing HA tests, a number of the 156 non-California engine families will have R&D work done at these facilities instead of the HA commerical facilities. We estimate that GM will have 32 LDV and LDT engine families in 1982. As discussed earlier, GM has a test facility in the Denver area which has 3 chassis dynos. At a testing rate of 6 FTPs per shift per dyno site x 3 dynos x 3 shifts per day x 7 days per week, GM could perform 378 FTPs per week. Testing at this rate for 8 months (i.e., from the promulgation of the final rule, November 1, 1980 to June 30, 1981) gives a potential of about 12,000 HA FTPs. Since all of GM's LDV engine families will have the C-4 system, they will need minimal R&D testing to comply with the HA standards. EPA estimates that GM's remaining engine families (diesels and LDTs) will require less than 1000 tests total. Therefore, GM should easily be able to handle all necessary R&D work at their own HA facility.

Ford's situation is similar to GM's. Ford has a HA test facility with 4 chassis dynos while GM had only 3. Thus, Ford's testing capacity is about 16,000 R&D tests. EPA estimates that Ford will need about 3000 R&D tests. Therefore, Ford should easily be able to handle all of their R&D testing in-house.

Mercedes Benz has both a facility at HA (Denver) and a HA chamber in Germany. Each facility has one chassis dyno. Therefore, Mercedes can run about 8000 FTPs in 8 months. However, EPA estimates Mercedes will have to run less than 100 tests for R&D purposes and, therefore, Mercedes will not have to use any of the commercial HA test facilities.

Similar analyses for Honda (2 engine families), BMW (3 engine families), Nissan (6 engine families), Fiat (2 engine families), Subaru/Fuji (3 engine families), Peugeot (2 engine families), Toyo Kogyo/Mazda (5 engine families), Toyota (8 engine families), VW/Audi (3 engine families), Porsche (3 engine families), and Saab (2 engine families) indicate that these manufacturers have the capacity to do all of their R&D work in-house either at HA or in chambers capable of simulating HA conditions. None of these manufacturers should need to use the existing commercial HA test facilities in Denver for R&D work.

The above discussion shows that the total number of LDV and LDT engine families for which the necessary R&D work can be done at manufacturers' facilities is 106. This leaves 50 LDV and LDT engine families that may have to use the commercial testing labs in

Denver. If all of these 50 engine families were gasoline-fueled LDVs and LDTs, which did not employ either the C-4 system or the Bosch Jetronic, then the required R&D tests at HA commercial facilities would be about 7500. However, since some of these engine families are diesels and some use the C-4 or Bosch Jetronic systems, EPA estimates that the number of R&D tests to be conducted at HA commercial facilities will be about 6400. As discussed earlier, EPA estimates that the commercial HA test facilities are capable of performing about 476 FTPs (excluding SHED) per week. This means the test capacity for 8 months is approximately 16,000 tests. Subtracting the tests needed for R&D work (6400) leaves a reserve capacity of 9,600 tests. Therefore, EPA has determined that adequate HA comercial testing facilities exist to handle the R&D work required for this rulemaking.

As mentioned earlier, the above analysis is based on a very conservative assumption -- that manufacturers will not begin high-altitude development testing until November 1, 1980, the projected date for promulgation of the final rule. Even assuming this to be true, we showed that existing commercial facilities would be able to provide the high-altitude R&D test capacities necessary for those manufacturers which do not have their own high-altitude test facilities.

EPA is aware, however, that many manufacturers have already begun their high-altitude R&D test programs. Chrysler has been running tests at ETC since February of this year (telephone conversation of June 30, 1980). JRT has also notified EPA that it has performed testing at high altitude as well (June 2, 1980 letter to EPA). Finally, conversations with ATL and ETC indicate that a substantial amount of high-altitude development work has been done by several manufacturers. The exact amount of testing that has been done by each manufacturer is unknown since manufacturers did not volunteer such information in their written comments and because the commercial labs will not divulge proprietary information. The point is that much development work has been and will be performed prior to November 1, 1980. Our above analysis ignores this work, and to that extent overestimates the test capacities needed after November 1. Thus, there will actually be an even greater safety margin than the near-60 percent hypothesized above.

In conclusion, when it is remembered that: 1) the number of R&D tests required per engine family was estimated on the high side, 2) most if not all manufacturers have already done some R&D testing at the time of this writing (July, 1980) and will certainly do more between now and November, 1980, 3) the estimate of existing commercial test facility capacity includes liberal estimates for maintenance and downtime, and 4) even with this worst case scenario there is 60 percent reserve capacity, EPA's determination that sufficient test capacity exists for high-altitude R&D work is both reasonable and conservative.

b. Certification Needs. High-altitude test facilities needed for certification testing appear to be more than adequate. Since each manufacturer will be required to test only one emission data vehicle per non-California engine family (see the issue entitled "Number of Certification Vehicles" in this document), the total number of certification tests at high-altitude should approximate the number of non-California engine families certified. However, the actual number of high-altitude certification tests may be somewhat more or less than the number of non-California engine families. Tending to decrease the number of certification tests which may be needed is the fact that some low-altitude, non-California engine families will not need to be tested under high-altitude conditions because of the exemption criteria discussed in the issue "Exemptions" in this document. Tending to increase the number of certification tests is the fact that some tests will be voided due to mechanical problems or human error. But, as discussed earlier, the void rate is included in the testing rates of the commercial facilities and, therefore, no further consideration of the void rate is required in this discussion of adequate commercial testing capacity. Another factor tending to increase the number of certification tests is emission test failures. Some emission-data vehicles may not pass the emissions test the first time. Those vehicles will have to be retested if the problems can be resolved or, possibly, instead of retesting, new engine families (almost identical to the ones which failed) could be created, tested at low altitude and then tested at high altitude. Emission test failure is relatively rare and it may well be that the exemptions will cancel out the retests leaving the number of high-altitude certification tests about equal to the number of engine families to be certified. However, since the exact number of non-California engine families in 1982 and 1983 is unknown and the exact number of exemptions and retests are unknown, a safety factor of 50 percent will be used.

The number of non-California engine families to be certified in model years 1982 and 1983 will be estimated by using the number of non-California engine families that were certified in 1980. Analysis of certification data for model year 1980 indicates that 156 certificates of conformity were issued for engine families that could be sold only in the 49 states excluding California or could be sold in all 50 states. Certification for California-only engine families were not included. Applying the safety factor of 50 percent gives the estimated number of 234 high-altitude certification tests per model year. As discussed earlier under "Existing Facilities", the two commercial testing laboratories (ATL and ETC) in Denver can perform 175 full FTPs (including SHED tests) per week. This number assumes a void rate of 20 percent. The above numbers show that the entire industry's high-altitude certification testing could easily be done in less than two weeks if only the two commercial laboratories were used. However, EPA expects that most manufacturers who have high-altitude test facilities will do their own certification testing. These manufacturers include GM, Ford, Mercedes Benz, Honda, VW/Audi, Nissan, Toyota, Toyo Kogyo, Fiat and Renault. The number of 1980 non-California engine families represented by these ten manufacturers is 94, thereby leaving only (156 - 94) x 1.5 or 93 certification tests to be performed by the two commercial laboratories in Denver. Thus, of the total amount of commercial facility test time available between now and the 1982 model year, EPA estimates that less than 5 days would have to be devoted to the actual certification of the emission-data vehicles.

c. Selective Enforcement Audit (SEA) Needs. One commenter expressed concern that there would be no test facilities available for SEA testing. EPA expects that HA commercial test facility availability for SEA testing will be more than adequate. SEA testing would not begin until after the start of the 1982 model year. Therefore, development work needed for the first year of implementation will be finished long before SEAs are required. While it is likely that some development work will need to be done for the 1983 model year, that effort should be less than that required for the first year of implementation (i.e., 1982 model year). Thus, there should be ample reserve testing capacity at the time that SEAs would be done.

Furthermore, the number of SEAs that might be required at HA is expected to be quite small. As discussed in the issue entitled "Selective Enforcement Auditing (High Altitude)" in this document, the number of SEAs at HA should approximate the percent of HA sales. Since HA sales are about 4 percent of all sales, HA SEAs would be about 4 percent of all SEAs. This is a very small number; maybe 3 at most. Three SEAs might require 30 tests which is a liberal estimate. Since EPA believes that excess HA commercial testing capacity will be many times the 30 tests required for the maximum number of SEAs, the Agency concludes that existing capacity for commercial HA testing will be more than adequate for HA SEAs.

d. In-Use Surveillance Needs. The fourth area of demand to be placed on existing commerical high-altitude test facilites is the use of those facilities for EPA's In-Use Surveillance (IUS) program. EPA contracts with test facilities each year to test limited numbers of vehicles in different regions of the country. The data from this testing are used to develop EPA's Emission Factors which are subsequently used in air quality projections and analyses. ATL's Denver lab will be testing vehicles for EPA's IUS program from December, 1980 through July, 1981. At most, this testing effort will require about 350 tests at ATL. Even if utilization of the existing commercial HA test facilities approaches the 40 percent rate discussed earlier (an very unlikely possibility), the 60 percent reserve capacity represents more than enough full FTPs with SHED (3300) of certification quality to handle the 350 tests needed for the IUS program. Therefore, EPA expects that IUS testing will be absorbed by existing HA commerical test facilities with little or no impact on their capability to supply the auto industry with adequate capacity for R&D and certification testing.

Recommendation

EPA has determined that available high-altitude testing facilities are adequate to meet the testing requirements imposed by the proposed regulation. Therefore, it is recommended that no change to the proposal be made concerning this issue.

D. Issue: Selective Enforcement Auditing

Summary of Issue

In the preamble to the NPRM, EPA stated that, "The Agency may also require manufacturers to perform assembly-line testing (Selective Enforcement Audits) at high-altitude locations." No regulatory changes to the current SEA program were proposed in the NPRM.

Summary of Comments

EPA received many comments with respect to the high-altitude NPRM and Selective Enforcement Audits (SEA). Some commenters stated that since EPA failed to explicitly propose a regulatory system for implementation of SEA at high altitude, EPA would have to repropose the SEA portion of the rulemaking. Many commenters simply believed that high-altitude SEA testing would be impossible due to an inadequate number of high-altitude test facilities (in view of developmental and certification testing requirements and too little time to construct new facilities) and/or the difficulties involved in obtaining a sufficient number of high-altitude SEA vehicles in a specified time period. A few commenters desired clarification of EPA's position, with respect to whether foreign manufacturers would be required to construct high-altitude test facilities in the U.S., and whether a suspension or revocation of a certificate would apply only to vehicles operated at the altitude at which the SEA failure occurred, or at all altitudes. Finally, several commenters recommended alternate test procedures for high-altitude SEA and one manufacturer expressed concern about the criteria EPA would use to determine when a SEA was required.

Major Subissues

1. Adequacy of Proposal. Ford commented that EPA had failed to propose a responsible regulatory system for the implementation of SEA at high altitude and, therefore, reproposal of this portion of the NPRM is required. Ford also believed that the actual mechanics of the high-altitude SEA program were impermissibly vague. The Motor Vehicle Manufacturers Association (MVMA) stated that EPA should withdraw its high-altitude SEA testing requirements. After certain problems (discussed under other SEA subissues) have been resolved and a specific need for a high-altitude SEA program has been identified, MVMA recommended that the program then be reproposed for public comment.

2. Facilities. EPA regulations require that manufacturers provide a test facility that would be capable of performing high-altitude (HA) emission testing for SEA. Some commenters expressed concern that not enough HA facilities are available to conduct SEA testing, or to perform the testing within the time constraints imposed by the SEA regulations. The Motor Vehicle Manufacturers Association (MVMA) stated that leasing or renting facilities would present considerable problems to manufacturers and EPA because of

the following reasons: (1) facilities may not be available quickly enough to conduct SEA in an expeditious manner due to the requirements of HA development and certification testing; and 2) scheduling problems might occur due to the unknown number of required audit tests or the possibility of an audit failure. In addition, MVMA noted that §86.079-30(d)(2) requires all manufacturers to provide HA SEA test facilities and manpower, but stated that with a large number of manufacturers competing for available facilities and because of the difficulty of predicting how many tests would be required, scheduling problems would be encountered. Chrysler stated that it does not have a HA facility, and would have to purchase cell time from a private firm. Therefore, they would be competing with other manufacturers and with EPA itself for time, and this would result in extremely complicated scheduling difficulties. Chrysler believed that a SEA at a contractor facility would take up to one month, depending on cell availability. In addition, Chrysler felt that there was no guarantee that the minimum requirement of four tests per day could be achieved utilizing a contractor facility. Further, Chrysler commented that the development of rolls validation data prior to conducting SEAs would require several weeks of contractor time. Volkswagen (VW) stated that they can not contract for HA testing in the short time frame imposed by the SEA regulations. VW also suggested that test capability at the HA location, or the development and availability of HA chambers at manufacturing facilities, are extremely limited, and that the capacity of these facilities would be fully utilized for development testing. Subaru of America stated that there are problems with testing in Denver because of scheduling problems and lack of available facilities. They indicated that they are considering building a HA facility in Japan, and that approximately 22 months of lead time is necessary to develop operating procedures and do some engine design work. Therefore, they suggested that the effective date for these HA regulations be extended to the 1983 model year. Ford stated that they needed to acquire an environmental chamber. They claimed that it would take a "couple of years" to construct an operational facility.

3. Impact on Foreign Manufacturers. Several foreign manufacturers were concerned that their HA test facilities might have to be located in the U.S., thereby increasing the cost of SEA testing due to shipping costs. Nissan stated that a high-altitude test facility for SEA testing, e.g., a pressure chamber, would be required at each assembly plant, or SEA test vehicles would have to be sent to Denver, Colorado; in either case, Nissan believes it is too expensive and unreasonable. Renault stated that high-altitude SEA testing would have to be conducted in the U.S. and would, therefore, be very expensive for an importer. Jaguar/Rover/Triumph (JRT) believes that HA SEA is financially burdensome due to the company's lack of HA testing facilities and the distance to suitable commercially available facilities. (JRT did not indicate where they anticipated these facilities would be located.)

4. Available Vehicles. Some manufacturers were concerned

that a sufficient number of HA vehicles would not be available in a specified time period for SEA testing. American Motors stated that there would be a lack of sufficient HA vehicles for SEA testing. International Harvester stated that, based on their 1979 audit, SEAs can not be easily completed in a short period of time because a sufficient number of HA vehicles may be difficult, if not impossible, to find. The Motor Vehicle Manufacturers Association (MVMA) stated that there may be a lack of HA-equipped vehicles to complete the audit within a reasonable time period, especially for low-volume manufacturers. MVMA pointed to a possible lack of necessary engine, transmission, and axle ratio categories at the assembly plant or on dealer lots, and stated that pre-sold vehicles would further reduce the number of vehicles available. Chrysler stated that SEA test vehicles required under the batch sampling plans may exceed the entire sales population of a high-altitude configuration.

5. Sanctions. Ford asked for a clarification of the Selective Enforcement Audit (SEA) implications of the new regulations. Ford inquired whether a suspension or revocation of a certificate of conformity would apply only to vehicles operated at the altitude at which the audit failure occurred, or at all altitudes. Ford contended that EPA lacks authority to suspend or revoke certificates based upon testing at any altitude other than the altitude at which the vehicles in question are principally operated. Ford provided no basis for this statement.

6. Alternative Test Procedures. Currently the Federal Test Procedure (FTP) is used to test vehicles during SEAs. Several manufacturers suggested that EPA use an alternate test procedure for HA SEAs to ease the scheduling and cost problems that the manufacturers believe will occur as a result of the HA SEA program. American Motors and Ford suggested that EPA adopt a test procedure patterned after the California Air Resources Board (CARB) test procedure for vehicles that will be operated at high altitude. Ford further recommended that a more representative driving cycle be developed for high-altitude testing. Chrysler believes that HA vehicles should be tested at low altitude and a mathematical adjustment should be used to determine anticipated high-altitude performance. Chrysler also recommended the development of a more representative driving cycle. Nissan recommended, for economic reasons, that altitude compensator functional tests be used for HA SEAs instead of chassis dynamometer tests.

7. Test Order Criteria. Section 206(b) of the Clean Air Act authorizes the Administrator to test new motor vehicles to determine whether they do in fact conform with the regulations with respect to which the certificate of conformity was issued. International Harvester (IH) stated that EPA should limit SEA test orders only to situations where there is a specific indication that a vehicle configuration is failing to conform to the regulations at HA.

Analysis of Comments

1. Adequacy of Proposal. Section 206(b) of the Act authorizes EPA to test new production vehicles to determine compliance with emission requirements contained in regulations issued under Section 202 of the Clean Air Act. The Agency established the LDV/LDT SEA program to accomplish that objective. As additional standards become applicable to these vehicles, EPA may exercise its discretionary authority to test for compliance with those standards.

The SEA regulations in Subpart G of Part 86 are structured to accommodate new LDV and/or LDT emission standards within the existing SEA program. For example, when particulate standards become effective in the 1982 model year, diesel LDVs and LDTs will also be tested under SEA for compliance with those standards. The only changes that EPA made to the SEA regulations because of the new particulate standards were: additional information required with regard to particulate testing results (a new test procedure was promulgated) and wording changes to indicate that compliance must be determined for all "regulated" pollutants instead of just the "three" pollutants presently tested for (i.e., HC, CO, and NOx). See 45 FR 14524-14525, March 5, 1980. The only mention of SEA in the preamble to the particulate rule was the discussion of the deletion of separate SEA test procedures and the adoption of the test procedures used during certification in Subpart B of 40 CFR 86, including the new particulate test procedure, for SEA purposes.

For the proposed high-altitude emission standards, EPA had determined that no regulatory changes to the existing SEA program were required due to the new standards and, therefore, no proposed changes were included in the NPRM. EPA believes that any unique situations which may develop when testing vehicles under high-altitude conditions can be dealt with adequately under the purview of the existing SEA regulations. Manufacturers viewed their high-altitude SEA testing responsibilities within the context of the SEA program as it presently exists and indentified or alluded to these unique situations. As discussed in other SEA subissues, the Agency believes that all of the manufacturers' concerns can be accommodated under the present SEA program and has therefore made no amendments to Subpart G of Part 86 in this final rule.

In summary, EPA does not believe that a reproposal describing a program of high-altitude vehicle Selective Enforcement Auditing is necessary because this program is already covered by the present SEA regulations. The SEA regulations apply to both high-altitude and low-altitude vehicles and are not "impermissibly vague," as Ford suggested, because the special high-altitude testing situations and problems anticipated by both EPA and the manufacturers, and discussed under other SEA subissues, can be handled by the flexibility contained in the existing SEA regulations, e.g., very low-volume high-altitude vehicle configurations can be tested using sampling plans A, B, or C of Appendix VIII of 40 CFR 86, if necessary (see Subissue 4); additional time for shipment to high altitude facilities may be granted under §86.608(e) (see Subissue 3); and the 4-test-per-day requirement may be relaxed under §86.608(g) if a manufacturer experiences scheduling difficulties at contractor facilities (see Subissue 2).

MVMA suggested that a high-altitude SEA program be established only after a specific need for this program has been identified. Experience with the current SEA program indicates that compliance by a prototype certification vehicle does not necessarily indicate that the manufacturer's production vehicles will also meet the standards. Since the initiation of the program in 1977, eight vehicle configurations have been terminated as a result of SEA test orders, with failure rates varying from 72 to 91 percent. MVMA did not identify any characteristic of high-altitude vehicles which indicate that they will comply with high-altitude emission standards to a greater degree than that of low-altitude vehicles to low-altitude standards.

SEA provides a logical means of ensuring that production vehicles comply with standards at the time of manufacture by testing vehicles at the completion of assembly. In this manner, SEA provides a deterrent to the production of noncomplying vehicles, as experience with the program has illustrated, and thus serves to prevent introduction into commerce of vehicles polluting above the established standards. Considering the substantial contribution of mobile source emissions to ambient HC and CO in high-altitude regions and the air quality benefits to be obtained from adherence to the proposed standards, EPA sees a very definite need for monitoring compliance of motor vehicles destined for high-altitude use.

2. Facilities. Presently, two of the five domestic manufacturers (GM and Ford) have test facilities in Denver, Colorado, a high-altitude location, which are capable of performing the Federal Test Procedure (FTP). GM has three chassis dynamometers; Ford has four.1/ Chrysler, American Motors Corporation (AMC) and International Harvester (IH) do not have their own HA test facilities. Of the seven Japanese manufacturers, only Honda has an emission test facility capable of performing the Federal Test Procedure at a high-altitude location.2/ Mercedes-Benz and Fiat are the only European manufacturers which have test facilities in high-altitude locations.3/

At the present time, only a small proportion (approximately 4.0 percent) of total vehicle sales are expected to occur at high altitude. Once the Agency is satisfied that HA vehicles are not more likely to be in noncompliance with the emission standards than low-altitude vehicles, the proportion of test orders applicable to HA vehicles should generally approximate their sales fraction. Thus, EPA does not expect manufacturers to construct facilities solely for HA SEA testing if other options exist.

Presently, there are two independent HA testing facilities (Automotive Testing Laboratory (ATL) and Environmental Test Corporation (ETC)), both located in the Denver area. ETC has two test cells, with the capacity to do a total of 12 tests per eight-hour shift, while ATL has one cell with the capacity to do 6 tests in an eight-hour shift.4/

Since fewer than 12 tests would be required to complete a typical HA audit, these facilities provide a substantial testing capability for manufacturers, even considering those tests required for preconditioning, voided tests, and normal downtime. Therefore, with presently available contractor facilities, the Agency believes sufficient capacity exists to accommodate HA SEAs as well as certification and emission calibration testing. The ability of contractors to operate on more than one shift and the possibilities of HA SEA testing by foreign manufacturers outside of the United States should supplement high-altitude test facility availability. Further, if a manufacturer which has no HA facility of its own is unable to schedule a facility for SEA testing on an "as-needed" basis, sufficient lead time may be provided before actual testing must begin so as to enable the manufacturer to obtain the use of a HA test facility. EPA may also exercise its authority under §86.604 of the regulations to perform HA SEA testing using its own mobile emission testing facility (METFac). In this latter instance, the EPA facility would be devoted exclusively to SEA testing, so that the manufacturers should experience no facility availability or scheduling problems.

The two manufacturers (Ford and Subaru of America) who mentioned problems with insufficient lead time for building a HA facility did not provide any documentation to substantiate the amount of time they claim is needed to build this facility. According to ATL, a lead time of 9 months is necessary to build a HA test facility.

In summary, the Agency believes that there will be a sufficient availability of high-altitude facilities to meet SEA testing needs.

3. Impact on Foreign Manufacturers. The SEA regulations require manufacturers to provide the personnel and equipment (facility) needed to conduct testing. This facility (the manufacturer's own or a contractor's) could be located anywhere as long as the high-altitude conditions are satisfied when the exhaust emission tests are conducted under Subpart B of 40 CFR 86. Therefore, a foreign manufacturer has the option of testing at a HA facility in the U.S. or in its own country. If a foreign manufacturer has access to a HA facility in its own country and wishes to test there, EPA will conduct any HA SEAs at that facility to minimize shipping costs and to help provide for more expeditious auditing. However, if a foreign manufacturer elects to use a HA test facility in the U.S., then EPA will require that manufacturer

to ship the HA SEA test vehicles from its assembly plant (or, if feasible, from storage at a U.S. port of entry) to the test facility in U.S. Any increases in shipping costs should be nominal since the vehicles were presumably destined for sale in the general area of the test facility. The Agency's possible use of its mobile emission testing facility (discussed earlier) for SEA testing may also lessen the impact of HA SEAs upon foreign (and domestic) manufacturers. When a manufacturer believes it needs more than 24 hours for shipping test vehicles to the appropriate HA facility, it can request additional time under §86.608(e) of the regulations.

4. Available Vehicles. None of the manufacturers' comments were specific enough to demonstrate to EPA why it would not be possible to complete an audit. The SEA regulations require that the sampling plans in Appendix VIII of 40 CFR 86 be used in selecting test vehicles (§86.607(c)). These SEA sampling plans are structured to accommodate low-volume configurations, e.g., only 21 vehicles need be selected under sampling plan "A" and the audit can be passed after testing as few as 4 vehicles. In certain situations, not all of the vehicles need to be shipped to the test site, e.g., if the audit was passed before selection was completed. A manufacturer may request an alternative random sampling plan under §86.607(a), provided that the request is made in advance of receipt of a test order and that the Administrator approves the alternative plan. EPA usually does not elect to audit configurations with a production volume so low as to cause unexpeditious selection. However, if a HA configuration were chosen for auditing and there were problems in finding enough HA-equipped vehicles to complete the audit, the manufacturer could select low-altitude vehicles and have them modified for HA use as a dealership would, under authority of §86.603(c) and §86.607(a), since the HA regulations require that any vehicle (including low-altitude vehicles) manufactured for sale in the U.S. shall comply with the HA standards, or be capable of being modified to do so. EPA is considering the proposal of a sequential sampling plan for LDV SEA testing which would further ameliorate problems associated with the lack of SEA test vehicles. Using sequential sampling plans, only a small number of vehicles (as few as 4) would have to be selected and tested to complete an SEA, and the selection of large numbers of vehicles under the current batch sampling plans would be eliminated.

5. Sanctions. Paragraphs (h) of §86.082-8 and (h) of §86.082-9 require that all light-duty vehicle (LDVs) and most light-duty trucks (LDTs) must be capable of complying with both the low and high-altitude emission standards, "by initial design, adjustment, or modification," with a possible waiver of the requirement for certain low power, high fuel economy LDVs. Accordingly, certificates of conformity certify compliance with both low and high altitude emission standards (§86.082-30(a)(3)). Vehicles sold for principal use at high-altitude locations must have undergone the required adjustments or modifications, if any, necessary to be covered by the certificate.

EPA may issue a test order requiring the testing of new high-altitude vehicles under high-altitude conditions. Under Section 206(b) of the Clean Air Act (Act), the purpose of this testing is to determine whether the production vehicles conform with the regulations with respect to which the certificate of conformity was issued. According to Section 206(a), certificates are issued when a manufacturer has demonstrated conformity with regulations prescribed under Section 202. Since the high-altitude regulations are being promulgated under the authority of Section 202, a manufacturer that does not comply with these regulations can not be granted or retain a certificate of conformity. One of the regulatory requirements, as stated previously, is that all LDVs and most LDTs must be capable of meeting the applicable emission standards for any altitude operation.

If the results of SEA testing indicate that vehicles do not comply with the high-altitude standards, then the EPA Administrator can, under the authority of Section 206(b)(2) of the Act, suspend or revoke the certificate covering those vehicles. Since any configuration is originally issued its certificate on the basis of compliance with both low-altitude and high-altitude standards, even if a modification or adjustment to the low-altitude vehicle was necessary in order for it to become a high-altitude vehicle, the low-altitude vehicles will also be affected by the suspension/ revocation order. Due to the audit failure, the latter vehicles will have not satisfied the regulatory requirement that they be capable, by initial design, adjustment, or modification, of complying with the high-altitude emission standards.

To suspend or revoke only the certificates for the high-altitude vehicles may result in certain vehicle models only being available in the low-altitude configuration. This is the situation that developed during the 1977 model year, when high-altitude vehicles needed to demonstrate compliance only with high-altitude standards in order to be granted a certificate of conformity applicable only to those standards. (Note that the language of §86.077-30(a)(3), "One such certificate...will certify compliance with no more than one set of applicable standards," was amended, in §86.082-30(a)(3), to add "...except for low-altitude and high-altitude standards.") The resulting limitations on model availability in high-altitude areas generated adverse public reaction and caused Congress, in 1977, to revoke EPA's separate high-altitude certification program. For the Agency to begin in the 1982 model year to selectively suspend or revoke certificates of conformity, based on altitude of operation, could produce the situation that Congress was attempting to rectify in the 1977 amendments to the Clean Air Act. EPA will therefore use its statuatory authority to apply a particular sanction (e.g., suspension of a certificate) to the entire configuration, i.e., at all altitudes, when vehicles fail a Selective Enforcement Audit based on testing under either low-altitude or high-altitude conditions, unless the manufacturer can demonstrate, under §86.612(j), that the decision to suspend or revoke a certificate of conformity for a configuration is not appropriate for the configuration as a whole.

6. Alternative Test Procedures. The SEA regulations, at §86.608(a), require that SEA vehicles be tested according to the FTP. This was done to ensure that the results of SEA tests could be compared with the applicable emission standards. These alternative test procedures were also suggested for HA certification testing, but have been rejected by the Agency. The CARB test procedure and the altitude compensator functional test were rejected for certification purposes because they do not give a result that can be compared with the standard. EPA rejected the mathematical correction that Chrysler suggested because it does not yield accurate results. These alternative test procedures and the specific reasons they were rejected are discussed in the certification portion of this Summary and Analysis of Comments.

7. Test Order Criteria. In the determination of which vehicle class should be subject to a SEA test order, EPA uses several criteria which provide information regarding potential nonconformance of vehicles with the standards. These include certification emission testing results, manufacturers' assembly-line emission data from new vehicles, and other indications of noncompliance. In this manner, EPA focuses its audits on those new vehicle classes most likely to be in noncompliance with the emission requirements. Therefore, the suggestion of IH is already substantially incorporated into the SEA Program.

Recommendation

Based on the above analysis it is recommended that no changes be made to the high-altitude Selective Enforcement Audit program.

References

1/ Letters from GM and Ford to T.D. Mott, U.S. EPA, Ann Arbor, Michigan, both dated May 28, 1980.

2/ Letters from Japanese manufacturers to T.D. Mott, dated May 28, 29 and 30, 1980.

3/ Letters from Mercedes-Benz and Fiat to T.D. Mott, dated May 28 and 29, 1980, respectively.

4/ Letters from ATL and ETC to T.D. Mott, U.S. EPA, dated May 15 and 16, 1980, respectively.

E. Issue: High-Altitude Certification

Summary of Issue

EPA proposed that compliance with the proposed high-altitude (HA) standards be shown in the same basic manner that low-altitude compliance is shown. That is, emission-data vehicles would be required to be tested according to the light-duty vehicle (LDV) and light-duty truck (LDT) Federal Test Procedure (FTP). However, the testing would be done at HA instead of low altitude.

Summary of the Comments

Major Subissues

1. Alternative Certification Test Procedures. The manufacturers who commented on this issue mainly requested that EPA drop the proposed certification program and adopt some form of alternative certification program. Most commenters claimed that the HA certification program used in California (see the Appendix to this issue) would be acceptable to the manufacturers and would reduce their costs and leadtime requirements. In addition, MVMA claimed the California procedures have "already been found to meet the needs of high-altitude population centers" and AMC claimed that the California procedures are "an effective means of reducing high-altitude emissions." However, neither commenter included any analysis or supportive data to substantiate the claim.

2. Testing in Foreign Countries. Peugeot and Renault both asked EPA to address the question of where can certification testing be done by foreign manufacturers. Could the testing be done in their countries and the results sent to EPA, or would the testing have to be done in the U.S.?

3. FTP Driving Cycle Change. Ford and Chrysler commented that the driving cycle used in the FTP is inappropriate for use at HA. They claimed that since performance is adversely affected at HA, the emission-data vehicle will experience decreased acceleration rates and increased time at wide open throttle (WOT) when being operated over the driving cycle at HA. They claimed that a new driving cycle should be developed to represent HA driving patterns since the current driving cycle is unrepresentative.

4. HA Coastdown. Honda expressed concern that the dynamometer power determination as described in EPA Advisory Circular No. 55B (coastdown) should not be used at HA. The coastdown procedure is performed at low altitude where the air density is greater than at HA. Therefore, coastdown power settings obtained at low altitude would be too high to represent HA coastdown.

Analysis of comments

1. Alternative Certification Procedures. Since most commen-

ters requested that EPA adopt the State of California Air Resources Board's (CARB) HA certification scheme, a brief discussion of that program follows. CARB's Manufacturers Advisory Correspondence #78-2 which explains the program in more detail is attached as Appendix 1.

CARB's basic requirement is that the tailpipe air to fuel ratio (TAFR) during selected driving modes (e.g., idle, 30 mph cruise, 50 mph cruise, and WOT) be shown to be stoichiometric or leaner at elevations up to 6,000 feet except in those modes where the sea level TAFR is richer than stoichiometric. In those instances, the TAFR up to 6,000 feet must not be richer than at sea level.

CARB gives three acceptable methods to demonstrate compliance with their HA test requirement. For the "Flow Bench Testing" method the fuel and air mass flow rates, including secondary air injection if applicable, are measured under sea level conditions and under simulated conditions of 6,000 feet of altitude. The results are compared and if the above TAFR criteria are met then that vehicle is deemed to be in compliance. Another method suggested by CARB is called the "Analytical Method." This method first measures the fuel and air mass flow rates at sea level by using the "Flow Bench Testing" method. However, instead of measuring the mass flow rates under altitude conditions, they are calculated from the sea level mass flow rates using correction factors which were derived by comparing the air density at sea level to that at 6,000 feet of altitude. The mass flow rates at sea level and 6,000 feet are compared and compliance is determined. The third method suggested by CARB is called the "Dynamometer Testing" method. The concentrations of oxygen (O_2) and carbon monoxide (CO) are measured for each driving mode while operating the vehicle or engine on a dynamometer. This is done both under sea level conditions and altitude conditions. If the concentration of O_2 is greater than or equal to one half the concentration of CO, then the TAFR is considered to be stoichiometric or leaner. For the sea level driving modes that have a rich TAFR, the ratio of O_2 to CO at altitude must be greater than or equal to the same ratio at sea level.

EPA acknowledges that there is probably a reduction in HA hydrocarbon (HC) and CO emissions which results from CARB's compliance program. Certainly the primary reason for increased HC and CO emissions at HA as compared to low altitude is that the air-to-fuel ratio becomes richer with increasing altitude. This is due to the fact that the density of air decreases with altitude. Thus, the mass of oxygen necessary for the combustion of the fuel decreases with increasing altitude while the amount of fuel entering the combustion chamber remains about the same. This results in an overly rich mixture, incomplete combustion and increased HC and CO emissions. Furthermore, fuel economy and driveability are adversely affected. Since CARB's HA compliance program seeks to ensure that enough O_2 is present to fully combust the fuel, the potential exists to improve HA emissions. The problem is that the CARB certification procedures do not require that the O_2 be used efficiently to reduce emissions. For example, if secondary air is injected into the exhaust manifold or somewhere else downstream of the combustion chamber, the TAFR at HA can be made stoichiometric or leaner very easily by merely being sure to inject plenty of air. This would satisfy CARB's certification criteria. However, this in no way guarantees that the tailpipe emissions have been significantly reduced. Sufficient oxygen is not the only factor needed to assure further combustion of the emissions from the chambers.

For example, if the temperature is too low then there may not be much oxidation of the unburned emissions. Proper mixing of the injected air with the exhaust stream is necessary because the O_2 and the unburned emissions must come in contact in order to react. Residence time is also important since the more time the molecules have to get together, the more complete the reaction will be. The CARB procedure does not account for any of these factors.

The most that the CARB procedure can claim is that there is sufficient O_2 available for potential oxidation of the unburned emissions during selected driving modes. As discussed above, there are a number of other factors which must be considered to actually achieve oxidation of those unburned emissins. Furthermore, the CARB procedure does not even require proof of sufficient oxygen for the most complex of driving modes - transient operation. A carburetion system designed and calibrated to deliver enough air to ensure a stoichiometric or leaner TAFR at idle or cruise or WOT will not necessarily give a stoichiometric or leaner TAFR during transient operation. Since much of the operation of a vehicle is transient, especially in urban areas where air pollution is the worst, this mode is very important. The Federal Test Procedure (FTP) has transient operation as a major part of it and, therefore, EPA's proposed HA certification program will account for this important driving mode.

For the above reasons, EPA is convinced that if the CARB HA certification program were implemented, the reductions in emission levels of HA vehicles would be substantially less than under EPA's proposal is needed to meet the National Ambient Air Quality Standards (NAAQS) in HA areas (see the issue "Air Quality" in this document), and EPA's proposal is cost effective (see the chapter "Economic Impact" in the "Regulatory Analysis" of this rulemaking), the Agency finds it unacceptable to use CARB's HA certification program in which HC and CO emissions would be substantially more than under EPA's proposal.

In summary, EPA believes that the proposed HA certification program will reduce HA emissions substantially more than the CARB program because it will require closer scrutiny of all the factors which affect emissions generation and control. For example, EPA's proposal will assure that proper attention is given to adequate O_2, reaction temperature, residence time and reactant mixing instead of just O_2 concentration. Additionally, all driving modes will have to be considered, including complex transient operation, instead of just the four modes required by CARB.

Another problem with the CARB HA certification program is that the emission reductions are not known. Although there may well be some reduction in emissions for California-certified HA vehicles as compared to pre-certification HA vehicles, the reduction will not be quantified. If EPA were to adopt a HA certification program similar to California's (the significantly less reduction notwithstanding), the Agency would have to increase its in-use surveillance to determine the emission levels of the HA vehicles. Because of the large variation in emission levels that would likely occur among different models under alternative certification schemes, it would take a larger in-use surveillance program to characterize emissions since the more variation there is in a population, the more samples it takes to define the mean and variation of that population. Such an in-use surveillance program could be quite costly.

The reason actual emission levels must be determined is because of their crucial role in projections of air quality. The national programs for reducing air pollution and attaining the National Ambient Air Quality Standards (NAAQS) depend on the projection of air quality in different regions to some future date. If such projections indicate that a region will not meet the NAAQS, then planning can begin now for additional air pollution control programs to bring the region into compliance. On the other hand, if the air quality projections indicate that a region will be in compliance, then additional air pollution programs probably are not needed. Thus, air quality projections are critical tools to help in the decisions of when more control is needed as well as when enough control has been achieved. These projections would not be possible if the emission levels of different sources of air pollution (e.g., automobiles, trucks, power plants, etc.) were not known.

Emission levels of vehicles also need to be known in order to analyze the effects of proposed urban projects such as parking structures and traffic corridors. Such projects must consider whether or not the local environment (in this case the local air quality), can withstand the additional stress of the proposed plan. The CARB certification procedure for HA vehicles gives little or no information as to what the emission levels of the vehicles might actually be.

Another reason CARB's compliance program should be rejected in favor of EPA's proposed program involves what is known as 207(b) warranty protection. In 1977, Congress authorized EPA to develop a warranty program to protect consumers from defective emission control systems or components. In Section 207(b) of the Clean Air Act, 42 U.S.C. 7541(b), Congress stated that if an in-use short test could be developed which had reasonable correlation with the FTP, then that short test could be used to determine whether or not to invoke warranty regulations.

EPA has spent a number of years developing a short test which correlates with the FTP. If a vehicle fails the short test, it is assumed that it would fail the FTP. Since vehicles are supposed to pass the FTP for the first 50,000 miles of their useful life, something must be wrong with the vehicle's emission control system if it fails before 50,000 miles. The vehicle owner may have maladjusted, tampered with, or abused the emission control system. On the other hand, the emission control system could have been improperly assembled and/or installed at the factory or defective emission control components might have been used. If the failure to pass the short test and, by implication the FTP, is the manufacturer's fault, then the manufacturer will have to pay for necessary replacement or repairs.

The 207(b) warranty program will become increasingly important as Inspection and Maintenance (I/M) programs become implemented, and more and more vehicles are subjected to the short test. Congress obviously intended that the manufacturer pay to fix faulty emission control systems. EPA has no reason to believe that Congress intended that only low-altitude consumers be afforded this important warranty protection. Certainly HA consumers have just as much right to emission control system warranties as do low-altitude consumers.

However, in order to give HA consumers this warranty protection, a HA standard is needed. Since the short test is correlated with the FTP, only the FTP can be used for HA certification if the short test is to be used for HA warranty protection. In fact, HA consumers will not have any warranty protection unless the HA, full FTP, certification program is implemented. Theoretically, if another certification program (such as California's) for HA was promulgated, then another short test might be developed which would correlate with that certification test and HA warranty protection could be provided. Not only would such a certification scheme present the problems of inadequate emissions control and unknown emission levels as discussed earlier, but the effort needed to develop a new short test could be huge. It could take a tremendous amount of time and money to develop a reliable new short test which could accurately identify vehicles with faulty emission control systems especially when the emission levels at certification are not even known. It could be many years before HA consumers would have warranty protection. It may well not even be possible to develop such a short test and, in that case, the HA consumer might never receive HA warranty protection. EPA does not believe there is sufficient reason to undertake for the second time such a large effort when the Agency already has a short test and the cost of EPA's proposed HA certification program is minimal as will be discussed below.

EPA has determined that HA areas need further HC and CO reductions and that reducing LDV and LDT emissions to the levels proposed is both feasible and cost effective. EPA is convinced that CARB's HA certification program will not provide the reduction required to meet the proposed standards. Therefore, EPA intends to retain its HA certification program in a modified form to make it even less burdensome than originally proposed. As discussed more fully in the issue entitled "Number of Certification Vehicles" in this document, EPA has reduced the cost of certification by about 67 percent. The Agency estimates that the cost of certification will increase the retail price of a new HA vehicle by only 0.01 percent (about $.76). It will be even less if the cost is spread over all of the sales of a manufacturer rather than just HA sales. EPA is convinced that the benefit gained from retaining the proposed certification program far outweighs this minimal cost.

In summary, EPA's HA certification program as modified in this document is the most cost effective method of assuring that the required emission reductions are achieved in HA areas. CARB's certification program for HA vehicles not only wouldn't provide the required emission reductions but the amount of emissions actually being produced would be unknown. This would lead to a substantial increase in expenditures by the Agency to determine actual emission levels so that necessary air quality projections can be made. EPA's proposed HA certification program is also necessary to give HA consumers the same timely emission control system warranty protection as low-altitude consumers will have. EPA's program is very inexpensive and the burden on the manufacturers is minor.

2. Testing in Foreign Countries.

Certification protocol will be the same for both high- and low-altitude standards. Currently, manufacturers perform emission certification tests at the facility of their choice and submit data to EPA demonstrating their vehicles comply with the applicable standards. After reviewing this data, EPA may select a particular vehicle for conformity testing at a facility designated by the Administrator. This facility may or may not be the manufacturer's. These procedures are the same for both domestic and foreign manufacturers, and will not be changed by the promulgation of high-altitude standards.

3. FTP Driving Cycle Change.

EPA received no data demonstrating that the driving habits of low-altitude and high-altitude residents differ from one another. Furthermore, it is not intuitively obvious that just because a vehicle performs poorer at altitude, a driver will not demand just as much acceleration at altitude as would be demanded at low-altitude, i.e., the high-altitude driver may simply push harder on the accelerator peddle. In this case, where a vehicle operator demands similar acceleration the existing driving cycle is representative of high-altitude driving patterns. Therefore, there appears to be no reason to change the existing FTP driving cycle.

4. High Altitude Coastdown.

The comments on this subissue are based on the fact that the air density under high-altitude test conditions (5282 ± 328 feet or 83.3 ± 1.0 kilopascal) is less than that under low-altitude test conditions. EPA agrees that the lower air density at high-altitude results in less aerodynamic drag on a vehicle. However, these high-altitude standards have already accounted for this air density difference.

Both the LDV and LDT high-altitude standards were derived by adding an "altitude increment" to a low-altitude baseline to get a high-altitude baseline. Then, the standard was determined by taking a percentage of the high-altitude baseline (see the issue entitled "Standards" in this document). The part of the above standards determination relevant to this discussion is the "altitude increment."

This "altitude increment" was obtained from MVMA data. MVMA tested 25 vehicles at low altitude (St. Louis) and then tested them at high altitude (Denver). The sales-weighted average emissions at low altitude were subtracted from the sales-weighted average emissions at high altitude to give the "altitude increment." In the MVMA tests at high altitude no compensation was made for the decreased air density when the dynamometer load factor was set. Therefore the dynamometer load factors for the high-altitude emissions tests were somewhat greater than they would have been had the vehicles been subjected to the coastdown procedure at high altitude.

It is logical to assume that since the dynamometer settings were higher than they would have been if high-altitude coastdowns had been used, HC and CO emissions were somewhat more too. This increase in HC and CO emissions is presumably why the commenter requested that EPA consider a high-altitude coastdown procedure. Since the MVMA tests at high altitude produced levels of HC and CO greater than if high-altitude coastdown had been used, the sales-weighted average for high altitude was greater. Thus the "altitude increment" was also greater as was the high-altitude baselines and finally the high-altitude standards. In other words, the fact that MVMA did not account for decreased air density at high altitude when setting the dynamometer load factor carried through the entire high-altitude standard setting technique and produce high-altitude standards which are higher than they would have been had high-altitude coastdowns been used by MVMA.

If EPA had unlimited time and resources, the Agency could reestablish the standards (at a lower level) using new test program data which had utilized high-altitude coastdowns in setting the high-altitude dynamometer load factors. Then a high-altitude coastdown procedure would be appropriate as a part of the high-altitude certification testing procedure. However, since the Agency does not have unlimited time or resources and these high-altitude standards already account for the decreased air density of high-altitude conditions, EPA concludes that a high-altitude coastdown procedure is not required or correct for this rulemaking.

Recommendation

It is recommended that EPA retain the HA certification program as proposed except for the modifications discussed in the issue "Number of Certification Vehicles" which can be found in this document.

Appendix 1

State of California Air Resources Board's Manufacturers Advisory Correspondence # 78-2

STATE OF CALIFORNIA EDMUND G. BROWN JR., Governor

AIR RESOURCES BOARD LABORATORY
9528 TELSTAR AVENUE
EL MONTE 91731
(213) 575-6800

February 23, 1978

MANUFACTURERS ADVISORY CORRESPONDENCE #78-2

TO ALL PASSENGER CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE MANUFACTURERS

The attached material clarifies our policy concerning compliance with Subsection 5.d. of the "California Exhaust Emission Standards and Test Procedures for 1980 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," relating to the California High-Altitude Test Requirement. General criteria and three acceptable methods of demonstrating compliance are described.

Should you have any further questions, please feel free to contact Robert Weis, Manager, Certification Section at (213) 575-6897.

G. C. Hass

G. C. Hass, Chief
Vehicle Emissions Control Division

Attachments

Attachment to Manufacturers Advisory
Correspondence #78-2

CARB Policy Manual
Date Issued:

Subject: Compliance with California High-Altitude Test Requirement

Applicability: 1980 and subsequent model year passenger cars, and 1981 and subsequent model year light-duty trucks and medium-duty vehicles.

Reference: Subsection 5.d. of the "California Exhaust Emission Standards and Test Procedures for 1980 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," as amended September 30, 1977.

Background: Many vehicle fuel metering systems have an inherent enrichment characteristic with increasing altitude. This characteristic can affect emissions of carbon monoxide (CO), which may be significantly increased by an excess of fuel or, conversely, by a lack of oxygen. California's high-altitude test requirement was promulgated in an effort to stabilize CO emissions up to 6000 feet by requiring sufficient oxygen in the exhaust to theoretically maintain sea level CO emission performance.

Policy: A vehicle will be deemed in compliance with Subsection 5.d. if the manufacturer demonstrates that the tailpipe air/fuel ratio (TAFR) is, at elevations up to 6000 feet, stoichiometric or leaner in each of several driving modes. However if a vehicle operates in a given driving mode at sea level with a TAFR richer than stoichiometric, then for that particular driving mode the manufacturer is only required to show that the TAFR is, at elevations up to 6000 feet, no richer than the TAFR at sea level. The driving modes selected for testing shall be representative of the full range of normal driving conditions, and shall include the following steady-state modes: idle, 30 mph road load cruise, 50 mph road load cruise, W.O.T. in the 20-30 mph range. Assuming the use of dry air and indolene fuel (hydrogen to carbon atom ratio of 1.85), a TAFR of 14.6 shall be considered a stoichiometric ratio. The vehicle manufacturer may correct this value for different fuels and/or humidity, subject to approval by the Executive Officer.

Three acceptable methods of determining the TAFR are attached. The first, "Flow Bench Testing," is an example of a method using flow bench measurements of the fuel and air mass flow-rates to determine the TAFR's at sea level and altitude. The second, "Analytical Method," illustrates a theoretical calculation of the TAFR at altitude from measurements of the TAFR at sea level. (To use the "Analytical Method" to determine compliance of vehicles using carburetor feedback control systems, the calculated value of the TAFR at altitude, as modified by the control unit, is compared to the TAFR measured at sea level with the control unit connected.) The third, "Dynamometer Testing," uses exhaust analysis, under chassis dynamometer driving conditions at both sea level and altitude (or simulated altitude), to determine the TAFR's. Other methods of determining the TAFR, or of demonstrating compliance, may be used provided the manufacturer supplies the California Air Resources Board (CARB) with acceptable explanations and examples of use. In particular, for fuel injected vehicles, compliance may be demonstrated upon a showing by the manufacturer that the fuel injection system distributes fuel based on air <u>mass</u> flow, rather than volume flow, and is therefore self-compensating.

CARB Policy Manual

Methods of Determining the TAFR

I. Flow Bench Testing

A. Measure the fuel and air mass flowrates, including secondary air injected if applicable, for each selected driving mode under sea level conditions.

B. Measure the fuel and air mass flowrates, including secondary air injected if applicable, for each selected driving mode under simulated 6000 feet altitude conditions.

C. The TAFR shall be determined from the above data using the following equations:

$$TAFR = \frac{\dot{m}_i + \dot{m}_s}{\dot{m}_f} \quad TAFR_o = \frac{\dot{m}_{io} + \dot{m}_{so}}{\dot{m}_{fo}}$$

Where $\dot{m}_i$ = mass flowrate of intake air

$\dot{m}_s$ = mass flowrate of secondary air injected

$\dot{m}_f$ = mass flowrate of fuel

(Flowrates and densities used here and on the following page are at an altitude of 6000 feet, except that an "o" subscript indicates values under standard conditions at sea level.)

II. Analytical Method (for non-altitude compensated carburetor systems, with or without feedback control)

A. Using the "Flow Bench Testing" method, measure the fuel and air mass flowrates, including secondary air injected if applicable, for each selected driving mode under sea level conditions, and calculate the TAFR's from this data. For systems with feedback controls, make these measurements with the control unit first connected, and then disconnected.

B. The TAFR at an altitude of 6000 feet may be determined using the above data (for systems with feedback controls, using the measurements made with the control unit disconnected) and the following assumptions and equations:

$$\frac{\rho}{\rho_o} = .84 \qquad \sqrt{\frac{\rho_o}{\rho}} = 1.09$$

Where ρ = density of air

1. For idle and cruise driving modes:

$$TAFR = \frac{\dot{m}_i + \dot{m}_s}{\dot{m}_f} = \frac{\dot{m}_{io} + .84\,\dot{m}_{so}}{1.09\,\dot{m}_{fo}}$$

2. For W.O.T. driving modes:

$$TAFR = \frac{\dot{m}_i + \dot{m}_s}{\dot{m}_f} = \frac{.84(\dot{m}_{io} + \dot{m}_{so})}{.84\,(1.09)\,\dot{m}_{fo}} = \frac{\dot{m}_{io} + \dot{m}_{so}}{1.09\,\dot{m}_{fo}}$$

III. Dynamometer Testing

A. Measure the concentrations of O_2 and CO in the tailpipe while operating the vehicle or engine in each selected driving mode, both at sea level and at an altitude (or simulated altitude) of 6000 feet.

B. For a given driving mode, if the concentration of O_2 is greater than or equal to one half the concentration of CO, the TAFR in that driving mode shall be considered to be stoichiometric or leaner.

C. For a given driving mode, if the concentration of O_2 is less than one half the concentration of CO, the TAFR in that driving mode shall be considered to be richer than stoichiometric.

D. The relative magnitudes of the TAFR's at sea level and at an altitude of 6000 feet shall be determined by the relative magnitudes of the ratios of the O_2 to CO concentrations. For example, if a vehicle operates in a given driving mode at sea level with an O_2:CO concentration ratio of 0.3, then for the same driving mode at an elevation of 6000 feet, the vehicle must operate with an O_2:CO concentration ratio greater than or equal to 0.3.

F. Issue: Number of Certification Vehicles

Summary of Issue

EPA proposed that any certification vehicle selected for testing at low altitude could be selected for testing under high-altitude conditions. Additionally, one other certification vehicle for each engine/system combination within an engine family could be selected for high-altitude testing if such a vehicle is expected to have high exhaust emissions when operated at high altitude.

Summary of Comments

Most commenters stated that the certification costs of the proposed regulation were overly burdensome. (Certification costs are further discussed in the chapter entitled Economic Impact in the "Regulatory Analysis" for this rulemaking.) The number of vehicles selected to undergo certification testing (emission-data vehicles) is, understandably, a major factor in certification costs. Under the proposal, EPA could select as many (and even more) vehicles for testing under high-altitude conditions as were tested at low altitude. The commenters observed that if the same number of emission-data vehicles were tested under high-altitude conditions as were tested at low altitude, the cost of certification testing for high altitude could be more than the cost for low-altitude certification testing. This is true because the cost of shipping vehicles to Denver for high-altitude testing may be substantial and, in addition, testing at commercial facilities will be more expensive than testing at the manufacturers' facilities due to the extra link in the profit chain.

The commenters continued that although EPA's proposed high-altitude certification program would be certifying less than 4 percent of LDV and LDT annual sales, the cost of that certification program could be substantially more than the cost of certifying the other 96 percent of LDV and LDT annual sales.

Chrysler claimed the proposed regulations were inconsistent concerning the number of emission-data vehicles which might be selected for testing under high-altitude conditions. They stated that §86.082-24(b)(1)(v) allowed the Administrator to select only one vehicle for each engine/system combination within an engine family while §86.082-26(a)(3)(i)(D) allowed the Administrator to select for high-altitude testing, any vehicle that was selected for testing at low altitude under §86.082-24(b)(1)(ii) through (vii). The apparent contradiction occurs if the Administrator selects (for low altitude testing) more than one emission-data vehicle to represent a particular engine/system combination within an engine family. In practice, the usual case is that more than one vehicle per engine/system combination is selected for testing at low altitude.

Analysis of Comments

The proposed regulation was not as clear as it could have been concerning the maximum number of certification vehicles which EPA could select for testing under high-altitude conditions. However, the proposed regulation was not inconsistent as Chrysler claimed. Section 86.082-26 (a)(3)(i)(D) was correctly interpreted by Chrysler. It would have allowed the Administrator to select any vehicle that was tested at low altitude to be tested under high-altitude conditions.

Chrysler's confusion arises from their interpretation of §86.082-24(b)(1)(V). Their interpretation that this subparagraph allowed the Administrator to select a maximum of only one emission-data vehicle per engine/system combination is not correct. This subparagraph was intended to allow the Administrator to select one emission-data vehicle per engine/system combination for testing under high-altitude conditions that had not been previously selected for testing at low altitude. It would have given the Administrator the option of picking a high-altitude, worst case calibration if that calibration had not been selected for testing at low altitude.

EPA agrees that, as proposed, the possibility exists that the cost of certifying the high-altitude fleet could be greater than the cost of certifying the low-altitude fleet. As discussed above, the maximum number of certification vehicles which could be selected is actually greater for high-altitude certification. This fact together with the increased cost of conducting a high-altitude certification test due to vehicle shipping expenses and commercial facility usage certainly allows the possibility of an expensive certification program for the high-altitude fleet.

However, it was never EPA's intent to test the maximum allowable number of emission-data vehicles. That maximum would have been about six emission-data vehicles per engine family assuming there is only one engine/system combination per engine family. (This is presently true for the large majority of engine families.) In the draft "Regulatory Analysis" for this rulemaking, EPA assumed that only three emission-data vehicles per engine family1/ would be tested. This assumption was intended as a maximum and a maximum certification testing cost was developed from it. This certification testing cost was (215 engine families) x (3 tests per family) x $1,800 per test) x (2 model years) = $2.3M. Spreading this maximum certification testing cost over the 1.1 million high-altitude vehicles expected to be sold during the 1982 and 1983 model years, gives certification testing costs of about $2.00 per high-altitude vehicle. This represents a 0.029 percent increase in the new car retail price if the average retail price is assumed to have been $7,000 2/ in 1979.

In the Preamble to the NPRM, EPA again stated that the $2.3M for certification testing was a maximum. Also, EPA stated that while the proposed rules provide broad selection criteria, the number of vehicles actually chosen for testing will be small and limited to vehicles which, in the Agency's engineering judgment, are likely to have poor emission performance at high altitude.

Although EPA made it clear in the proposal that the actual number of certification vehicles selected for testing under high-altitude conditions would be small, the Agency appreciates the concern of the industry that high altitude certification testing could possibly be very expensive. In order to assure the industry that the cost of high-altitude certification testing is kept minimal, we have changed the selection criteria for certification vehicles.

The new selection criteria require the manufacturer to choose the one emission-data vehicle per engine family expected to have the worst emissions when tested under high-altitude conditions. The emission-data vehicle selected for testing under high-altitude conditions will be one of the emission-data vehicles previously selected for testing at low altitude. Thus, this regulation will not cause the manufacturers to incur the additional cost of building a new emission-data vehicle and of accumulating 4,000 miles.

The total cost of certification has been modified also. In the draft "Regulatory Analysis" EPA estimated that 215 engine families would be affected by the proposed regulation. The Agency had counted all LDV and LDT engine families in that estimate. It is now recognized that vehicles certified for California sale only will be exempt from this regulation. Thus, the estimated number of LDV and LDT engine families to be certified per model year is 156. A retest rate of 50 percent is used in calculating certification costs. Retests are often required because of equipment malfunction, operator error, manufacturer and administrative errors, lack of correlation with previous test, etc. The cost of certification now becomes (156 engine families per model year) x (1.5 tests per family) x ($1,800 per test) x (2 model years) = $842,400. If this maximum certification testing cost is spread over the 1.1 million high-altitude vehicles expected to be sold during the 1982 and 1983 model years, then the retail price increase of a high-altitude vehicle due to certification testing is about $0.76 or 0.01 percent of a $7,000 vehicle. The impact on sales of a $0.76 retail price increase would be insignificant.

The new emission-data vehicle selection criteria, while not providing the extent of assurance for high-altitude certification that the proposed selection criteria would have, will give EPA adequate assurance that high-altitude vehicles are meeting the high-altitude standards. Since the Administrator can select any of the low-altitude emission-data vehicles in an engine family, the manufacturers assume substantial risk if they do not adequately design all of their calibrations to meet high-altitude standards. Also, Selective Enforcement Audits (SEAs) at high altitude lend incentive to the manufacturers to adequately design all of their high-altitude calibrations.

In summary, although EPA emphasized that the number of certification vehicles selected for testing under high-altitude conditions would be kept to a minimum, the Agency recognizes that the manufacturers would prefer more definitive language. EPA has concluded that the new selection criteria (i.e. one emission-data vehicle per engine family) does not jeopardize the high-altitude certification program and allows the Agency more accurately to estimate the certification costs of this regulation.

Recommendation

It is recommended that the certification vehicle selection criteria be changed to allow the Administrator to select one emission-data vehicle per engine family for exhaust and evaporative emission testing under high-altitude conditions. This emission-data vehicle can be any engine calibration and any evaporative emission control system offered by the manufacturer.

References

1/ "Draft Regulatory Analysis; Environmental and Economic Impact Statement for the Proposed 1982 and 1983 Model Year High-Altitude Motor Vehicle Emission Standards," ECTD, OMSAPC, OANR, EPA., pg. 43.

2/ Automotive News, 1980 Market Data Book Issue, April 30, 1980.

G. Issue: Economic Impact

Summary of Issue

In the NPRM, EPA assessed the economic impact of the proposed regulations. Among other things, the Agency projected that vehicles using electronic feedback emission control hardware would automatically meet the standards, or would only require an adjustment to better control open-loop emissions at no cost. EPA estimated that feedback systems would be utilized on 90 percent of the LDVs in 1982 and 1983. Non-feedback vehicles which required additional hardware were estimated to include 10 percent of the LDVs and all of the LDTs sold at high altitude. For these vehicles, EPA estimated an average of two aneroids would be required per vehicle to meet the high-altitude standards, at an average cost of $10 per aneroid (1979 dollars). The total cost of the package was estimated to be $2.32 million for certification, $1.4 million for LDV hardware, and $6.6 million for LDT hardware. No change in fuel consumption was assumed in the NPRM. The cost effectiveness of the proposed high-altitude standards was $170 per ton of HC reduced and $5 per ton of CO reduced. The average cost increase for a high-altitude vehicle which required additional hardware was $26.

In this section, the comments concerning hardware cost and complexity, economic impact on individual manufacturers, certification costs, SEA costs, and cost effectiveness are analyzed. The economic issues relating to the $40 vehicle modification limit, fuel economy, exemptions, and available facilities are discussed in their respective sections of this report.

Summary of Comments

Manufacturers were unanimous in attacking the proposed standards because of their economic impact. Generally, their comments stated that EPA had significantly underestimated the cost of the proposal.

A few private individuals and one from a high-altitude dealership commented, in a general way, that the proposed regulations would unnecessarily increase consumer costs in high-altitude areas.

Major Subissues

1. Requisite Hardware And Its Cost. Only comments containing specific information on high-altitude emission control hardware are summarized below. Since EPA has previously decided to delete the proposed $40 limit for modifying a vehicle to conform to the emission standards, only those comments concerning vehicle modification costs that are relevant to the remaining issue of the increment in new vehicle prices are summarized below.

Ford - EPA was given two different estimates from Ford concerning an increase in the retail price equivalent (RPE) for newly-manufactured high-altitude vehicles. In comments at the public hearing, a price for a non-feedback system (aneroid) was estimated to range between $35 and $50. Generally, this is a small increase over what Ford is currently charging for an aneroid carburetor, i.e., $36 to $37.50. The added cost was attributed to the need for additional carburetor work. In Ford's written comments, a RPE of $200 to $225 for LDVs and $150 to $180 for LDTs was presented. No elaboration was provided to justify these costs. If a crash program were required to comply with the standards, the shortened development cycle would increase these costs to $800 to $900 for LDVs and $450 to $500 for LDTs.

Ford presented cost information for "minimum" and "maximum" vehicle modifications in their written comments.

<u>LDV Maximum Modification - $600 (1980 dollars)</u>

Axle Ratio Change
Replace Carburetor
Re-Indexed Distributor Stator
Transmission Aneroid
Revised Air Pump Pulley
Change Speedometer Gear

<u>LDV Minimum Modification - $280 (1980 dollars)</u>

Axle Ratio Change
High Flow PCV
Revised Choke Pulldown
Re-Indexed Distributor Stator
Change Speedometer Gear

<u>LDT Maximum Modification - $1,100 (1980 dollars)</u>

Change Front and Rear Axle Ratio
Carburetor Change with Aneroid
High Flow PCV
Revised Choke Pulldown
Re-Indexed Distributor Stator
Transmission Aneroid
Change Speedometer Gear
Change Driveshaft Assembly

<u>LDT Minimum Modification - $50 (1980 dollars)</u>

High Flow PCV Valve
Revised Choke Pulldown
Re-Indexed Distributor Stator
Transmission Aneroid

The above costs include labor based on rates typical of Ford dealers in Denver.

Ford also provided cost information at the public hearing.

Modification	Cost per Vehicle
Adjust Choke	\$ 40 - \$ 50
CAN Change	\$ 30 - \$ 50
Axle Change	\$220 - \$230
Carburetor Change	\$140 - \$330

Chrysler - This manufacturer presented various comments on the RPE for newly-manufactured vehicles and on the cost of modifying vehicles. For feedback vehicles (LDVs), Chrysler indicated that two types of emission control changes might be required: replacement of the electronic spark advance (ESA) module for high-altitude vehicles and the addition of a manifold absolute pressure (MAP) sensor. Chrysler stated at the public hearing and in their written comments that the high-altitude RPE of these changes would be about \$100 and the modification would be about \$200. They indicated that the MAP sensor accounted for the greatest portion of these costs. The new vehicle RPE was broken down as follows:

New Car Factory Installation

Average per Vehicle Variable Design Piece Cost, Plus, Average Proration of Program Costs	\$55
Fixed and Off Standard Allowance, Margin and Contingency	\$20
Dealer Mark-up (includes profit, overhead, etc.)	\$15 to \$ 25
Suggested Retail	\$90 to \$100

Chrysler stated that non-feedback systems would have costs similar to those for their feedback systems. Subsequent to Chrysler's final written comments on the proposed rules, EPA received a request to provide a decision in advance of the final rulemaking pertaining to the proposed \$40 limit for modifying a vehicle. EPA requested a clarification and elaboration of Chrysler's request and received additional information on costs. At that time, Chrysler had decided that a MAP sensor would not be required but that a change in the ESA module would still be needed to recalibrate the open-loop portion of the system for high altitude. This would be accomplished at the factory on newly-manufactured vehicles at no increase in price because there is essentially no difference in cost for a high-altitude unit versus a low-altitude unit. They also stated that the cost of replacing the ESA unit as a modification would be about \$270 and not the \$200 previously reported. For modifying non-feedback systems they suggested that the RPE of a new carburetor was about \$75 to \$100 and that the RPE of an aneroid was about \$25. Labor for changing carburetors was not estimated. Chrysler also commented that it was likely that they may institute a program for exchanging the replaced parts for the "modification" parts which will reduce the overall cost of new vehicle modifications. Replacement of the ESA was cited as an example where a small handling charge and the labor to install the part would be the only costs of the modification.

GM - Some LDVs might require wiring harness changes to accomodate additional control features. Since this would not be practical on high-altitude LDVs only, a cost penalty would result for every such car nationwide. GM also commented that high-altitude LDVs would probably need a barometric pressure sensor and a programmable read only memory (PROM) change at an estimated cost of $60. For LDTs, GM stated that air pumps would be needed on their 4.1 liter, 5.0 liter 4-bbl and 5.0 liter 2-bbl engines. These air pumps were estimated to cost about $50 per unit. GM pointed out that, if strictly interpreted, the proposed regulations would force the addition of air pumps on both high- and low-altitude production at an estimated cost of $25 million. They requested that GM be allowed to place air pumps only on the 22,000 high-altitude vehicles involved. For diesel engines, GM provided no cost estimates, but stated they were optimistic that the proposed standards could be met with a reasonable recalibration effort.

AM - The only significant comment concerning hardware and its cost was that AM agreed with EPA that aneroids could be purchased for under $10, but added that design and retooling would more than double the cost due to limited application. AM also commented in general that the adjustment of parameters covered by the parameter adjustment regulations (PAR) would increase the cost of modifications.

Volkswagen - Commented that in the past they have offered an optional high-altitude package which included an aneroid at a cost of between $60 to $80 to the consumer. Volkswagen claimed the full cost of the option was $165 and that PAR may make it more expensive. They claimed they did not have enough time to supply a breakdown of the component costs for their 1977 high-altitude kits but that they would provide the information when it was available. (EPA has received no additional information from Volkswagen to this date.)

IH - Commented that it was possible that carburetors could be replaced as part of a vehicle modification and that the old carburetor could be sold as a reconditioned part. IH indicated the modification cost in such instances could be about $100. Also, IH commented that fixed fuel metering systems would require idle mixture recalibration at altitude and that timing and idle speed may also need to be reset. Thus, three of the sealed parameters may need to be defeated in order to allow for adjustment. Since PAR requires that sealed parameters can not be defeated for less than $20, a minimum of $60 may be involved.

Toyota - The cost to meet the proposed standards was estimated to vary from $30 to $50. Toyota commented that they were planning to use an automatic altitude compensation system on all high-altitude models (except feedback systems) even in the absence of high-altitude standards. It was not clear whether the estimated $30 to $50 was the full cost of their altitude system or whether the altitude standards would add this amount to the existing price. Toyota stated that an axle change was needed as part of a vehicle modification. They also commented that their feedback systems would require an altitude compensating device and that their evaporative controls would also require additional compensation because some data indicated an evaporative emission ratio for low-to-high altitudes to be 1.7 instead of the 1.3 calculated by EPA. No further explanation was given. Their estimate of $30 to $50 also included whatever changes would be needed to bring feedback systems and evaporative control into compliance.

Honda - An automatic compensation device (Air Jet Controller) will be used instead of a fixed fuel metering calibration which, according to Honda, tends to have some deficiencies when temporarily operated at different altitudes. The price for modifying a vehicle is itemized below:

Item	Cost
Air Jet Controller	$ 90
Replacement Carburetor	$300
Labor Cost	$ 30
Total	$420

The Honda comments did not specifically address new vehicle prices for factory installed original equipment orders. However, the Air Jet Controller described above is presumably the same altitude compensating system that Honda has provided since 1977 on most of their models. Honda describes this system as being offered "economically" to high-altitude customers.

Nissan - The following table lists the components and costs that Nissan believed would be necessary to modify a low-altitude vehicle into a high-altitude configuration.

Vehicle Type	Component	Modification Cost
Carb Vehicle	Altitude Compensator Unit Check Valve Vacuum Tank Solenoid Valve Vacuum Switch Timer Unit Vacuum Hose & Harness	$130 - $170
EFI Vehicle	Altitude Compensator Unit Harness	$ 45 - $ 70
Diesel Vehicle	Aneroid Compensator Bracket	$165 - $185

No estimate of the price increase for factory installed high-altitude components was given.

2. Certification. Several manufacturers and the Motor Vehicle Manufacturers Association (MVMA) commented on the cost burden that the proposed standard would inflict on the industry. MVMA stated that certification testing is very expensive and indicated that special 4,000 mile emission data vehicles and 50,000 mile durability vehicles would have to be built. Furthermore they estimated that the high-altitude certification requirement would involve 25 percent of the low-altitude fleet. GM stated that most of their cars will meet the standards anyway; therefore, certification is the real cost burden of high-altitude emission standards. Based upon this fact they said standards are unnecessary.

All commenters were unanimous in their advocacy of an alternative certification program that would allegedly lessen the certification burden. Commenters urged EPA to adopt a program tailored after the State of California's high-altitude requirement. This program allows manufacturers to use engineering evaluations in lieu of full FTP certification testing. Ford was the only commenter to try and quantify the alleged saving. They estimated the alternative certification scheme would save $750,000 per year for their LDVs or about $20 to $25 per high-altitude vehicle.

Peugeot asked who pays for shipping vehicles to the United States for high-altitude certification testing?

3. Selective Enforcement Audits. All of the comments concerning high-altitude SEA stated that it would be too expensive and burdensome. Manufacturers pointed to logistical problems such as the probable lack of an adequate number of vehicles already at high-altitude dealerships from which to select SEA test vehicles. They concluded that vehicles may have to be shipped in from low altitude at a prohibitive cost. Chrysler was the only manufacturer that presented cost data for high-altitude SEA. This data is summarized below:

Item	Cost
Rental of high altitude test facility	$450 per test, plus additional costs
Drop shipment per vehicle	$ 30 - $120
Shipping costs per vehicle (up to 70 vehicles involved)	$500 - $600
One fulltime engineer to coordinate SEA (surveillance) program	$50,000 per year

Chrysler also noted that if it must lease high-altitude test facilities the cost could be $1.5 million dollars for two years. In a related comment, Chrysler also implied that their own surveillance program would be more costly because it is difficult to conduct such a program at a rented facility, and that repair and diagnosis are virtually impossible. No additional explantion of these alleged problems was given. It was indicated that a full time engineer would be required to select vehicles, test, and coordinate this program.

4. Economic Effects on Manufacturers. Several manufacturers commented that the standards should not be promulgated because they were so costly at a time when the U.S. automotive industry was experiencing record losses. Ford also commented that their financial and technical resources are already being strained excessively by the requirements to achieve fuel economy improvements and meet the cumulative effects of other governmental regulations.

Jaguar, IH, AM, and Chrysler commented that the burden of the regulation would be disproportiately greater for the smaller volume manufacturers. This would raise vehicle costs more for small manufacturers than for larger ones.

5. Cost Effectiveness. Manufacturers generally commented that the standards would be less cost effective than EPA calculated in the Draft Regulatory Analysis when all of the costs of the standards are accounted for.

Analysis of Comments

1. Requisite Hardware and Its Cost. EPA is frequently confronted with the issue of what the consumer cost will be for systems installed on motor vehicles for the purpose of controlling emissions. Ideally, it would be desirable to determine the economic impact on the consumer for any emission standard proposed and on any vehicle for which such a standard would be applicable. Such a task as this requires a very high level of effort, whether it is performed by EPA or by the manufacturer when commenting on a rulemaking. Therefore, it is usually more realistic to use generic descriptions of the requisite control hardware to represent the costs of all components or systems of a similar nature. This is the approach that EPA used to estimate the costs of emission control in the Draft Regulatory Analysis and is the approach that manufacturers used in responding to the Notice of Proposed Rulemaking.

Using generic descriptions of the requisite control hardware can be very useful if proper attention is given to detail and supporting evidence. In almost every case, the comments on hardware costs were general and provided no breakdown of the associated cost elements or other supporting detail. This lack of substance and, hence, justification, prevents EPA from effectively analyzing the manufacturers' technology cost comments. As an example, Ford and Volkswagen stated that in 1977, they offered vehicles for sale with an optional aneroid system. Ford said they charged up to $37.50 for this option and Volkswagen said the actual retail cost of their system was $165. Ford provided EPA with no further description or cost breakdown for their system, while Volkswagen provided a description but no cost breakdown of their system. Without further information, it is impossible to determine not only why the costs of these two systems are so different but what the charge should be for these types of systems in 1982 and 1983.

The Agency attempted to ensure that comments would contain useful information by requesting at the public hearings that manufacturers provide greater detail in their final written submittals on this rulemaking. Despite this request and a reopening of the comment period to allow for further comments, few manufacturers significantly expanded on their cost comments. In fairness to the manufacturers, it must be pointed out that many of them may have been unable to provide substantive comments because of their relative unfamiliarity with the high-altitude requirements of their new 1981 emission systems which will generally also be used in 1982 and 1983.

In addition to the general and unsupported nature of the manufacturers' comments, EPA's technology analysis found that some estimates appeared to be very pessimistic and could not be used as generic descriptors of a particular manufacturer's high-altitude requirements. As an example, Volkswagen and Nissan estimated that they would have to modify their electronic fuel injection system by adding an altitude sensor and that this modification would be expensive. The technology assessment (Issue B) presents evidence that these systems should have the inherent capability of meetng the standards without any change. Also, Chrysler continually stated that a manifold absolute pressure (MAP) sensor was needed on their high-altitude feedback systems, but then in response to EPA's specific request for additional information, stated that the MAP sensor would not be needed. EPA believes that these examples illustrate the generally conservative trend in the cost comments.

Some of the comments from the same source were internally inconsistent. In their final written comments, Ford estimated the retail price equivalent (RPE) increase for a factory produced high-altitude vehicle to be $200 to $225. At the public hearings, a Ford representative estimated the new car RPE for an aneroid system at up to $50. In addition, although Ford presented no justification for their $200 to $225 estimate, they did present a list of items which were part of a "modification kit." This list should also represent the items that Ford would have to use in producing a new car at the factory. Producing the high-altitude vehicle is obviously cheaper than modifying a vehicle after it is built: there are no existing parts to replace or modify. If we assume that Ford's upper limit of $225 is representative of their "maximum" modification, the cost for some items can be segregated and their retail price discussed. In this brief analysis assume an optional axle ratio is $30 and the carburetor is $50 as stated at the hearing: a total of $80. If this cost is subtracted from the $225 estimate, then $145 is left to account for the different distributor stator, transmission aneroid, air pump pulley, and speedometer gear. These parts and their installation as original equipment should be nowhere near that cost. An examination of the lower cost estimate of $200 for a new car and Ford's "minimum" modification is even more inconsistent. Ford lists an axle change as part of this modification. However, the axle they are changing to must already be used on a vehicle that also must have some other modification to meet the standards, so a true minimum modification can only include the changes that must be made to the vehicle already possessing the axle that any other vehicle must change to. Therefore, an optional axle should not be part of the "minimum" high-altitude package. Nevertheless, we will assume $30 for an optional axle. This leaves $170 ($200-$30) to account for a different PCV valve, distributor stator, speedometer gear, and choke adjustment. Again this seems very unreasonable for these items as original equipment.

The above serves only to indicate that if EPA were to accept industry cost estimates on face value, a representative indication of the economic impact of these proposed regulations would probably not result. Therefore, EPA must develop its own cost estimates of the requisite control hardware based on the comments and the best judgment of its technical staff.

Some conclusions regarding the cost estimates contained in EPA's Draft Regulatory Analysis can be made based on the comments, however. The Agency's estimate of the most likely control hardware, which was based on discussions with industry representatives, was essentially correct, but the complexity of the changes which may be required for some feedback systems was in error. The development effort was also underestimated. Therefore, the revised analysis should pay careful attention to these two areas in particular.

As previously stated, EPA's costing methodology should be based on generic descriptions of the systems that the comments and the Agency's technical experience indicate most likely to be used by manufacturers to meet the proposed standards. Implicit in this approach is the fact that some individual systems will cost more or less than the generic system used in the analysis. However, in order to ensure that the analysis does not underestimate the cost of this regulation, the generic systems should be conservatively chosen. This requirement is met by using the following five generic systems in the analysis:

<u>Unmodified feedback system</u> - These systems have the inherent capability to meet both the low- and high-altitude standards as they are currently designed. These systems are characterized by the GM C-4 system and the Bosch Jetronic fuel

injection systems used by Volkswagen, Nissan, and others.

Recalibrated feedback system - These systems cannot meet the proposed standards as currently designed. A special calibration to reduce open-loop emissions will be necessary. Therefore, a different electronic unit will be used for high and low altitudes. These systems are characterized by the two electronic spark advance modules that Chrysler estimates they will need.

Aneroid non-feedback system - These sytems will use a pressure-sensing device on the carburetor to lean the fuel-air mixture at high altitude. These systems are characterized by the aneroid carburetors described by Ford and Chrysler for which EPA has the best information.

Air injection non-feedback system - Although EPA cannot confirm that air pumps will be necessary on GM 2.2 liter, 5.0 liter 2-bbl, and 5.0 liter 4-bbl LDT engines, the analysis should account for this possibility.

Diesel engine system - As discussed in the technology assessment (Issue B), the analysis should assume that diesel-engined vehicles can comply with the proposed standards by simple recalibration. No additional hardware such as aneroids appears to be necessary.

By using these generic systems to characterize the high-altitude motor vehicle fleet, a conservative estimate will be ensured because (1) there are likely to be more feedback systems that will automatically meet the standards than are identified in the Agency's technical assessment, (2) there are likely to be non-feedback systems, such as those used by IH, that will employ different fixed-calibrations at high altitude instead of the more expensive and complex aneroid carburetors, and (3) there are likely to be non-feedback systems, as suggested in the Ford, IH, and AM comments, that will require changes as simple as readjusting idle mixture and choke.

The economic analysis should retain the assumption that current evaporative emission control systems can comply with the proposed high-altitude standard. Only one commenter specifically commented that EPA's calculated ratio of 1.3 was incorrect. Toyota alluded to "some" data that indicated for some of their systems the correct ratio was 1.7. No data or further explanation of Toyota's contention were supplied to EPA for analysis. Ford had included the cost of an evaporative cannister change as part of a high-altitude modification in their comments at the public hearings. However, this was excluded in the subsequent and more detailed final written comments. EPA assumes that Ford had found such a change unnecessary.

2. Certification. The commenters raised three basic issues

regarding certification costs: (1) full certification testing as proposed is expensive and burdensome, (2) significant cost savings can be achieved by using an alternative certification technique patterned after California's high-altitude program, and (3) who pays the cost of shipping certification vehicles to a high-altitude test location?

MVMA indicated in their comments at the public hearings that the proposed high-altitude regulations would require the building of special 50,000-mile durability vehicles and 4,000 emission data vehicles. EPA agrees that this would be very costly and burdensome, but the high-altitude standards as proposed would avoid this added expense by allowing the use of low-altitude durability and emission data vehicles for high-altitude certification. Also as discussed in Issue F, EPA expects to reduce the number of high-altitude certification vehicles and, hence, the cost of certification from that which was possible in the proposal. Instead of the possibility that three vehicles per engine family could be tested, EPA will reduce this number to one vehicle per family. If 156 engine families are certified at $1,800 per high-altitude test, the cost is reduced from $2.3 million, as estimated in the Draft Regulatory Analysis, to about $842,400. This is about $0.76 per high-altitude vehicle. EPA does not consider this to be a cost burden on the manufacturers.

EPA accepts the manufacturers' assertions that alternative certification could significantly reduce the costs of high-altitude regulations. However, EPA rejects the assertion that alternative certification is appropriate for a Federal high-altitude motor vehicle emissions program. Alternative certification is discussed in detail in Issue E, but because of its significance to the cost of regulation, it will be briefly discussed here. It is important to realize that the savings attributable to an alternative certification technique are mainly due to the potential savings in development efforts. Also, the savings in development are dependent on the fact that the alternative technique used in certification must also be the technique used in Selective Enforcement Audits (SEA) of production vehicles. If full FTP testing were used in SEA, EPA believes that manufacturers would also do their development work using full FTP testing to provide them with confidence that they can pass an FTP SEA and, hence, will not be subject to very expensive production line changes and later, recalls. EPA feels that FTP SEA is needed to assure that production vehicles do indeed meet the high-altitude standards; therefore, development will not be significantly different whether or not EPA allowed alternative certification or retained full FTP certification. As calculated above, the difference cannot be greater than about $0.76 per high-altitude vehicle. EPA believes the benefits of full certification outweigh this small cost. With regard to Peugeot's comment concerning shipping costs, current Federal emission certification procedures call for the vehicle's manufacturer to assume the cost of transportation. This will remain unchanged for the high-altitude standards.

3. Selective Enforcement Audits. EPA is aware of the manufacturers' concerns about the cost of a high-altitude SEA and will attempt to administer the HA SEA program so as to minimize the financial burden on the industry. However, EPA believes that a high altitude SEA program is necessary for EPA to fulfill the tasks mandated by Congress in the Clean Air Act (Act). Section 206(b)(10) of the Act authorizes testing of vehicles from the assembly line. The enforcement mechanism EPA presently uses to perform these assembly line tests is the SEA program, the major purpose of which is to provide a deterrent to the production of noncomplying vehicles. Accomplishing this purpose will help to ensure that the air quality benefits anticipated from adopting the high-altitude emission standards will be achieved.

Any increased cost due to high-altitude SEA testing will depend on many factors, the most significant of which are whether the manufacturer has its own high-altitude test facility and the location of whatever facilities it employs to conduct high-altitude testing. With regard to facility location, any manufacturer, either foreign or domestic, which tests in the U.S. should not experience any substantial increases in shipping costs. This is because during audits of low-altitude vehicles, manufacturers ship vehicles to test facilities which are often hundreds of miles away from the assembly plant and then must re-ship them to the correct (dealer) destination. When auditing high-altitude vehicles at a location such as Denver, Colorado, the cost of shipment to Denver represents part of the shipping costs the manufacturer would incur in delivering the vehicle to its correct destination, i.e., at a high-altitude dealer in the Western U.S. In the latter case, therefore, little or no shipping cost increase will be incurred.

Foreign manufacturers which elect to test in their home countries can be accommodated under the existing SEA regulations. These manufacturers may incur some extra costs in shipping to their local high-altitude facility, but, as discussed in Subissue 4 on SEA test vehicles, not all vehicles selected may have to be shipped to the test site. With regard to the cost of performing high-altitude testing, manufacturers having their own high-altitude test facilities should experience costs similar to those for low-altitude testing. If the manufacturer must use a contractor facility, however, some additional costs will be incurred.

EPA has received manufacturer estimates of the cost of performing high-altitude SEA testing at a contractor facility ranging from approximately $800 to $1050 per test. Automotive Testing laboratory (ATL) and Environmental Testing Corporation (ETC) have submitted information to EPA indicating that their costs of performing all of the procedures involved in the SEA testing requirements (drain/refuel, preconditioning, soak, heat-build, and emission tests) average out to about $875, which is in general agreement with the manufacturer estimates.

Manufacturers that must use contractor facilities are generally small volume manufacturers whose low testing volume does not warrant establishing their own high-altitude test facility. The EPA emission testing laboratory in Ann Arbor, Michigan, which is representative of a manufacturer that only tests vehicles on an infrequent basis, estimates its own costs at about $750-1000 per test. This cost is comparable to the cost at a high-altitude contractor facility. Therefore, a small manufacturer should incur no substantial cost increases when contracting for high-altitude SEA testing.

It should be emphasized, when considering the incremental costs of a high-altitude SEA program, that high-altitude SEA test orders, if passed, will count towards a manufacturer's annual quota of audits. High-altitude audits are merely being substituted for low-altitude audits and do not increase the quota. Therefore, manufacturers whose audited vehicles comply with the standard will experience no increase in the number of audits they must perform due to the implementation of high-altitude regulations in 1982.

4. Economic Effects on Manufacturers. EPA will make every attempt to prescribe standards that are the least costly to industry but that also adequately protect the health and welfare of high-altitude residents. In addition, EPA will implement and enforce these standards so as to minimize compliance costs.

EPA agrees with the commenters that the standards have the potential of impacting smaller manufacturers more heavily than larger manufacturers, simply because of the lower production volume over which fixed costs can be amortized. The Regulatory Analysis should identify the cost of compliance for each manufacturer.

5. Cost Effectiveness. The Regulatory Analysis will include a calculation of the cost effectiveness of the proposed standards using EPA's revised cost methodology and updated air quality information.

Recommendation

EPA's Regulatory Analysis should include a determination of the proposed standard's economic impact by using generic descriptions of the emission control systems that will be used to comply with the regulations. The analysis should also reflect the reduced certification requirement as recommended in Issue F. The economic impact on individual manufacturers should be discussed and a new cost-effectiveness figure should be calculated. The Regulatory Analysis should not include additional costs for high-altitude SEA.

H. Issue: Environmental Impact

Summary of Issue

The Environmental Protection Agency (EPA) estimated that the interim high-altitude standards would significantly reduce hydrocarbon (HC) and carbon monoxide (CO) emissions from high-altitude vehicles. For Denver, Colorado the reduction in 1987 would be 0.8 tons/day for HC and 19.8 tons/day for CO or a reduction of 0.6 percent and 2.0 percent for the pollutants, respectively.

Summary of Comments

All automobile manufacturers commented that the interim standards are unjustified and will not result in any significant improvement in air quality. Opposing this view were comments from political representatives and the general public which stated that the standards were necessary to improve air quality and protect the public health.

Major Subissues

1. Justification for the Standards. Industry representatives basically stated that Denver's air pollution problem was not unique and was not serious enough to warrant special action.

The Motor Vehicle Manufacturers Association (MVMA) submitted data from low and high altitudes of CO and ozone levels and of the number of exceedances of the CO standards. MVMA concluded that no general trend relating higher air quality levels or exceedances with increasing altitude can be established. MVMA also stated that the National Jewish Hospital monitoring site in Denver was an apparent anomaly because it had a greater number of exceedances than the other Denver sites. The MVMA also submitted trend data showing an improvement in Denver area CO and ozone levels between 1973 and 1977.

Chrysler stated that eight of the twenty cities listed in the Draft Regulatory Analysis (RA) as high altitude do not meet the EPA definition of high altitude. Chrysler further commented that Denver has now dropped to fifth place in number of days in violation of the air quality standards according to the 1979 Council on Environmental Quality (CEQ) Report, instead of being second only to Los Angeles as stated in the RA.

Many industry representatives pointed out that recent air quality trends up to 1977 have shown an improvement in pollution levels, and that because many new cars have the capability to compensate somewhat for altitude changes, this air quality improvement will continue without the standards. Chrysler went even further and stated that the ambient air quality standard for CO in Denver would be met within the next few years even without standards.

2. Effects of CO on Health. Chrysler stated that no medical evidence exists which demonstrates the relationship between ambient CO levels and health problems in the general public. Commenters from the general public stated that the effects of CO on individuals at high altitude were more pronounced than the effects of the same level of CO on individuals at low altitude because of the thinner air at higher elevations.

3. Effectiveness of Interim Standards. Commenters pointed to EPA's own analysis of the interim standards' effect on air pollution as evidence of the ineffectiveness of these standards.

The Colorado Department of Highways stated that EPA's Mobile Source Emission Factors document (March 1978) shows low- to high-altitude ratios for recent model year vehicles to be 2.06 for CO and 1.62 for HC's. They pointed out that applying these ratios to the 1981 low-altitude standards would result in high-altitude emissions levels below the interim standards, and concluded that high-altitude certification would be an unnecessary expense.

Ford stated that a proportional relationship exists between low- and high-altitude emission levels, and that without standards high-altitude emissions will continue to decrease proportionally, particularly with voluntary offerings of high-altitude calibrations.

Chrysler referred to an EPA Issue Paper, February 12, 1978, "High Altitude Emissions Standards for 1981-83 Model Year Cars," which concluded that there would be no air quality benefit from 1981-83 standards.

The MVMA also submitted emission trend data for CO and HC, and concluded that high-altitude emission levels have continued to decline even though high-altitude standards were in effect for only one model year--1977. MVMA stated that the reductions due to the high-altitude standards, shown in the regulatory analysis between 1980 and 1987 in Denver, are so small over what they would be without standards as to be within the expected error of emission inventory analysis.

The Utah Division of Environmental Health commented that the ratio of high- to low-altitude emissions has increased as a result of the Federal Motor Vehicle Emission Control Program (FMVECP). They stated that the pre-controlled CO ratio was 1.61 while for 1968-74 model years it was 2.46. For 1975-1983, with the exception of 1977, the ratio was 2.06. Utah goes on to state that high-altitude CO emissions in 1975 were 20 percent greater than if they had been maintained at pre-controlled levels. This statement is obviously in error. Examination of that attached tables indicate that they meant emissions were 20 percent greater than if the high to low altitude ratio were maintained at the precontrolled level.

4. The Effect of the Standards on Ambient Nitrogen Dioxide and Ozone. Chrysler stated that some high-altitude nitrogen dioxide (NO^2) levels are currently just below the National Ambient Air Quality Standards (NAAQS) and that if the standards result in leaning the engines fuel-air mixture, the standards may be violated. They also pointed out that NO^2 is a catalyst for photochemical smog and that any increase in oxides of nitrogen (NOx) from motor vehicles could lead to a more severe ozone problem.

5. The Effect of the Standards on the "Brown Cloud". Industry representatives noted that the standards will have no beneficial effect on the brown cloud.

6. Non-Resident Vehicles. Commenters pointed out that out-of-state cars are a significant portion of Denver's total vehicle population and so all cars must be able to meet the standards when sold, instead of merely being capable of modification to meet the standards.

7. In-Use Modifications. Very few in-use vehicles will be modified and so there is no air quality justification for requiring high-altitude certification.

Analysis of Comments

1. Justification for the Standards. The Clean Air Act requires attainment of the CO and oxidant standards by 1982. An extension up to 1987 can be allowed if all reasonable control measures will not attain the standards by 1982. Denver and Boulder, Colorado, and Salt Lake City, Utah, require extensions to meet both the ozone and the CO standards. Albuquerque, New Mexico, has both an ozone and CO problem, but is expected to achieve the ozone standard by 1982. Albuquerque, New Mexico, Colorado Springs, Greeley, and Fort Collins, Colorado require extensions to meet the CO standard. These areas also are required to implement an inspection and maintenance (I/M) program to reduce HC and CO emissions. Even with I/M and other transportation control measures, attainment of the standards in the Denver area by 1987 is not assured.

Chrysler is correct in that Denver is listed in the 1979 CEQ Report as being the fifth worst city in the nation in number of days in 1977 in violation of the NAAQS. Denver was second only to New York City in violations of the CO standard; however, Denver had 127 days in 1977 over the CO standard while New York had 247. No other cities had more than 100 days of violation of the CO standard in 1977. Chrysler's comment concerning eight of the areas listed as high altitude not meeting EPA's definition is relevant. The RA has been revised to remove seven of the cities from the list of high-altitude areas. Reno, Nevada (Washoe County), was not included in the original proposal of high-altitude areas but has since been included.

The MVMA statement that there is no general trend relating higher CO and ozone air quality levels or exceedances with increasing altitude is not surprising. Ozone is a very complicated pollutant which is not directly emitted but formed in the atmosphere from the photochemical reaction of NO and HC. There are both mobile and stationary sources of these two pollutants. The high-altitude areas with ozone problems are isolated and are not affected by long range transport of ozone precursors as are many sea level cities.

CO is directly emitted, almost entirely, from mobile sources--motor vehicles. However, CO is generally a localized problem in areas with high traffic density. Ambient CO levels are dependent on the density of CO emissions and atmospheric dispersion conditions such as mixing depth and wind speed. CO emission densities are in turn dependent on traffic volume, vehicle mix, vehicle speed, ambient temperature, percentage of vehicles operating from a cold or hot start-up, and altitude. Finally, the geometry of the traffic pattern and distance of the receptor or monitoring location is critical to the CO level measured.

Given all of these factors, it is far from surprising that a plot of air quality levels or exceedances against altitude does not produce a one to one relationship. The fact remains that emissions of CO and HC from mobile sources are higher at high altitude, exacerbating existing air quality problems.

The MVMA assertion that the National Jewish Hosital site in Denver may be providing anomalous CO data is related to the factors mentioned above, concerning the localized nature of ambient CO levels. The fact that all but one of the sites measuring CO in the Denver area experience violations of the standard indicates that the CO problem in the Denver area is pervasive and more of a regional nature than is usually the case. However, there is a wide variation in CO levels due to variations in traffic density within the Denver area.

The one site which did not measure CO violations in 1978 is a new site located on the extreme southern fringe of the metropolitan area. This site is normally outside of the "urban plume" and only is affected by traffic on a single arterial. The other sites ranged from four exceedances above the standards at the Overland site to 125 exceedances at the National Jewish site in 1978. The CAMP station experienced 50 exceedances; CARIH, 25: Arvada, 15; and Welby, 10. Welby is located on the extreme northeastern fringe of the metropolitan area, but is often within the urban plume and indicative of the urban background CO concentration. Neither the CARIS or Arvada sites are located in high traffic density areas. The National Jewish site is at the intersection of Colfax and Colorado Boulevard, two fairly high density arterials. The total average daily traffic on these two streets was about 69,000 vehicles in 1978. The CAMP station is at the intersection of 21st and Broadway and Champa Streets. The total average daily traffic on these streets was 20,000 in 1978.

The high CO levels and exceedances recorded at the National Jewish site is due to the higher traffic density at this site compared to the other sites. The traffic density at this site is not the highest in the Denver area, however. For example, Interstate 25 and U.S. 6, which intersect, had a combined volume of over 215,000 vehicles per day in 1978. Many other intersections have densities similar to that at the National Jewish site. Denver does not have a center city "street canyon" monitoring site which may produce even higher CO levels due to the combination of poor dispersion and high density.

The MVMA statements about decreasing trends in CO and ozone must be qualified. Ozone is a regional scale pollutant, but the area of highest concentration varies as the urban plume drifts across the city and reacts photochemically. It is unlikely that a particular monitor will coincide with the highest actual concentration. The station measuring the highest concentration will also change from day to day. Due to this variation, ozone trends are difficult to establish. Based on a photochemical dispersion model calibrated for the Denver area, the State of Colorado was not able to project attainment of the ozone standard by 1987 using Mobile I emission factors and I/M.

The MVMA trend chart for CO stops at 1977. CO levels in 1978 were higher than 1977 and not significantly different than those in 1975 and 1976. In 1977 the National Jewish site had 94 exceedances of the CO standard versus 125 in 1978, the CAMP site had 31 in 1977 versus 50 in 1978. Colorado was able to predict attainment of the CO standard by 1987 using Mobile I and I/M, but the Mobile I emission factors are lower than those used in the RA. Mobile I was based on the assumption that 1980 and later model year vehicles would exhibit the same ratio of high- to low-altitude emissions as 1975 and 1976 model year vehicles. Data from prototype 1980 and 1981 control system vehicles were used in the RA to update emission factors for 1980-83 model year vehicles without high-altitude standards. This analysis has since been revised to include new information. The new vehicle CO emission rates for 1980 light-duty vehicles at high altitude has been increased in the revised analysis from 6.18 to 9.44 grams per mile (gpm) and for 1981-1983 from 2.88 to 6.24 gpm. Light-duty truck emission rates were increased from 29.90 to 38.31 gpm for 1979 through 1982 model year vehicles, and from 8.00 to 27.68 gpm for 1983. The deterioration rates were assumed to be the same at high altitude as at low altitude. This assumption may not turn out to be valid, especially for light-duty vehicles. In the absence of standards, vehicles will be designed for low altitude. This will cause emissions from vehicles with disabled control systems to be higher than at sea level due to richer mixtures. There may also be higher tampering rates at high altitude due to poorer fuel economy or performance from failure to design for high-altitude use. Furthermore, the Colorado I/M program has been revised by the Colorado Legislature and may not provide as much emission reduction by 1987 as was assumed when attainment of the CO standard was demonstrated.

The estimates in the RA for the air quality benefits of the standards may be substantially higher if there is a higher reliance on control technologies which are not inherently altitude compensating. Ford Motor Company stated at the public hearing that most of their vehicles would utilize non-feedback carburetors in model years 1982 and 1983. The RA has been revised to account for this change in technology by Ford. Other manufacturers may rely more on technology which is not altitude compensating over at least part of the vehicle operation cycle. These standards are necessary to ensure that excessive emissions from such systems will not result in high-altitude areas. The RA has also been revised to account for the higher usage of light-duty trucks in the Denver area. The reduction in total Denver area 1987 emissions has increased from 0.6 percent to 1.0 pecent for HC's and from 2.0 percent to 3.4 percent for CO.

Without the high-altitude standards, the State of Colorado and other high-altitude states would be required to adopt additional control measures to make up for the loss in motor vehicle emission reductions. In order to be granted an extension beyond 1982, the Clean Air Act requires that all reasonably available control measures be adopted as expeditiously as practicable. Attainment of the standards is required by 1987. It would not be reasonable to expect high-altitude nonattainment states to provide any additional measures beyond those that are already required in order to make up for the lack of the interim standards.

2. Effects of CO on Health. Justification of the NAAQS for CO is not necessary in an automotive emission regulation action. Ambient standards are promulgated in separate rulemaking actions which provide an opportunity for public review and comment. However, a brief summary of the NAAQS for CO will be presented in response to Chrysler's comment. The justification for the CO standard is contained in the air quality criteria document. Air quality criteria documents are required by Section 108(a) of the Clean Air Act to identify effects on public health and welfare caused by varying amounts of pollutants in the air. These criteria must be supported by the latest available accurate scientific information. The purpose of these criteria is to identify air pollution effects and serve as the basis for NAAQS. The original criteria document for CO, the National Air Pollution Control Administration publication AP-62, was issued in 1970.

Section 108(c) of the Clean Air Act requires that the Administrator of the EPA from time to time review and, as appropriate, modify and reissue criteria published pursuant to Section 108(a). Section 109(d)(1) requires both that the Administrator complete a thorough review and, as may be appropriate, make revisions in the criteria by December 31, 1980, and at five-year intervals thereafter. EPA pubished a preprint of a revised criteria document for CO in October 1979, (EPA-600/8-79-022). This document states that fetuses, persons with cardiovascular or central nervous system defects, sickle cell anemics, young children, older persons,

persons living at high altitudes, and those taking drugs, comprise groups at special risk to CO exposure. There is little information regarding the high risk groups; however, it is apparent that exposure for eight hours to CO concentrations as low as 15-18 parts per million (ppm) may be detrimental to the health of persons suffering cardiac impairment. Such concentrations are routinely exceeded in high-altitude areas. In 1977, there were 18 days with CO levels above 15 ppm in the Denver area.

CO affects health because it decreases the oxygen carrying capacity of blood. At high altitude there is less oxygen available anyway, and so the effects are additive. While residents of high-altitude areas may somewhat adapt to the lack of oxygen (18 percent less available oxygen in Denver than at sea level) overlong periods of time, visitors and tourists are not able to do so.

3. Effectiveness of Interim Standards. The Colorado Department of Highways comment that the interim standards are higher than the high- to low-altitude ratio for 1978 model year vehicles applied to the low-altitude standards disregards the effect of the control technology which will be used to meet the low-altitude standard. Data from prototype vehicles (tested at low and high altitudes and representative of the types of control technology to be used in 1982 and 1983) was used in the regulatory analysis to determine the expected high-altitude emission rates without standards, as explained in the Justification of Standards Section.

The EPA Issue Paper referenced by Chrysler was also written without consideration of the effect of control technology differences on the high-to low-altitude ratio. The issue paper and Mobile I emission factors were developed prior to the availability of emission data on prototype 1981 control systems. In the absence of such data, the assumption that 1981-1983 vehicles would have the same high- to low-altitude ratio as 1975 and 1976 vehicles is the best that could be made. However, the high- to low-altitude ratio has changed as the control technology has changed. The following table gives the high- to low-altitude ratio for various technology classes as calculated from Mobile I emission factors based on actual test data.

Model Year	High- to Low-Altitude Ratio	
	CO	HC
Pre-1968	1.61	1.36
1968-1974	2.46	1.67
1975-1976	2.06	1.62

As can be seen, the ratio does vary with control technology. 1981 model year emission standards for low altitude are 0.41, 3.4, and 1.0 grams per mile for HC, CO, and NOx respectively (excluding waivers). In 1975 and 1976, the standards were 1.5, 15, and 2. Considerable changes in control technology will occur between the 1976 and 1981 model years, and the high- to low-altitude ratio can also be expected to change. The use of prototype data provides a better estimate of how emissions will vary with altitude than assuming that the ratio will remain constant when the control technology changes.

This same discussion applies to Ford's comment that high-altitude emissions will continue to decrease proportionally with low-altitude emissions. Ford also stated that some high-altitude calibrations will be made available voluntarily, but the impact of such a voluntary program would be impossible to estimate. In fact, Ford was unable to determine the number of vehicles sold with optional high-altitude calibrations in past voluntary programs.

The MVMA similarly relied on past trends in low- to high-altitude emissions and did not consider the impact of the newer technology's response to altitude changes. MVMA also referred to the continued decline in high-altitude emission rates after 1977 when no high-altitude standards were in effect. This decline is in part due to the turnover of vehicles, i.e., older high polluting vehicles being replaced by new lower polluting vehicles. Another factor in this decline was the carryover of 1977 certifications of high-altitude vehicles into 1978 and 1979. With the change in emission standards in 1980 this carryover stopped; therefore, the rate of decline will not continue to be enhanced by this effect.

The MVMA statement that the emission reductions due to the interim standards in the Denver area are so small as to be within the errors of emission inventory analysis is misleading. An emission inventory, particularly for motor vehicles, has many sources of error. The reductions due to the interim standards were calculated by holding those other sources of errors constant. Thus, these sources of error were moderated in the analysis, and the reductions indicated are as good an estimate of the impact of the standards as can be made. As stated in the Justification of Standards Section, the RA has been revised and the estimated impact of the interim standards increased. The reductions presented in the draft analysis were significant and favorably comparable to other emission control strategies of similar cost as presented in the RA. The revised estimates are even more favorable.

Another benefit of the standards will be to provide the protection of the warranty provided by Section 207(b) of the Clean Air Act. This warranty provides that properly maintained vehicles failing an I/M test must be corrected at the vehicle manufacturers' expense for the vehicle's useful life, although after the first two years or 24,000 miles the manufacturer's liability is limited to devices which are solely or primarily used for emission control. EPA regulations will make this warranty available in low-altitude areas beginning with the 1981 model year. Since 1981 vehicles are not required to meet standards at high altitude, the warranty cannot apply at high altitude. Promulgation of the 1982 and 1983 interim high-altitude standards will end this inequity for consumers in the high-altitude areas with I/M programs. Additional air quality benefits may also result, since any cost limits on maintenance required to pass an I/M program will not apply to vehicles covered by the warranty.

The Utah Division of Environmental Health commented that the high- to low-altitude ratio for pre-controlled vehicles (pre-1968) was lower than for controlled vehicles (post-1968). The Clean Air Act, however, requires EPA to base the high-altitude standards on 1970 model year emission rates. It is unfortunate that the high- to low-altitude ratio for the 1970 control technology was higher than either pre-controlled or catalytic converter controlled vehicles because this relationship results in a more lenient standard than if any other model year was used as the baseline. This fact, however, should be considered upon setting the interim standards. The most stringent standard that can be justified from the available data on 1970 model year high-altitude emissions should be used.

4. The Effect of the Standards on Ambient Nitrogen Dioxide and Ozone. While controlling HC and CO emissions may cause an increase in NOx emissions over what they would be without the standards, the high-altitude NOx standard must still be met. The high-altitude NOx standard is lower than present fleet average high-altitude NOx emission levels. Even though high-altitude emissions of NOx of 1982 and 1983 vehicles may increase slightly over what they would be without standards, the high-altitude NOx standard (1.0 gram per mile for light-duty vehicles) is much lower than high-altitude NOx levels for any model year prior to 1981 (the lowest new vehicle NOx rate prior to 1981 was 1.5 gpm and the average fleet NOx rate for 1982 is 1.77 gpm). Thus, overall ambient NO_2 levels will continue to decline with the interim high-altitude standards.

Denver is the only high-altitude area with high levels of NO_2. Denver only marginally exceeded the standard from 1975 to 1977, and in 1978 NO_2 levels were below the standard. Denver also has levels of ozone which exceed the national standards. Analyses of attaining the ozone standard by the State of Colorado and EPA indicate that reductions in HC emissions are more critical than reductions in NO_2. Furthermore, reductions in vehicle miles traveled (VMT) in the Denver area are needed, in addition to reductions in per-vehicle emissions, in order to provide enough reduction in HC's to attain the ozone standard. These required VMT reductions will also reduce ambient NO_2 levels.

5. The Effect of the Standards on the "Brown Cloud". The assertion that the standards will have no beneficial effect on Denver's "brown cloud" is based on the MVMA's "1978 Denver Winter Haze Study." The MVMA study concluded that automobiles contribute

about 14 percent of the "brown cloud." About 36 percent of the cloud was unidentified, 14 percent was from diesel vehicles, and about 27 percent was from fuel combustion in stationary sources. The remaining 9 percent was water and crustal material. The study relied highly on emission factors for these allocations. The only emission data for particulates from motor vehicles at high altitude, used in the study, were from ten 1970 model year vehicles which were restored as completely as possible to a new vehicle condition. Data presented by the MVMA does show that particulate emissions from automobiles are increased by rich air-fuel mixtures. However, the ten 1970 model year vehicles were tuned to manufacturers' specifications and may not have been as rich as in-use vehicles. Furthermore, no catalytic converter vehicles were tested to establish high-altitude particulate emission rates.

The lack of particulate emission data from in-use vehicles at high altitude leaves the contribution of motor vehicles to the brown cloud still very much in question.

The primary effect of the proposed standards will be to reduce HC and CO emissions, by obtaining altitude compensation of non-feedback vehicles and phases of feedback vehicle operation which are "open loop." This compensation will provide leaner air-fuel mixtures which will also lower particulate emissions. The effect of these lower particulate emissions on the brown cloud cannot be determined at this time, but the effect will tend to be beneficial.

6. Non-Resident Vehicles. Although there may be a significant number of non-resident vehicles in the Denver area, high levels of CO and ozone are primarily due to rush hour traffic. Non-resident vehicles are not a significant part of rush hour traffic.

7. In-Use Modifications. The State of Colorado is requiring the use of high-altitude performance adjustments developed under Section 215 of the Clean Air Act on vehicles failing the I/M program. Such a requirement could also be used for the interim high-altitude standards. Of course, the proposed regulations require all new vehicles sold for principal use at high altitude to be modified prior to delivery.

Recommendation

The finding required by Section 202(f)(3)(c) of the Clean Air Act, that the interim high-altitude standards will result in a significant improvement in air quality, should be made in the affirmative.

I. Issue - Leadtime

Summary of Issue

EPA proposed that the interim high-altitude standards take effect in the 1982 model year for light-duty vehicles and light-duty trucks.

Summary of Comments

Comments on the leadtime which is available before the standards become effective were directed at the time required to develop the necessary hardware and the exaggeration of the normal development time because of inadequate high-altitude test facilities.

Major Subissues

Development Leadtime - Cars: Many manufacturers commented that time was not available to develop hardware for the 1982 model year. GM commented that their C-4 system could meet the 1982 date only if any necessary modifications were extremely minor. In another comment, GM stated that leadtime was nonexistent for 1982 because they have already begun certifying some subcompact models for that year. Chrysler commented that they had enough time if all that would be needed were modifications to the electronic components of the control system. But if more significant hardware changes needed to be made (i.e., MAP sensor), the decision would have to have been made in the spring of 1980. However, in a later communication with EPA (see the docket) Chrysler stated that they would not need a MAP sensor. Nissan stated that for 1982, a final decision on the system must be made in the summer of 1980, and also that development would take one year. Ford commented that for the 1982 model year, development should begin in July 1980. Ford also stated they didn't have enough leadtime for aneroids on all vehicles but were planning to meet standards with unique calibration. AMC stated that they could not adapt GM's control system to their vehicles by 1982 and possibly not by 1983 because of a lack of experience with the system and conflicting resource commitments with other programs. NADA commented that the interim standards should not be finalized because manufacturers need until 1984 to design high-altitude vehicles. Jaguar submitted two divergent comments. First, they said there was insufficient leadtime for testing to determine changes. Second, they said they were confident they could meet the standards except for those engines which were granted a CO waiver. Finally, Jaguar stated their suppliers need 6-10 months notice before production starts to make hardware change. Toyota and Puegeot generally commented there was insufficient time to comply.

Development Leadtime - Trucks: Chrysler stated that there is no time left to make the necessary carburetor tooling changes on their 318-2 trucks. AMC maintained there was inadequate resources and time to modify their trucks for 1982 or even by 1983. They claimed that extensive retooling and design would be needed. GM stated that air pump capacity for 1982 would not be sufficient for national production, but if allowed to put them on at altitude only, they would have enough. GM also commented that the truck standard should be delayed until 1983. Ford commented in a general statement that there was inadequate leadtime for all of their vehicles to meet the 1982 standards. IH commented there was inadequate leadtime to incorporate aneroids on their trucks by the 1982 model year and indicated they would be forced to use fixed calibrated carburetors.

Leadtime - Facilities: Several manufacturers commented that there were inadequate facilities for high-altitude testing. Ford stated that their facilities were limited. More specifically, Fuji made two comments concerning their need to construct a high altitude test SHED because of the likely unavailability of commercial facilities at Denver, Colorado. In their comment at the public hearings, they said it would take 22 months to build and operate their SHED. However, in their written comments, they indicated that 12 months would be needed. Nissan commented that if demonstration tests are required, more facilities will be needed and that even meeting the standards in 1983 would be difficult.

Analysis of Comments

Development Leadtime - General: The determination of adequate leadtime involves two central issues: technical complexity and availability of testing facilities. In this analysis the issue of technical complexity is examined to find if enough leadtime is available to adequately develop and certify high-altitude emission control hardware for 1982 model year vehicles. The issue of available facilities is examined in the section entitled, "Adequacy of Existing High-Altitude Test Facilities."

Leadtime is dependent upon the complexity of the requisite control technology and the effort required to translate the technology into production hardware. Manufacturers' comments lacked adequate detail with which a specific analysis could be conducted. Alternatively, this analysis of leadtime is based on "worst case" examples which will require the longest time. If adequate time exists in which to develop, certify, and produce the "worst case" examples, than it is reasonable to expect that other less complex and, hence, less time consuming changes can be made. Therefore, this analysis begins with a delineation of "worst case" development requirements to characterize the level of effort which will be required to meet the 1982-1983 standards. After the hardware has been described, it will be related to the historical development-certification schedule of the automotive industry. Conclusions can then be drawn regarding the adequacy of leadtime based on the complexity of the required hardware and the way in which the industry has historically dealt with similar problems in the past.

Finally, this analysis will briefly review some of the comments for support of the conclusion.

The principle control strategy for vehicles that do not have the inherent capability to meet the standards is to enlean the fuel-air mixture to promote more complete combustion. After carefully reviewing all of the comments and after conducting an independent investigation, EPA believes that this will be achieved with recalibrations of engine and emission control parameters. The required recalibrations will probably include short leadtime tooling on both feedback and nonfeedback systems. The most critical, or "worst case," hardware modifications include calibration changes to carburetors for non-feedback systems and the addition of electronic components for feedback systems. Other techniques include changes to timing, air pump, and EGR.

Several commenters pointed out that not enough time is available for developing and tooling long-leadtime items. EPA is in basic agreement with these comments. However, the Agency rejects the position that major hardware and tooling changes are necessary to accomplish the types of control strategies mentioned above.

For non-feedback systems, modifying carburetors to accomplish enleanment can be accomplished by using either fixed calibrations or automatically compensating aneroids. Aneroid controls are preferred because they can provide near optimal control at various altitudes and, because, if properly designed, they have the potential of providing less complex and lower cost high-altitude modifications. Aneroids are currently available on some car/truck models; other models could easily change to existing aneroid controlled carburetors; while still other carburetors could be modified by machining air bleed passages or through simple modifications to castings.

The remaining non-feedback carburetors, could be redesigned to accept an aneroid only by more complex changes to die patterns. This type of change is a long leadtime modification. In developing the parameter adjustment regulations, manufacturers commented that these more complex changes can take 1.5 or more years to complete. Therefore, aneroids can not be used to comply with the proposed high-altitude standards in all cases. In these instances, however, manufacturers can obtain the same emission control results at the design altitude by using carburetors specifically calibrated for use at high altitudes (fixed calibration). This type of control hardware has been certified for high altitude sales in the past by GM. Fixed calibration carburetors cannot be optimized for different altitudes and can be somewhat more expensive if vehicles are modified from a low-altitude configuration to a high-altitude configuration. But they do offer substantial control at high altitudes.

Optimal high-altitude fixed calibrations can usually be achieved by simple machining or readjustment of certain carburetor parameters. Fixed calibrations will not require long leadtime retooling efforts as might be necessary if the whole carburetor casting pattern had to be modified in order to accept an aneroid. Recalibration of low-altitude engine/emission control systems for high-altitude use can be accomplished by changing such items as the fuel jet(s), the choke, the power enrichment circuit, the idle fuel-air mixture, the idle speed, etc. The time to make the tooling changes required to produce the above described fixed calibrations is basically a function of the number of tests that are needed. In the Regulatory Analysis for this rulemaking, EPA has estimated that not more than about 150 tests on the average (i.e., Federal Test Procedure not including evaporative emissions determination) will be required for each LDV and LDT engine family to determine high-altitude fixed calibrations. At the very slow testing rate of only one test per day, the 150 tests can be finished in less than six months, thereby leaving plenty of time to implement any minor tooling changes before August 1, 1981.

EPA currently estimates that 70 percent of the vehicles manufactured in 1982 and 1983 will use feedback (electronically controlled) fuel systems. All of these systems have an inherent capability to compensate for changes in altitude. In this regard, some systems have a greater range of compensating authority than others. Although many systems appear to be able to automatically meet the high-altitude standards, others will need to be recalibrated. As delineated in the comments at the public hearings, leadtime is most critical if a manifold absolute pressure (MAP) sensor must be added to the feedback system. However, MAP sensors are no longer expected to be necessary as indicated by Chrysler's statement. Reprogramming the electronic control unit may be required for some vehicles, but, as stated by GM and Chrysler, it is not as difficult as adding a MAP sensor. Chrysler specifically commented that adequate leadtime existed to recalibrate the electronics.

At this point, the worst case items for feedback and non-feedback systems have been delineated. It has been shown that the requisite hardware changes do not involve long tooling or development leadtimes. What will be required are modifications to existing hardware which include the two "worst case" examples of recalibrating fuel systems: fixed calibrations for non-feedback fuel systems and reprogramming the electronics control unit for feedback fuel systems. Now that the scope of the required changes has been described, the worst case recalibration efforts can be related to the historical development, certification, and production cycle of the industry.

Current development, certification, and production schedules vary with each manufacturer. Table 1 shows Chrysler's projected schedule for certifying 1982 low-altitude LDVs and LDTs. EPA's past experience with industry schedules shows that Chrysler's schedule is somewhat optimistic. As an example, Chrysler projects the submission of final certification documents to EPA is May 26, while the Agency typically receives these submissions as late as June or July. However, Chrysler's scheme is useful as a representative schedule of events.

Historically, manufacturers' production hardware calibrations are determined through a series of iterations which occur throughout the development and certification process. Calibration changes can occur even after a certificate of conformity has been issued by applying for "running changes." Therefore, depending on the complexity, production calibrations can be finalized as late as the beginning of production which usually occurs near August 1.

It may be argued that calibrations must be developed to a great degree in time for the building of 50,000-mile durability vehicles or, alternatively, at least in time for 4,000-mile emission data vehicles. This is true for vehicles which must currently be certified for compliance with low-altitude standards. It is not true for compliance with high-altitude standards. As discussed in the section entitled, "Number of Certification Vehicles," manufacturers will not be required to build and accumulate mileage on high-altitude hardware for 50,000-mile durability or 4,000-mile emission data tests. Even though preliminary calibrations would be specified to EPA earlier, specific calibrations would not absolutely need to be developed and built until the high-altitude emission tests were ready to be conducted. These tests would not be performed until the 4,000-mile low-altitude tests had been completed and the vehicles were ready to be modified into high-altitude test configurations. Therefore, in "worst case" situations the first high-altitude test hardware could be delayed until a March-June time frame. Final production calibrations might be completed as late as August.

From the time the final high-altitude standards are scheduled to be published in November 1980, until the start of production in August 1981 is about 9 months. EPA believes that this provides the industry with adequate leadtime to meet the 1982 standards for the worst case recalibrations. As discussed above, EPA is convinced that the 150 tests which may be needed to recalibrate a low-altitude engine family (reprogramming of the electronic control unit requires even less testing) can be done in six months at most. This conclusion is further supported by the fact that many manufacturers appear to have already had significant experience with the affects of altitude on fuel systems. This experience is based on several things. Many manufacturers either have high-altitude test facilities, as described in the issue entitled, "Adequacy of Existing High-Altitude Test Facilities," or have experience with non-facility high-altitude tests such as conducted by AMC and others for driveability and performance demonstrations. In 1977, manufacturers produced vehicles in compliance with mandatory high-altitude standards. Several manufacturers have participated in the voluntary high-altitude certification programs subsequent to 1977. Among them are Volkswagen, GM, Ford, and Chrysler. Finally, vehicles certified to the California standards must demonstrate control of emissions at high altitude, although the requirement is admittedly less rigorous than that necessary for 1982 and 1983 standards. All of the above examples indicate that manufacturers have amassed a significant body of knowledge from which they can draw upon when developing high-altitude calibrations. This experience should enhance the rate at which high-altitude hardware can be developed.

Although many of the general comments indicated that leadtime was not adequate for the 1982 model year, there is support for the conclusion that recalibrations can be produced in time for 1982. Ford said that the time required to build, develop, and certify an emission-data vehicle calibration is one year. Previously it was pointed out that final calibrations could be delayed until very near the start of production which is August. Assuming a worst case situation in which Ford does not begin development until the final rule is published (November 1980), and that they need to delay the finalization of production hardware until August 1981, they would still have approximately 9 of the 12 months they suggest is necessary. When it is remembered that neither the 50,000-mile durability vehicle nor the 4,000-mile emission-data vehicle will need to be run for high-altitude certification, it is apparent that adequate leadtime exists for Ford. The overall burden of meeting the high-altitude standard is further moderated for Ford in light of the fact that about 50 percent of their models in past years have been available with a high-altitude option. This option apparently consisted of an aneroid carburetor. Since Ford stated that their aneroid carburetors could meet the standards, presumably little or no effort need be directed at aneroid equipped vehicles so their resources can be used to develop calibrations for the remaining non-aneroid models. Ford also indicated at the public hearings that they had been planning to meet the standards with fixed calibrations rather than designing every car to meet both the high- and low-altitude standards. Because EPA has deleted the $40 modification limit, Ford can now proceed with their previous plans.

Chrysler stated that they required three changes to recalibrate vehicles to meet the high-altitude standards: reprogram the electronic control unit, add a MAP sensor, and the addition of aneroids to some truck families. At the public hearings, Chrysler said that recalibrating the electronic unit could be delayed until about October or September. They commented that the MAP sensor was a more critical problem. However, since then they have stated a MAP sensor is no longer necessary. Chrysler commented on the aneroid carburetor leadtime issue subsequent to the hearing.1/ They indicated that if they were allowed to place aneroid carburetors on only the vehicles sold at high altitude, they could avoid problems that might "make it impossible to design and tool the necessary hardware in time for the 1982 year." By deleting the $40 limit on the cost of modifications, EPA has removed the obstacle which Chrysler alluded to. With the deletion of mileage accumulation, Chrysler should have adequate leadtime.

IH said they would not have enough time to add aneroids and that their only approach would be to develop fixed calibrations for high-altitude vehicles. Again, this will be possible now that the $40 modification limit has been deleted. In comments on the proposal, Jaguar stated they needed 6-10 months notice for their suppliers to produce the necessary high-altitude hardware. If the regulation is promulgated in November 1980 and production begin in August 1981. Jaguar would have up to 3 months in which to develop high-altitude calibrations. Further, in a letter dated April 2, 1980, Jaguar stated they are confident they can meet the standard on all engine families except the 215 CID V-8 and the 326 CID V-12.3/ Those engines have been granted waivers from the statutory CO standard.4/ For waivered engines, EPA has provided an alternative high-altitude standard which is more lenient. The Agency's technology review shows Jaguar should be able to meet that alternative standard. Furthermore, Jaguar has stated that they will be conducting high-altitude testing for six weeks during July and August 1980.3/ GM, like Ford, will not require development testing for many of the vehicles in their product line. Data presented by GM shows that their C4 systems has the capability to meet the standards for the majority of their LDVs. The potential development burden is, therefore, greatly reduced and, hence, leadtime required to recalibrate non-complying vehicles should also be reduced. Based on the above, Ford, Chrysler, Jaguar, IH, and GM, in particular, appear to already be well on the way to comply with the 1982 and 1983 standards.

Development Leadtime - Specific: GM commented that leadtime was inadequate for their subcompact cars which have already begun 1982 certification testing. EPA has confirmed that GM has begun durability testing for one model line of subcompact cars. Apparently GM plans to introduce this model early in 1981. These subcompacts utilize a new front wheel drive, transverse mounted engine. There is no preexisting data to indicate whether this engine would require additional development to meet the high-altitude standards. However, the subcompacts will use the same C-4 emission control system as other GM cars. For the other cars this system apparently either has the inherent capability to meet the standards or can do so with a relatively minor modification. EPA believes that the use of the C-4 system in GM's new subcompact model will allow the vehicles to be certified and produced without significantly compromising GM's current production schedule.

AMC commented that they will use GM's C-4 system on their 1982 LDVs. They claimed that this system had the ability to meet the standards but they would be unable to recalibrate the system in time to comply. AMC presented no data to substantiate this claim. This same argument, however, was used in their application for a waiver from the statutory CO standards which are applicable to 1981 and 1982 model year vehicles. In response to that waiver, EPA carefully considered AMC's alleged leadtime problems.2/ The Agency concluded that AMC could not complete development of the C-4 system for the 1981 model year but that they should be able to certify the system by the 1982 model year. AMC was granted a CO waiver for 1981. By approving the waiver, EPA noted that the effort saved in developing a system for 1981 should enhance AMC's ability to calibrate and certify the C-4 system for 1982. Regarding the high-altitude standards, AMC and GM have similar situations. It appears that once the C-4 system has been calibrated at low altitude, any recalibration, if required at all, will be a relatively simple task. Therefore, there is no reason to believe that AMC cannot comply with the high-altitude standards beginning in 1982.

EPA concludes, therefore, that adequate leadtime exists for specific vehicles to comply with the high-altitude standards beginning in the 1982 model year. This conclusion is based primarily on the fact that time is available in which to develop and certifiy the required "worst case" hardware, i.e., recalibrations of low-altitude engine and emission control parameters. The conclusion is further supported by the fact that most manufacturers already have significant experience with the effects of altitude on vehicle emissions and that many vehicles have already demonstrated the ability to meet the standards.

However, EPA recognizes that in light of the late promulgation date of this rule, that the resources, personnel and facilities, may occasionally be strained to do all the work necessary for all engine families. This problem is perceived to be particularly acute in the truck field where the technical difficulties associated with compliance are greater, in part, because of the absence of feedback control systems and the wide variety of configurations, all requiring unique calibrations. Relief from some of the development and certification burden will assure success for the remainder. Thus, on exemption in 1982 for some fraction of the LDT fleet based upon sales or number of models is very utilitarian at this point.

Recommendation

Adequate leadtime exists for LDVs in which to develop, certify, and produce vehicles in compliance with the 1982 and 1983 high-altitude standards. LDVs manufactured for the 1982 model years should be included in the high-altitude standards. It appears that the manufacturers of LDTs may be excessively strained to obtain the necessary certification for their entire fleets in time for the start of 1982 production. On the other hand, the problem seems not so severe as to abandon 1982 altogether. A rational compromise is to provide a sales-based exemption for some fraction of the LDT fleet, perhaps, 30 percent, as recommended by Ford. This would alleviate the time constraints.

Table 1

Chrysler 1982 MY Certification Program

	1980												1981							
Program	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
4k Data Vehicles						X (6/23) Hardware Chart Published			X (9/25) 4k Final Calib. Hardware		X (11/13) 4k Hardware Delivery	X (12/15) 4k Start			X (5/4) 4k Stop	X (5/28) Cert. to EPA			X (6/30) EPA Cert.	X (7/28) Job #1
50k Durability Vehicles		X (1/28) Hardware Chart Published		X (3/24) Emission Hardware Calibrated		X (5/27) Hardware Delivery	X (7/1) Dur. Test Start					X (12/1) Dur. Test Stop								

J. Issue: Exemptions

Summary of Issue

The high altitude NPRM proposed to require all vehicles to meet or be modifiable to meet the high-altitude as well as the low-altitude standards. This would ensure the same selection of vehicles at high altitude as at low altitude. However, EPA intended to offer exemptions from the high-altitude rules to those fuel efficient vehicles whose low power-to-weight ratios lead to technical difficulty in achieving compliance and which tend to make them unsuitable for high altitude use anyway because of poor performance.

Summary of Comments

The variety of possible criteria that were suggested included (1) exemption for vehicles having automatic compensating devices (Honda), (2) exemption for all vehicles having fixed calibration (GM), (3) exemption for all high fuel economy vehicles, based upon power-to-weight ratio or percentage of sales (GM, AMC, Honda, Chrysler, Ford).

In addition, most manufacturers objected to EPA's labeling idea that exempted vehicles be labeled "unsafe at altitude" (Ford, AMC, GM, Chrysler). A more accurate label would be "unsuitable."

Major Subissues

1. Need for Exemptions. This addresses the basic issue of whether exemptions are necessary and desirable at all, and their justification.

2. Circumscription of Exemptions. This section delineates the various criteria which have been suggested by manufacturers and EPA to be used to determine exemptions and responds to comments about the proper labeling for exempted vehicles.

Analysis of Comments

1. Need for Exemptions. There are three possible reasons for providing for exemptions: (1) to save the manufacturers the needless expense of certifying for high altitude, certain vehicles that are sold there in very small quantity, (2) to avoid having the most fuel economic vehicles eliminated from the general market because they could not comply with the high-altitude standards, and (3) to offer relief to the manufacturers if there is insufficient leadtime to complete the development and certification processes before production. [The rule requires compliance with both the high- and low-altitude standards (with modification, if necessary) for certification; hence, failure to comply with either standard precludes certification and, therefore, marketing at any location, regardless of altitude.] The first argument is strictly economic,

the second, technical and societal (need to conserve fuel), the third, temporal.

EPA does not consider it particularly valid to exempt low sales volume vehicles per se, if in fact their low sales do not reflect a high-altitude performance problem, but only the specialized nature of the vehicle (e.g., trailer tow packages).

The issue of fuel economy is not restricted to vehicles of maximum fuel economy in the absolute sense, but rather to those vehicles within a utilitarian classification. Thus a half ton LDT could be "fuel economic" in the relative sense of being superior to other half ton trucks and yet certainly be inferior to the best subcompact auto. The claim of technical difficulty is based upon the fact that high fuel economy vehicles typically have low power-to-weight and low drive train ratios (the latter obtained by a low rear axle ratio). The problem such vehicles have with a high-altitude standard is that the combination of reduced available power (due to less dense air), the already low power, and high gearing (low axle ratio) force the vehicles to spend excessive time in the "power enrichment" mode during the FTP. This may produce too much HC and CO, despite the usual calibration changes that are effective at higher elevations: timing and carburetor flow. Technical solutions appear to exist for the few possible "worst case" situations. The most direct would be to disconnect the power enrichment mechanism. While this sacrifices perhaps five or more percent of the available power, it eliminates the source of the ultra-rich operation. This may, however, lead to complications not only in driveability, but more significantly, in durability because of too-lean operation at maximum load. An alternative solution, if permitted, is to change the rear axle ratio. This approach "gears down" the entire vehicle and thus avoids some portion of the use of the power enrichment. All in all, it is possible in isolated cases that either compliance is impossible or, if possible, it results in a vehicle of unacceptable driveability or durability unless axle ratio changes are permitted. Such vehicles are expected to be relatively fuel economic ones. On the other hand, no such vehicles have yet been identified (see Technology issue). The new vehicles, such as the Chrysler K and GM J cars, have emissions performance unknown to EPA as yet.

The leadtime analysis suggests that there may be some manufacturers whose personnel resources would be strained to complete all the requisite tasks leading up to and including certification. The argument would be credible of course, only for the 1982 standards. If a portion of the fleet were granted an exemption, then the work burden on the manufacturers is lightened and presumably they could get the remaining portion properly certified in a timely manner. As the issue is basically that of leadtime, therefore, the analysis is not repeated here.

What, then, are the ramifications of providing or not providing exemptions? First, if exemptions are not offered, then all vehicles, including those with small or zero high-altitude sales, must comply. There is a possibility, perhaps remote, that some fuel economic ones will not be able to comply with the high-altitude rules by the usual recalibration methods, including automatic schemes. Those which cannot comply are faced with certain options.

First, probably all of these vehicles can achieve compliance by having the power enrichment disconnected. Being thus certified, the vehicle will be offered for sale at low altitude, but probably not sold at high altitude because of the anticipated durability and driveability problems of such a high-altitude configuration. It is possible that this extreme fix may not even suffice on a few vehicle configurations, thus forcing the second option.

Second, they may retire from the general market (low, as well as high altitude), thus costing the nation one fuel economic option to the consumer. This concern is also addressed in the issue, Model Availability.

The third possible option for non-complying vehicles, if permitted, would be a change in the rear axle ratio. Such a change was not a viable option in the proposal because of the $40 limit on modifications but is now possible because EPA is deleting this requirement. Therefore, if now permitted, it could be expected that a number of less fuel economic vehicles might also incorporate this fix instead of extensive recalibration of the carburetor and timing, or the introduction of automatic compensating devices (i.e., rather ordinary fixes). These vehicles would not suffer the durability and driveability problems which might plague those few whose power enrichment was cut off. With this situation, there should be no vehicle-engine-transmission combination that could not meet the standard and, hence, in a general sense to the consumer, model availability is maximized. Manufacturers should be more willing to sell these vehicles at high altitude because with the power enrichment mode still available, the potential durability and driveability problems will not occur. Also, these vehicles, unlike other fuel economic, low power-to-weight vehicles, will tend to have better performance (acceleration) because of the higher gearing and, hence, are likely to be better received by the high-altitude consumer. These vehicles, however, would likely be somewhat less fuel economic.

However, it must be recognized that by allowing axle changes, the overall drivetrain gearing ratio becomes a limited option to the consumer. Thus, while he will be able to get any model, engine, and transmission, he may not be able to get at high altitude, all of the rear axle ratios that are available at low altitude. While this may not seem a significant loss, as most consumers are not particularly sensitive to the axle choices, it should be remembered that those vehicle-axle combinations that would not be available at altitude are most likely those of maximum fuel economy (at least relatively) and may, therefore, have a large degree of public notoriety. Their failure to be sold at altitude may have a significant impact on the public perception of model availability, despite their lack of suitability for high-altitude use.

In summary, then, if exemptions are not permitted, all engine-vehicle combinations will have to be certified at both high and low altitudes or will not be allowed to be sold at all. If axle ratio changes are not permitted as a high-altitude control technology, then some fuel economic vehicles may have to resort to disconnection of the power enrichment. With this fix, probably most engine-vehicle-transmission combinations can comply, although a few may not. Potential driveability and durability problems arising from a lack of power enrichment may force some manufacturers from offering those few vehicles at high altitude, despite certification. Of those offered though, all drivetrain options (axle ratios) will be available. If, on the other hand, axle ratio changes are permitted, then probably disconnection of power enrichment will not likely be used. All engine-vehicle-transmission combinations will be certified at high altitude although many axles may not be. Those will tend to be the higher fuel economy vehicles which may be especially sought by the public despite poor performance at altitude. In any event, without exemptions the manufacturers will have to finance development and certification of high altitude configurations, despite the purported limited sales of very high fuel economy vehicles.

On the other hand, if exemptions are permitted and properly circumscribed, then fuel economic vehicles (i.e., those with low power-to-weight ratio which are underpowered at high altitude) will be offered exemptions. This means, of course, that such vehicles will not be sold at all at high altitude because they are not certificated. It may be that these vehicles would have been low sales volume vehicles anyway at high altitude, owing to their relatively poor performance, and that little in the way of purchasing options has been lost to the consumer. However, these exempted vehicles, though few in number, are among the most fuel economic and probably of considerable consumer interest despite their poor performance at altitude. Their absence from the market may impact the _perceived_ model availability more than actual sales.

For exempted vehicles, some savings lie in the avoidance of the cost of development and certification of vehicles that have little utility at high altitude. If technically feasible, however, the manufacturer may elect to obtain high- as well as low-altitude certification if he feels that the sales potential at high altitude warrants the effort. Therefore, the availability of an exemption will not automatically preclude all eligible vehicles from being offered for sale at high altitude.

2. _Circumscription of Exemptions_. The scope of the exemption impacts heavily on industry's reliance on disconnection of

power enrichment, use of axle ratio changes (if permitted), and industry's overall cost of development and certification. A very limited exemption, that which exempts only the worst performers at high altitude, may still dictate in some instances disablement of the power enrichment. Although certified, these vehicles probably would not be offered at altitude. This may have a practical effect of removing from sale at altitude entire carline/engine/transmission combinations. However, permitting changes of axle ratio may lead to a greater offering at high altitude of vehicle-engine-transmission combinations.

The principal negative considerations of allowing axle changes are that (1) it would make in-use retrofit and dealer trade modification exceedingly expensive, thus discouraging those activities (Dealer trades could be preserved if trade-in of the essentially new replaced axle were permitted by the manufacturer); and (2), it would remove the most fuel economic vehicles from the market at high altitude. However, because any exemptions do the latter to some degree, only an absence of exemptions offers any hope of getting the most economic cars to market at high altitude. Clearly, however, allowing axle changes would limit to a larger degree the models available at high altitude (both the more fuel efficient models and limited sales models) than a performance or technological exemption.

The basic purpose for the exemption rule is, once again, to avoid the loss of fuel economic vehicles from the low-altitude market because those vehicles could not, without great difficulty, comply with the high-altitude rule. This is less of a concern if axle ratio changes are permitted. But allowing axle ratio changes would likely significantly limit model availability at high altitude.

With this purpose in mind, reasonable criteria for exemptions can be evaluated. These are:

(1) Percent of sales volume.

(2) Fuel economy number.

(3) Unacceptable performance, as determined by design parameters.

(4) Unacceptable performance, as determined by acceleration testing.

(5) All automatic altitude compensating vehicles.

(6) All fixed calibration vehicles.

(7) Any vehicle configuration for which a demonstration of inability to comply is provided.

The basic advantages and disadvantages of these are summarized below:

(1) Percent of sales volume (10-30 percent)

(a) It provides the most economic exemption from the manufacturers' viewpoint.

(b) It does not consider technological feasibility.

(c) It is imprecise and may offer exclusion needlessly or refuse it improperly.

(d) It, or a modification such as percent of models, correctly addresses the issue of inadequate leadtime for 1982.

(e) It fails to address the issue of technical difficulty, poor performance, and fuel economy.

(f) Because it is likely to be defined favorably for the manufacturers, there is likely to be maximum reduction in model availability through excessive exclusion.

(2) Fuel economy number

(a) It is an absolute, unambiguous criterion that does not require additional testing by the manufacturer.

(b) Fuel economy data is obtained during the certification testing; hence, the information becomes available very late. Earlier testing is invalid as the prototype would likely not comply with even the low-altitude standards.

(c) This would exclude many vehicles in need of exemption, namely those of lower absolute fuel economy, but relatively high fuel economy for their size. Hence, it misses the point.

(d) Being an absolute criterion, as both the car and truck fleets are scaled down, a continually larger fraction would be exempted in succeeding years. Therefore, the value would have to be revised annually.

(e) EPA will have to determine the appropriate cut-off figure.

(3) Unacceptable performance, as determined by design parameters

(a) It is an absolute, unambiguous criterion that does not require any testing; hence, there would be no unexpected failures.

(b) The necessary data would be available very early to the manufacturers.

(c) It is possible for a manufacturer to adjust his offering to maximize exemptions.

(d) Being an absolute criterion, as both the car and truck fleets are scaled down, a continually larger fraction would be exempted in succeeding years. Therefore, the value would have to be revised annually.

(e) The values of the parameters could be set annually by each manufacturer's marketing strategy, thus solving (d) above.

(4) Unacceptable performance, as determined by acceleration testing

(a) Acceleration requires testing to establish the minumum acceptable level and to qualify certain vehicles for exemption. Thus, it is time-consuming.

(b) Testing could not occur before the certification testing because earlier prototype versions that do not meet the low-altitude standards could not be trusted to have the same performance as the certification version.

(c) The acceleration limit can be set annually by each manufacturer's marketing strategy.

(d) A simple maximum acceleration test may not properly reflect adequate overall performance or the increase in the time in power enrichment due to increased altitude.

(5) All automatic altitude compensating vehicles (but permit sales)

(a) Exempts all those that most easily comply.

(b) Saves considerable certification expense with potentially little air quality loss as all such vehicles are likely to come close to compliance, if not in fact comply. However, the reductions would not be assured.

(c) Would exempt such a large portion of the fleet that discrimination could be augued by those forced to comply.

(d) Would leave some fuel efficient, low-altitude vehicles still forced with compliance with the high-altitude standards. The failure of these to comply would have a serious deleterious effect on model availability of fuel economic vehicles at low altitude.

(6) <u>All fixed calibration vehicles (but permit sales)</u>

(a) Exempts all those whose non-certification most significantly impacts air quality.

(b) Would exempt such a large portion of the fleet that discrimination could be argued by those forced to comply.

(c) Would leave some fuel efficient, low-altitude vehicles still forced to comply. Any failure to comply would impair the availability of fuel economic cars at low altitude.

(7) <u>Any vehicle configuration for which a demonstration of inability to comply is provided</u>

(a) This criterion meets the purpose of the exemption exactly (technical ability).

(b) Like waivers, it requires continuing judgmental effort by EPA.

(c) EPA could easily be inundated by industry applications for exemptions.

(d) The subjective nature of the exemption could lead to inequities and, therefore, claims of abuse of power by EPA.

(e) Every manufacturer could, and likely would, request waivers regardless of his true capability to comply.

It is clear that some of the above schemes can readily be rejected. Options (5) and (6) simply seek to serve special interests. In fact, adoption of both together would result in no regulation at all. Option (1) addresses exemptions for leadtime considerations, but is irrelevant to the issues of fuel economy and performance. Option (2) would miss all the relatively, but not absolutely, fuel economic vehicles. Also, knowledge of exempted vehicles would be available too late to be useful, and the manufacturers would be forced to invest in compliance efforts as a hedge. Options (3) and (4) address the proper goal; that many fuel economic vehicles of all sizes have technical difficulty because of poor performance associated with its economy. Option (4), however, like Option (2), keeps the manufacturers in the dark until the last minute about the eligibility of their vehicles for exemption. Option (7) directly addresses the reason for exemptions, the technical inability of certain vehicle configurations to comply using any means. However, its implementation is fraught with difficulties as listed.

Some of the objections of the manufacturers to the proposed labeling requirement are reasonable. The intended vehicles to be exempted are not necessarily unsafe and labeling them as such would cause problems in future years when these vehicles may well be offered at high altitude in response to market demands. Rather, the label should reflect the true exemption criterion, namely that the vehicle is presently considered by the manufacturers and verified by test to have unsuitable performance for general high altitude use and that the vehicle does not meet the requisite high altitude standard. It is necessary to have exempted vehicles labeled so that a dealer will know that the sale of that vehicle to a high-altitude customer is forbidden; it is furthermore necessary to explain the rationale of the exemption for the benefit of a potential high-altitude consumer shopping an adjacent low-altitude dealer.

Recommendation

The basic criterion for exemption should be based upon unacceptable performance at high altitude. This should offer relief to those vehicles which might have technical problems. Of the two schemes which are directed at unacceptable performance, Option (3) is the simplest and most beneficial to the manufacturers while compromising nothing to EPA over Option (4). Option (3), which utilizes design parameters to measure performance capability, should provide the manufacturers with the same exemptions as Option (4), which utilizes acceleration testing. Yet, because the exemption information is available early on, the manufacturers need not expend effort attempting to comply as a hedge against unexpected failure to quality for exemption later on. Also, there is no testing cost, nor concern with high-altitude testing facilities for acceleration tests.

From the perspective of maximizing model availability, the acceptance of axle ratio changes as a control technique would seem reasonable. However, model configurations would likely be limited, and the lost configurations would likely be those with low axle ratios and high, advertised fuel economy. Otherwise though, some relatively low power-to-weight vehicles may be forced to disable their power enrichment mechanisms, leading in turn to possible durability and driveability problems. This may discourage the manufacturers from offering these vehicles at high altitude. On balance, however, the potential cost problems with regard to in-use and dealer-trade modifications if axle ratio changes were allowed, may lead to an unacceptable restriction of those activities. Therefore, axle changes should not be included in any vehicle exemption criteria.

Finally, the labeling requirement should simply state that the performance of the vehicle is unsuitable for high-altitude use because of its poor performance and that it does not comply with the required standard.

A second exemption provision, based upon a percentage of sales, should be provided for 1982 because of the apparent existence of leadtime problems among a few manufacturers (See Leadtime Issue, I). Several options are available. The sales-based exemptions may be given to LDVs, LDTs, or both. The actual percentage is arbitrary. To minimize the breadth of the exemption and to ease the administrative burden, only one class of vehicles should be considered. LDTs ought to be selected because the leadtime analysis suggests that greater technical difficulties are present among that group. Also, LDTs, are the fewer in number and, thus, further enhance the restriction and ease the administration. One manufacturer asked for a 30 percent and lacking any further input, that is recommended.

Vehicles exempted under this provision should still be eligible for sale at high altitude; to be otherwise, would be to penalize the manufacturers for circumstances beyond their control, namely the late promulgation of the 1982 rule.

K. Issue: Model Availability

Summary of Issue

The 1977 high-altitude rule required simply that vehicles sold at high altitude comply with the standard. Consequently, many manufacturers found it more economical to eliminate certain vehicle/engine/transmission combinations from the high-altitude market than to undergo the development and certification expense. This occurred with sufficient frequency to become a major annoyance to the consumer and a potential economic handicap to the dealer. The proposed rule sought to remove this deficiency by requiring that all vehicles comply or be modifiable to comply at reasonable cost ($40). This would have maximized model availability because all vehicles would have had a high-altitude counterpart. The dollar limit is being removed in this final rulemaking, but the modifiable requirement remains. In addition, some room for a limited number of exemptions to the rule is being considered. These exemptions primarily would apply to high fuel economy vehicles which might have technical difficulty complying. Such exemptions would preclude high-altitude sales, but would permit low-altitude sales.

There are other potential restrictions to model availability that have been raised as a consequence of the modification rule. First, if a vehicle configuration cannot be made to comply with the high-altitude standard, then it cannot be certified even for low-altitude sale, except by exemption. If not exempted, the configuration cannot be sold anywhere. Second, if exempted, the vehicle still cannot be sold at high altitude. Thus, availability is affected.

For 1982, a special, sales-based exemption is being considered in order to avoid possible failures to certify due to insufficient time to get all the development and certification work done. Such exempted vehicles would still be sold at high altitude. Failure to have this exemption may seriously impact model availability at all altitudes.

Summary of Comments

A number of commenters claimed that the $40 limit to modify any vehicle configuration to its high-altitude equivalent would reduce model availability rather than maximize it. This would occur because the infeasibility of holding to $40 would prevent certification altogether of some configurations (Honda, Toyota, Ford, GM). Two manufacturers felt that the mere presence of this rule on top of the other emissions and fuel economy rules would reduce their sales offerings simply because of a lack of resources (AMC, Chrysler). Some commenters pointed out a failure to certify at all on either technical or business grounds would reduce availability at high <u>and</u> low altitude; the vehicles lost would likely be the most fuel economical (Ford, NADA, Chrysler). Renault asserted the obvious fact that no manufacturer should be required to sell anything at high altitude.

Analysis of Comments

EPA recognizes, on the basis of the 1977 experience, that the regulation must be carefully structured in order to prevent undue hardship either to the consuming public or to the dealers (at high and low altitudes). The public seeks and, indeed, a free competitive market demands, a variety of vehicles from which to choose. The market is sensitive to selection among car lines, engine size, and transmission options. It is usually insensitive to axle ratio offerings except in a few specialized instances, usually in the truck line, or trailer tow packages for cars. On the other hand, it is sensitive to fuel economy, especially to widely-advertised claims of exceptional performance. Implicit in any claim of extreme economy is the presence of a very high geared drive train, including a low numerical axle ratio. Thus, any effort to maximize model availability should emphasize those vehicle descriptors to which the market is sensitive.

In brief, EPA sees four situations which may reduce model availability.

1) Technical failure to meet the high-altitude standard, but configuration is exempted - results in configuration loss only at high altitude.

2) Technical failure to meet the high-altitude standard - results in nationwide loss of vehicle configuration.

3) Business decision to restrict sales despite compliance - results in loss of certain configurations presumably only at high altitude.

4) For 1982 only, inadequate leadtime may preclude the timely certification of vehicles that are otherwise capable of of certification.

The first situation is likely to occur if exemptions are offered and result in a loss of availability at high altitude. However, this loss is minimized by limiting the scope of the exemption only to those vehicles which require it: certain low power-to-weight vehicles whose weak performance would make compliance difficult or impossible. These lowest performance vehicles (low power-to-weight) are also those least suited for use at high altitude because their low performance at low altitude degrades into unacceptable performance at high altitude. Hence, these exemptions will have minimal impact on the consumer at high altitude, and of course, none at low altitude. However, those exempted will also be the most fuel economic, and although unsuitable for high altitude by the traditional criterion (performance), the current interest in fuel economy, coupled with the intense national advertising of these vehicles, is likely to lead to some customer interest in these exempted vehicles at high altitude wherein they would not be available.

Of course, it should also be realized that a given car line/engine/transmission combination or even car line/engine combination can be eliminated from high altitude sales by the exemption and not only certain axle ratio offerings. This is especially true if the manufacturer offers only a single axle ratio (e.g., Chevette).

The second situation should be avoided, especially if the vehicle in question is particularly fuel economic as would likely be the case. However, as technical difficulty has never been demonstrated in any particular case and with the exemption criterion properly circumscribed, any vehicle having technical difficulty would be eligible for exemption. Thus, this adverse situation (affecting the CAFE averages) is not expected at all.

The third situation may well occur and EPA has no control over it. However, present experience shows that there is very little actual restriction of models available at high altitude. Therefore, so long as the manufacturers are required to certify vehicles, EPA expects that they will sell them at high altitude.

The fourth situation may occur in 1982 because of the short time between promulgation and production. If it were likely to occur extensively across the board, then it would be necessary to conclude that promulgation for 1982 is unrealistic. However, for the limited situations wherein leadtime may be a problem because of insufficient personnel resources, abandonment of the rule for 1982 would be contrary to the needs of the high-altitude urban areas. Hence model availability would be impacted unless an exemption were granted for those vehicles unable to certify in time. While exemption usually would imply forbidden sales at altitude, it would make more sense here to allow sales, thus not penalizing the manufacturer for his leadtime problem and simultaneously, retaining model availability at high altitude as well as at low.

It is possible, though unlikely, that some low power-to-weight vehicle is not eligible for exemption and simultaneously unable to comply with the usual recalibrations which would not adversely affect performance. If this were to occur, the vehicle could still achieve compliance by the more extreme fix of disconnection of the power enrichment mechanism in the high-altitude configuration. However, this fix may render the vehicle unsatisfactory because of degraded performance, driveability, or durability, and hence the manufacturer may indeed not actually offer it for sale at high altitude.

Recommendation

No action required; issue is resolved by the exemption provisions. The more extreme scenarios suggested above are only speculation with no evidence presently available to suggest they may actually occur.

L. Issue - EPA's Legal Authority

Summary of Issue

EPA proposed that all light-duty motor vehicles shall meet, or be capable of being modified to meet, the high-altitude standards. Any such modification shall be capable of being performed by commercial repair facilities at a cost to the ultimate purchaser, or any subsequent purchaser, of $40 (1979 dollars). In addition, the vehicle manufacturer would be liable to ensure that all vehicles sold for principal use at high altitude are in the configuration that provides for compliance with the high-altitude standards. The Agency also stated that the sale of high-altitude vehicles for principal use at low altitude would not be considered a violation of Section 203(a)(1) of the Act.

Summary of Comments

Industry representatives commented that EPA's $40 maximum cost was unauthorized and constituted illegal price fixing. Commenters also stated that manufacturers could not be held liable for dealer actions and that EPA lacked authority to recall vehicles built to conform with the high-altitude standards when operated at low altitude. One company commented that EPA no longer had the authority to promulgate interim high-altitude standards at all.

Major Subissues

1. Basic Authority. Ford stated that they believed that EPA no longer had the authority to set a standard that would require all vehicles to meet proportional or alternative standards at high-altitude for 1982-1983 model year vehicles.

2. $40 Maximum Fee. Most manufacturers commented that EPA's maximum allowable charge constitutes price fixing and is in violation of the antitrust laws. Ford stated that forcing manufacturers to reimburse independent repair facilities for high-altitude modifications was equivalent to taking property without due process of law. GM stated that even if EPA intends to use the maximum charge to only assure that the modification could be done for $40 or less, and then allow the free marketplace to charge any price that competition allows, the maximum charge is still illegal and unauthorized.

3. Liability for Sale. Most manufacturers commented that EPA had misunderstood the dealer/manufacturer relationship. GM stated that the manufacturer does not sell or deliver vehicles to the ultimate purchaser; therefore, they cannot be held liable for the dealer's action. Furthermore, GM cited Section 207(h)(1) of the Act as specifically imposing direct responsibility for the ultimate sale of a vehicle upon the dealer.

4. Recall Authority. Ford commented that EPA lacks authority to recall vehicles based upon testing at any altitude other than the altitude at which the vehicles in question are principally to be operated.

5. EPA Has Not Met Statutory Requirements for Standards. Chrysler commented that contrary to Section 202(f) of the Act, EPA has not considered and made a finding with respect to:

A. The economic impact of the standards;

B. The availability of control technology; and

C. The likelihood of a significant improvement in air quality.

6. Low Altitude Sale of High-Altitude Vehicles. Ford commented that recall and performance warranty actions against high-altitude vehicles found to be in noncompliance with low-altitude standards would be illegal because those vehicles would be adjusted or modified (if necessary) for principal use at high altitude. Ford's concern is compounded by the fact that EPA explicitly intended to allow the sale of high-altitude vehicles at low altitudes (the reverse situation was, of course, not allowed). Thus, the number of high-altitude vehicles operating at low altitude could have been substantially more than if only residence changes and transient operation accounted for such low-altitude operation of high-altitude vehicles.

Analysis of Comments

1. Basic Authority. The Clean Air Act does not explicitly forbid EPA from setting alternative standards for high-altitude vehicles. Section 206(f)(1) repealed the high-altitude regulations applicable to 1977 model year motor vehicles which did differentiate between high and low altitudes. However, Section 206(f)(1) continues on to state that:

> "Any future regulation affecting the sale or distribution of motor vehicles or engines manufactured before the model year 1984 in high altitude areas of the country shall take effect no earlier than model year 1981."

Since the proposed regulations apply to the 1982 and 1983 model year, the prohibition on high-altitude regulations has expired.

Furthermore, Section 202(f)(2) assumes EPA will have to set alternative standards, as the subsection forbids the Agency from setting standards that are more stringent at high altitude than at non-high-altitude locations. There would have been no reason for Congress to include this subsection if it desired to forbid EPA from setting alternative standards. The clear intent of Congress is to enable EPA to set standards which are numerically less stringent or as stringent for high altitude until the 1984 model year. Therefore, Ford's interpretation of the Clean Air Act appears to be incorrect.

2. $40 Maximum Fee. EPA disagrees with those manufacturers who considered the $40 maximum allowable charge to be illegal. However, for other reasons, EPA has decided to delete the proposed $40 limit (see 45 Federal Register 49254, July 24, 1980). One, EPA agrees with many commenters that $40 no longer represents a reasonable upper limit for high-altitude modifications. Two, EPA agrees that one result of maintaining the $40 limit would be to encourage some manufacturers to place unnecessary emission control hardware on all vehicles, rather than just vehicles sold at high altitude. Since high-altitude sales represent only about 3 percent of national sales, this could significantly increase the total cost of the standards. Furthermore, since the emissions reductions would occur at high altitude only, the cost effectiveness of the standards would diminish.

Another option would have been to raise the maximum allowable charge. However this, would have greatly eroded the potential benefits of a maximum charge, and would have made the concept practically worthless. Thus, EPA has decided to delete the maximum allowable charge altogether.

3. Liability for Sale. The question presented is whether the vehicle manufacturers can be held liable for the sale of motor vehicles configured to meet low-altitude emission standards for use at high-altitude locations. Section 203(A)(1) of the Clean Air Act prohibits the vehicle manufacturer from the " . . . distribution in commerce, the sale, or the offering for sale, or the introduction, or delivery for introduction, into commerce . . . of any new motor vehicle or new motor vehicle engine . . . unless such vehicle or engine is covered by a certificate of conformity issued (and in effect) under regulations prescribed under this part." Section 206(a)(1) provides that a certificate of conformity shall be issued if the Administrator determines that the vehicle conforms to the emission standards prescribed under §202. The requirement that all vehicles meet the applicable emission standards is clear. The only distinction drawn by Congress with regard to high-altitude use of vehicles is in §202f(1); §202f(2) merely prohibits the establishment of high-altitude emission standards for certification which are more stringent than non-high-altitude standards.

Recognizing the technological difficulties of designing a vehicle which could meet emission standards at all altitudes, the proposed regulations do not require that all vehicles be capable of meeting standards at high altitudes, but that they be capable of meeting the standards by adjustment or modification, §86.082-8(h)(i). The flexibility in the regulation does not relieve the manufacturer of his responsibility to see that the vehicle as sold meets the standards. Because §203(a)(1) prohibits the manufacturers from selling a vehicle without a certificate of conformity to the emission standards, it is the Agency's position that if the manufacturer sells a vehicle which conforms only to low-altitude standards for principal use at a high altitude, that vehicle would not be covered by the certificate of conformity, so that the manufacturer would violate §203(a)(1). The questions which arise with respect to §86.082-30 (4)(i) and (ii) of the proposed rules arise because of the nature of the dealer/ manufacturer relationship.

The standard dealer/manufacturer arrangement is a franchise type agreement under which the manufacturer sells the vehicles to the dealer, who resells them to the ultimate consumer. The vehicle manufacturers assert that because they do not sell vehicles to the ultimate consumer that they should not be held responsible for the improper sale of vehicles, that the independent dealers should be responsible for their own actions. The use of " . . . the offering for sale, the introduction, or delivery for introduction, in commerce . . ." in §203(a)(1) strongly indicates that Congress did not intend the manufacturers to escape liability for prohibited acts through their distributor agreements. Given that Congress was aware that automobiles are primarily sold through manufacturers' dealers, the proscription of only the "sale" to the dealer -- but not to the ultimate consumer -- is illogical. Such a narrow and crabbed reading would mean that neither the manufacturer nor the dealer would be liable for the distribution and sale of non-certified cars. In addition, §203(a)(4)(A) prohibits the manufacturer from selling a vehicle which does not conform to §207(a). Section 207(a) requires the manufacturer to warrant to the <u>ultimate</u> purchaser that the vehicle will conform to the applicable regulations under §202. It is thus much more likely that Congress intended "sale" as used in §203(a) (1) to mean the sale to the ultimate consumer since that is the apparent use of the term in §207(a). Both §203(a)(1) and §203(a) (4)(A) create a duty on the manufacturer running to the ultimate consumer, not just to his dealer.

Although the manufacturer may shift the performance of the required acts to another party, the responsibility for the proper performance of the duty cannot be shifted, because §203(a)(1) and §203(a)(4)(A) place their prohibitions solely on the manufacturer. The requirement that a vehicle conform to standards creates a non-delegable duty. The doctrine of the non-delegable duty is usually applied only when violation of a duty can result in harm to an individual or the public. The public health concerns connected with air pollution certainly qualify.

In <u>U.S. vs. Ira S. Bushey & Sons, Inc.</u>, 363 F Supp 110, the court held that the public interest of preserving the environmental integrity of the waters dictated that the parent company be held liable since it profited from the operations of its subsidiary. While the facts are somewhat different the case does show that courts look behind the apparent structure of a business where the public interest is concerned to determine where liability should finally rest. In a case involving similar facts under the Food, Drug and Cosmetic Act, U.S. vs. Parfait Power Puff Company, Inc. 163 F2d 1008 (7th Cir 1947) the doctrine of the nondelegable duty was used to hold a manufacturer and distributor of hair products criminally liable for introducing an adultered and misbranded product (hair lacquer pads) into interstate commerce, when another party the defendant contracted with to manufacture and distribute the product changed the contents of the product and shipped them into interstate commerce. In holding the defendant liable, despite their orders to the other party to discontinue manufacture, the court stated that:

> "In other words, one who owes a certain duty to the public and entrusts its performance to another, whether it be an independent contractor or agent, becomes responsible criminally for the failure of the person to whom he has delegated the obligation to comply with the law, if the nonperformance of such duty is a crime. Defendant may not put into operation forces effectuating a placement in commerce of a prohibited commodity in its behalf and then claim immunity because the instrumentability it has voluntarily selected has failed to live up to the standards of the law," U.S. vs. Parfait Power Puff, 163 F2d 1008, 1009.

The situations are analogous because the liability arises under a Congressional enactment intended for the benefit and protection of the public. While Parfait Power Puff involved a criminal statute, this is not a distinguishing factor as criminal statutes are usually read more strictly than civil statutes. Thus, under the doctrine of a nondelegable duty, a manufacturer cannot use its distribution system to escape liability for violations of §§203(a) (1) and 203(a)(4) of the Clean Air Act.

In spite of the direct responsibility placed upon the manufacturers by the Clean Air Act to ensure that vehicles sold conform to emission standards, the vehicle manufacturers have stated that they feel the imposition of liability for the sale of low-altitude vehicles for primary use at a high altitude holds them vicariously liable for the actions of their independent dealers. The essence of vicarious liability is the imputation of fault upon a person who otherwise is faultless. This imputed negligence is founded upon the existence of some relationship between the parties, such as the relationship between master and servant or employer and employee.

The manufacturers have stated that no such relationship exists between themselves and their dealers; that the dealers are independent businessmen over whom the manufacturers have no control. The courts have tended to agree that no agency relation exists between the auto manufacturers and their dealers for general purposes, based on a theory of "right to control". Anson v. General Motors Corporation, 337 F. Supp. 209, 213 (ND Ohio 1974). When it has been demonstrated that the manufacturer has a right to control a specific area of performance, such as the making of repairs or predelivery service, a limited agency relation has been found. Yale & Tonn, Inc. v. Sharpe, 118 GA App 480, 104 S.E.2d 318, 323, 324 (Ga: Ct. App. 1968) (making repairs); Ford Motor Company v. Pittman, 227 So.2d 246, 250 Fla. Dist. Ct. App. 1969) (no delivery service check).

The manufacturers should be able to exert control over the sale of vehicles configured for low altitude for high-altitude use, either through sanctions on the dealers for violations, or some sort of indemnification arrangement should the dealer not conform to the manufacturer's procedures. In addition, the manufacturers will have to dictate how the modifications and adjustments are to be made, which will entail a large measure of control. Because of the limited agency relationship, the vehicle manufacturers (the principal) will be liable for the actions of the dealers (the agents).

Even if the dealers are not the agents of the manufacturers for the sale of low-altitude vehicles for high-altitude use, holding the vehicle manufacturers vicariously liable for such a sale is not necessarily impermissible. Although several recent cases have invalidated EPA assignments of vicarious liability, they are factually distinguishable, and involve different statutes. Vicarious liability was deemed unacceptable in Amoco Oil Co. v. EPA (Amoco I), 501 F2d 722 (1974) because the regulation imposed liability by an irrebuttable presumption. In that case, Amoco challenged new regulations which would hold the refiner liable for the sale of gasoline contaminated with lead from a pump normally used to dispense unleaded gasoline. The court felt the regulation should provide an opportunity to show that the contamination of the gasoline resulted from an unforeseeable act of vandalism by a third party or from an unpreventable breach of contract by a distributor (501 F2d at 748), but otherwise did not question the validity of holding the refiner vicariously liable.

EPA revised the regulation in question to reflect the decision in Amoco I and the new regulation was challenged in Amoco Oil Co. v. EPA (Amoco II), 543 F2d 270 (1976). In striking down the regulation the court stated that:

> "In the absence of any indication of a specific intention on the part of Congress to create a 'new tort' the traditional common law rules of vicarious liability must apply" (543 F2d at 275).

The traditional common law rule is that there must be a closely integrated relationship existing between the person to be held vicariously liable and the negligent party, the essence of which is control of the acts of the negligent party (543 F2d at 276). The court then looked at the traditional lessee-lessor relation and determined that Amoco could not be held liable for the actions of its tenant under the Common Law. The court was careful to state however that they were "... not prepared to raise the general rule as a complete bar to refiner liability..." Amoco II at 276.

The proposed high-altitude regulations are distinguishable from the regulations promulgated under §211(c)(1)(B) of the Clean Air Act and which were held invalid in Amoco I and II. Section 211 (c)(1)(B) provides that the administrator may regulate the sale of any fuel additive which would impair the performance of any emission control system or device. The language of the Clean Air Act does not mention or place any express obligations or restrictions on the refiners. Sections 203(a)(1) and (a)(4) and 207(a) do place express obligations on the manufacturers to see that they sell only certified vehicles. Sale of an uncertified vehicle is in essence a "new tort" created by Congress to place liability on the manufacturer. It is especially important to keep in mind that EPA could require all vehicles to meet standards at high altitudes without modification.

In Amoco v. U.S., 450 F. Supp. 185 (W.D. Mo. 1978) the court disagreed with EPA's interpretation of its own regulation and found that the refiner was not a retailer simply because it leased the premises to the actual retailer. The court found that because of EPA's interpretation of the regulation it was, in effect, holding Amoco vicariously liable under the same circumstances as Amoco II without the further justification for its actions found in the vehicle certification requirements as discussed above.

The most recent decision of Chrysler Corporation v. EPA, 600 F2d 904 (DC Cir. 1979) which invalidated EPA regulations promulgated under the Noise Control Act is also distinguishable. Unlike the statute involved in Chrysler, Congress here clearly expressed its intent that the vehicle manufacturer be held liable for selling uncertified vehicles in §§203(a)(1), 203(a)(4) and 207(a). By contrasts in the Chrysler case, the regulations placed warranty liability on the manufacturer of an unfinished truck for work performed by a subsequent manufacturer who completes the truck. Besides not finding any authority in the Noise Control Act of 1972, the court noted that the legislative history expressly stated that the manufacturer was to be liable only for changes in noise emissions which were in fact in each manufacturers' control. The proposed high-altitude regulations require that the manufacturer be liable only for his own vehicles and for the modifications and instructions done to his specifications.

EPA has concluded that the requirement of the proposal whereby the manufacturer must affix a label to high-altitude vehicles stating that the vehicle was sold to the ultimate purchaser for principal use a high altitude is legal and appropriate. EPA recognized, however, that in certain instances, the manufacturer may not know the ultimate destination of a specific vehicle.

Due to consumer demand, some low altitude vehicles may be modified by dealerships to comply with the certified high altitude configuration (and thereby retain the certificates). The Agency has therefore revised the regulations to allow a dealer to perform these modifications and then to affix a label stating the vehicle has now been modified for principal use in a high altitude location. However, it should be emphasized that in making the necessary modifications and affixing the high altitude label, the dealer is merely acting on the manufacturer's behalf. The manufacturer is still responsible for assuring that the vehicle is in the configuration appropriate for the destination of its ultimate use and that the vehicle bears a label consistent with that destination.

One other point raised by the vehicle manufacturers is that §207 (h)(1) of the Clean Air Act requires the dealer to furnish the purchaser with a certificate that the vehicle conforms to the applicable regulations under §202. While this section does place a duty onto the dealer, there is no reason why that should release the vehicle manufacturers of their duty to also certify the vehicles as required by §203.

4. Recall Authority. Paragraphs (h) of §86.082-8 and (h) of §86.082-9 require that all light-duty vehicles (LDVs) and most light-duty trucks (LDTs) must be capable of complying with both the low and high-altitude emission standards, "by initial design, adjustment, or modification," with a possible waiver of this requirement for certain low-power, high fuel economy LDVs. Accordingly, certificates of conformity certify compliance with both low and high-altitude emission standards (§86.082-30(a)(3)).

EPA may perform surveys of in-use high-altitude vehicles to determine whether they conform to regulations prescribed under section 202 throughout their useful lives. Since the high-altitude regulations are being promulgated under the authority of sections 202(a) and 202(f), a manufacturer whose in-use vehicles do not comply with these regulations may be ordered to remedy nonconforming vehicles when it can be determined, from available information, that a substantial number of properly maintained and used in-use vehicles do not comply with these section 202 regulations. One of the regulatory requirements, as stated previously, is that all LDVs and LDTs (except that certain low-powered vehicles may be exempted) must be capable of meeting the applicable emission standards for any altitude of operation.

If in-use testing at high altitudes indicates that a substantial number of vehicles in use at high altitudes do not comply with high-altitude standards, a recall order may be issued for the high-altitude vehicles. However, testing conducted at high altitudes on high-altitude vehicles may not warrant the recall of low-altitude vehicles. Action to recall low-altitude vehicles would be appropriate only when the Administrator could determine from the high-altitude data that low-altitude vehicles did not comply with section 202 requirements for low-altitude vehicles.

However, circumstances can be foreseen where testing at high altitudes may warrant a recall of low-altitude vehicles. This action would be appropriate, for example, when a defect in design or materials existed in a component (e.g., a malfunctioning three-way catalyst) which was necessary to assure vehicle compliance at either altitude.

A similar analysis could be made of the issue of whether low-altitude testing would predict that high-altitude vehicles operating at high altitudes were failing to comply with the section 202 requirements and, therefore, warrant the recall of high-altitude vehicles.

5. EPA Has Not Met Statutory Requirements for Standards. Chrysler correctly pointed out in their written comments that section 202(f) of the Clean Air Act permits EPA to promulgate interim high-altitude standards only after the Administrator has considered and made a finding with respect to: (1) economic impact, (2) availability of emission control hardware, and (3) the likelihood that any significant improvement in air quality will result.

All three of these issues were specifically addressed in the draft Regulatory Analysis which was prepared as a support document for the proposed standards. These issues were further discussed in the Preamble of the proposal. For the final rulemaking, these issues will be again analyzed and made available for public review. Therefore, the Administrator has met the conditions of section 202(f) for promulgating high-altitude standards for 1982 and 1983 model year light-duty motor vehicles.

6. Low Altitude Sale of High-Altitude Vehicles. After further consideration, EPA agrees with Ford that the low-altitude sale of vehicles that are designed or modified for sale at high altitude would be in violation of section 203(a)(1) of the Act. In the NPRM EPA stated that the sale of high-altitude vehicles at low altitude would be legal. However, Ford's comment correctly pointed out that sections 207(b) and (c) of the Act allow that recall or performance warranty protection may only be undertaken upon making the determination that vehicles are in noncompliance with applicable standards. Therefore, the Agency could not require recall or performance warranty action if such vehicles were found to be in noncompliance with the low-altitude standards if the Agency were to allow the sale of high-altitude vehicles at low altitude.

The possibility does exist that high-altitude vehicles operating at low altitude would not meet the low-altitude standards, especially the NOx standard. Hence, it would be illegal for EPA to allow the sale of high-altitude vehicles at low altitude anyway because such vehicles may not meet the statutory requirements. In the proposal, EPA believed that a low-altitude consumer who lived at an altitude that approached the official 4,000 foot cut-off point between high and low altitudes would be better off concerning fuel economy, performance, and HC and CO emissions if he were to operate a high-altitude vehicle rather than a low-altitude vehicle. However, since the possibility exists that not only would these "fringe area" low-altitude consumers buy high-altitude vehicles but many consumers who live at very low altitudes would buy high-altitude vehicles, the Agency has concluded that the change to the Final Rule is necessary.

Recommendation

It is recommended that low-altitude vehicles be sold at low altitude only and that high-altitude vehicles be sold at high altitude only. In view of the revocation of the $40 maximum allowable charge, it is recommended that no other changes be made in this Final Rule.

M. Issue: Parameter Adjustment

Summary of Issue

In the proposal EPA anticipated that some manufacturers might be concerned about the effect of the parameter adjustment regulations on compliance with the proposed high-altitude regulations. EPA admitted that the parameter adjustment requirements might increase the costs of high-altitude compliance, but otherwise found the two sets of regulations to be compatible.

Summary of Comments

Many commenters argued that the parameter adjustment regulations would make compliance with the proposed high-altitude regulations more difficult and expensive. One commenter expressed concern over whether vehicles that were certified as high-altitude vehicles at 5,400 feet and which had sealed parameters would perform satisfactorily and meet emissions requirements at lower high-altitude elevations (e.g., 4,200 feet).

Major Subissues

1. Possible Conflict Between High-Altitude and Parameter Adjustment Regulations. Many commenters argued that the parameter adjustment regulations, which begin to take effect in 1981, would make it more difficult and expensive to comply with the proposed high-altitude regulations.

2. High-Altitude Areas Near 4000 Feet. One commenter inquired into the assurances EPA had that vehicles with sealed parameters that met high-altitude certification requirements at 5,400 feet (Denver) would also perform satisfactorily and meet emissions requirements at lower elevations which are still defined as high altitude (e.g., 4,200 feet).

Analysis of Comments

1. Possible Conflict Between High-Altitude and Parameter Adjustment Regulations. Beginning with the 1981 model year, LDV and LDT manufacturers must comply with "parameter adjustment" regulations (44 *Federal Register* 2960). The parameter adjustment regulations will permit EPA, and require manufacturers, to test vehicles with their engines adjusted to any combination of settings within the physically adjustable ranges of their adjustable parameters, as opposed to the previous practice of setting those adjustable parameters to the manufacturer's specifications. For gasoline-fueled LDV's and LDT's with carburetion systems, idle air/fuel mixture and choke valve action (e.g., bimetal spring tension and vacuum pull-off adjustments) will be subject to EPA adjustment beginning with the 1981 model year, and idle speed and initial spark timing will be subject to adjustment beginning with

the 1982 model year. Gasoline-fueled LDV's and LDT's with fuel injection systems will follow the same schedule, except that choke parameters will not be affected. There is as yet no schedule for adjusting specific parameters on diesel-powered LDV's and LDT's. These schedules do not exclude the possibility of EPA determining other engine parameters to be subject to the parameter adjustment regulations in subsequent model years, though EPA is required to give manufacturers adequate notice before determining additional parameters to be subject to adjustment.

There are several actions manufacturers may take to facilitate compliance with the parameter adjustment regulations; it is anticipated that many manufacturers will simply choose to either narrow the physically adjustable ranges of certain parameters or else make them entirely nonadjustable (i.e., "fix" or "seal" them). Parameters which potentially need no adjustment during a vehicle's life, such as idle mixture and choke valve action, are likely to be fixed or sealed by many manufacturers, while parameters which do often require adjustment in service, such as idle speed and initial spark timing, will likely have their physically adjustable ranges narrowed.

It is likely, however, that some of the parameters which are limited or sealed due to the parameter adjustment regulations might be some of the same parameters that would be adjusted or recalibrated by some manufacturer in order to comply with the 1982/1983 high-altitude standards. This is really only a problem for non-original equipment high-altitude vehicles which might have to be recalibrated (due to a dealer trade for example). Idle mixture, choke bimetal spring tension, and ignition timing are parameters which might both be affected by the parameter adjustment regulations and part of the recalibration recommended by manufacturers for high-altitude vehicles. It is certainly plausible that in the absence of parameter adjustment regulations, these parameters could be allowed enough variance such that recalibration to high altitude could be performed simply and cheaply, while the existence of parameter adjustment regulations would make such recalibrations more difficult and costly. EPA has recognized this situation; in the NPRM EPA stated that "the two sets of regulations are completely compatible, although the existence of parameter adjustment regulations may increase the cost of the high-altitude regulations in some instances."

No commenter disagreed with EPA's conclusion that the parameter adjustment and high-altitude concepts are compatible. A number of commenters did argue, however, that the constraints imposed by the parameter adjustment regulations would prohibit the manufacturers from providing the requisite high-altitude modifications for less than the $40 maximum charge proposed in the NPRM. It was pointed out that, according to the parameter adjustment regulations, parameter adjustments cannot be approved if they can be defeated in less than 30 minutes or for less than $20. If one adjustment must cost at least $20, there is little else that could be done and still keep the charge under the $40 maximum proposed in the NPRM. If at least two such parameters had to be adjusted to meet the high-altitude standards, then by definition the $40 maximum charge would be exceeded.

EPA agrees that the monetary restrictions imposed by both the parameter adjustment and proposed high-altitude regulations would make compliance by manufacturers with the latter very difficult. Thus, despite the fact that we consider it unlikely that manufacturers will choose to comply with the high-altitude regulations by recalibration of parameters outside of their physically adjustable ranges (unlikely except in the case of dealer trades), this is yet another reason why EPA determined the $40 maximum charge to be undesirable. EPA has thus decided to remove the $40 maximum charge from the regulations.

2. High-Altitude Areas Near 4000 Feet. It must be emphasized again that EPA expects the great majority of 1982 and 1983 LDV's to employ three-way catalytic converters with oxygen-sensor feedback control over the carburetor air-fuel ratio. Many of these vehicles will not require any high-altitude modifications and should meet emissions standards (and should have acceptable performance and driveability) over a wide range of elevations. It is anticipated that some LDV's and all LDT's will not utilize three-way systems in 1982 and 1983. EPA expects most (if not all) of these non-three-way catalyst vehicles and some three-way catalyst vehicles to utilize aneroid (pressure sensing) devices to meet high-altitude requirements. Because most aneroids act as automatic altitude compensating devices, again the stated concern would not be relevant. In fact, the commenter's concern applies only to the few (if any) vehicles which would require either recalibration of engine parameters outside of their physically adjustable ranges, separate high-altitude parts. It is true that such high-altitude vehicles would have somewhat different emissions and performance characteristics at, say, 4,200 feet than they would at the high-altitude certification elevation of 5,400 feet. And if certain parameters were sealed, field adjustment would be more difficult.

There is no problem in this regard with HC and CO emissions, of course, since it is well known that lower elevations promote leaner mixtures and lower HC and CO levels. Leaner mixtures do, however, produce higher NOx levels. The recent MVMA high-altitude baseline program found that 1970 vehicles tested in St. Louis (520 feet) emitted approximately 87 percent more NOx than the same vehicles tested in Denver (5,490 feet). Assuming a linear relationship between the percentage NOx increase and altitude, one might expect about a 21 percent increase in NOx emissions going from 5,400 feet to 4,200 feet. Of course, it must be noted that these were 1970 vehicles not designed with high-altitude emissions performance in mind. In its April 7, 1980 supplement to its comments on the high-altitude NPRM, GM reported relevant data on four of its 1977 high-altitude cars which required certification at high altitude. One car that was tested at Milford, Michigan

(950 feet) and in an altitude chamber (5,000 feet) recorded a NOx level 63 percent higher lower at Milford than at 5,000 feet, while a second vehicle emitted 8 percent less NOx at Milford when compared to its emissions in the altitude chamber. The third vehicle was tested at Milford and at Denver and recorded 1 percent higher NOx emissions at Milford. A fourth vehicle was tested at Milford, Denver, and in an altitude chamber and the results were inconsistent. The NOx emissions at Milford were 58 percent higher than at Denver but 9 percent lower than in the altitude chamber. No explanation was given by GM for this inconsistent data. It would seem from these data which represent special 1977 high-altitude vehicles that the NOx emission increases for specially-designed, high-altitude vehicles at lower elevations are somewhat lower and less predictable than the MVMA data would indicate. In conclusion, EPA agrees that it is very probable that 1982/1983 high-altitude vehicles certified in Denver will have somewhat higher NOx levels at high-altitude elevations nearer 4,000 feet; we would expect the increases to average on the order of 10 to 20 percent. This is unfortunate, but we see no easy solution. Similar situations exist at low altitude; for example, a vehicle certified at Ann Arbor (850 feet) would emit greater NOx levels when driven at or nearer sea level. But these emissions increases are not excessive. As the LDV and LDT fleets become dominated by three-way catalyst emission control systems, such problems will disappear.

With regard to vehicle performance and/or driveability the discussion is somewhat more straightforward. Defining acceptable performance and driveability is the manufacturer's prerogative; EPA does not involve itself in such judgments. Clearly, no manufacturer would attempt to sell vehicles at 4,200 feet that did not have acceptable performance and driveability. While the change in altitude from 5,400 feet to 4,200 feet would indeed cause leaner combustion on non-altitude compensating vehicles, we are relatively certain that the effects on performance and driveability would be minor. In the same submission referenced above, regarding its special 1977 high-altitude vehicles, GM stated that "in no case did General Motors release for production a high-altitude engine which we felt was commercially unacceptable at sea level." If GM found no major performance or driveability problems with its 1977 high-altitude vehicles at sea level, we would anticipate no problems whatsoever with 1982/1983 high-altitude vehicles at 4,200 feet. It is true that the emissions standards have become more stringent since 1977, but on the other hand emission control systems have also become much more sophisticated.

Recommendation

In view of the fact that EPA has already decided to remove the $40 maximum allowable charge, it is recommended that no additional action be taken.

N. Issue: Fuel Economy

Summary of Issue

In the NPRM, EPA did not claim that there would be any effect of the high-altitude regulations on fuel economy.

Summary of Comments

A few commenters argued that it would not be possible to modify certain high fuel economy vehicles to meet the proposed high-altitude standards. Others commented that to do so would require major modifications which could degrade fuel economy, and because of the proposed $40 maximum charge, such vehicles might be prohibited from being sold at both high and low altitudes. Finally, very few comments (and almost no data) were received as to the fuel economy effects of the types of modifications which EPA expects to be utilized to meet the high-altitude standards.

Major Subissues

1. Modifiability of High Fuel Economy Vehicles. A few commenters argued that it will not be possible to modify some high fuel economy vehicles to meet the proposed high-altitude standards, or else that such vehicles would require a major modification such as an axle ratio change. Accordingly, some high fuel economy vehicles might be prohibited from sale at high altitude, or would only be available in slightly less fuel efficient configurations. In addition, because of the proposed $40 maximum modification charge, many vehicles requiring an axle change to comply with the standards might also be prohibited from sale at low altitudes as well. All of these conditions would lower a manufacturer's corporate average fuel economy.

2. Effect of High-Altitude Modifications on Fuel Economy in General. Many comments were received on the general question of the effect of the high-altitude regulations on fuel economy. In other words, given that most (or all) vehicles will be able to meet the high-altitude standards without major design changes, will the high-altitude modifications increase or decrease fuel economy?

Analysis of Comments

1. Modifiability of High Fuel Economy Vehicles. The manufacturers which claimed that some of their vehicles could not be modified at all, or without major changes, to meet the proposed standards did not supply data to support their positions. Without such data, it is impossible for EPA to completely evaluate their claims.

First, examining the question of fuel economy at high altitude, as discussed elsewhere (see Technology Issue) EPA has concluded that most types of vehicles now sold in high-altitude areas are capable of being modified to meet the high-altitude standards without major modifications (like axle ratio changes) that might negatively impact fuel economy. EPA recognizes that there is a remote possibility that some high fuel economy vehicles might not be able to comply with the high-altitude standards, but these are generally the same low-power vehicles which are not now normally sold at high altitude due to performance limitations. Thus, EPA disagrees with those manufacturers which claimed that their corporate average fuel economy at high altitudes would be negatively impacted by these regulations.

With respect to the fuel economy of manufacturers' low-altitude fleets, EPA is convinced that these regulations will have no effect whatsoever. The availability of exemptions for certain low-power vehicles will enable the manufacturers to market certain high fuel economy vehicles at low altitude that possibly could not certify to the high-altitude standards. And the revocation of the $40 maximum charge eliminates the possibility that a manufacturer would be prohibited from selling vehicles at low altitude because of an excess cost for high-altitude modifications.

2. Effect of High-Altitude Modifications on Fuel Economy in General. Having dismissed the above argument that major vehicle modification or availability problems would reduce average fuel economy at either high or low altitude, the issue remains as to whether the types of modifications we expect to be used to comply with the high-altitude standards would have a zero or positive effect on fuel economy.

The basic parameter of interest with respect to altitude changes is the air/fuel ratio of the combustion chamber mixture (determined primarily by the carburetor or injection pump in the gasoline-fueled engine and primarily by the injection pump in the diesel-fueled engine). For each vehicle, the manufacturer identifies the optimum air/fuel ratio for optimization of emissions, fuel economy, driveability, performance, etc. As the altitude of the vehicle increases, and the atmospheric pressure decreases, less air will necessarily enter the combustion chamber. Unless compensated for, the engine will thus have a lower air/fuel ratio (a "richer mixture") and will suffer higher hydrocarbon and carbon monoxide emissions, and typically worse fuel economy. As discussed elsewhere, some manufacturers are expected to utilize three-way catalytic converters with oxygen sensor feedback systems by 1982 which, in varying degrees, compensate for altitude changes. Other manufacturers, who are not expected to use these systems, will definitely need to make minor changes, such as the addition of aneroid carburetors, adjustments of idle mixture, spark timing, choke, etc. Spark timing, in particular, can have an important effect on fuel economy. At high altitudes, where NOx emissions are naturally lower, there exists the ability to advance the timing to improve fuel economy.

Generally, the net results of the modifications which manufacturers are expected to adopt will be an increase in the air/fuel ratio (a "leaner mixture") to one that is as close to the optimized air/fuel ratio as possible. This would be expected to increase fuel economy. Again, the manufacturers provided very little data relevant to this issue. In fact, their written comments practically ignored this issue and EPA had to rely on questioning at the public hearing to obtain the opinions of several manufacturers. These voluntary decisions to ignore the effects of the proposed regulations on fuel economy, at a time when fuel economy is such a critical issue to the manufacturers (both because of rising fuel economy standards and because of market demand for more fuel efficient vehicles) are, at the least, interesting.

American Motors Corporation (AMC) and General Motors (GM) were two manufacturers which ignored this issue in their written comments but which were asked to respond at the public hearings. AMC admitted that it was possible that the addition of an aneroid (to adjust the timing) would improve fuel economy. GM stated, "[I]f you use the barometric sensor to adjust the spark and timing, that should result in a fuel economy advantage to the consumer." Asked to quantify the fuel economy benefit, they estimated it to be 2.7 to 2.8 percent. EPA would expect the same type of fuel economy benefit due to fixed calibration changes for high-altitude vehicles.

Ford also declined to comment directly on this issue, presumably because they predicted they would need major design modifications to comply with the proposed standards. In their written comments submitted at the public hearing, however, within the context of a discussion of octane requirements at high altitude, Ford provides a little insight into their position. To quote: "1979 truck data indicate that unique calibrations using aneroid fuel metering and spark advance devices improve driveability, improve wide open throttle acceleration times by as much as 7 percent, and improve steady state fuel economy by as much as 16 percent versus the non-aneroid system. Nevertheless, the octane quality of fuel available at high altitude caused the deletion of the 6° [spark] advance feature. This resulted in a 2 percent loss in performance and loss of most of the fuel economy benefit of the combined altitude compensating devices" (emphasis added). Thus, while discussing the problems their engines may have with lower octane fuels, they also pointed out the possible fuel economy benefits of aneroid systems. More evidence of Ford's position on this issue has been found in "A Special Message to Ford Division Dealership Personnel" dated November, 1979. In discussing the merits of their "Special High Altitude Performance Package", which features a special altitude-compensating carburetor, they reported that a series of LDT tests at altitudes of 600, 1900, 5200, 8000, and 14,200 feet resulted in an average 10.7 percent improvement in fuel economy at a steady speed of 55 mph with the high-altitude package. It is clear from Ford's statements in this "message" that they consider their high-altitude packages to improve fuel economy.

Finally, EPA consulted the recent MVMA high-altitude baseline program (draft SAE paper by J.B. Edwards, et al, June 11, 1979). Twenty-five 1970 vehicles were adjusted to manufacturers' specifications and tested at St Louis (elevation 520 feet), tested at Aurora, Colorado (elevation 5490 feet) as received (thus, still calibrated to low-altitude conditions) and adjusted to manufacturers' specifications and tested again at Aurora. The relevant comparison involves the testing at Aurora before (which could represent a vehicle calibrated at low altitude but operated at high altitude) and after (which could represent a "controlled" high-altitude vehicle) readjustment to manufacturers' specifications. The average fuel economy of the 25 vehicles was 2.4 percent greater after readjustment to specifications than before, again indicating that high-altitude modifications which would tend to recalibrate engine parameters (especially air/fuel ratio) as close to ideal conditions as possible would likely increase fuel economy.

In conclusion, it appears that there will be a slight fuel economy benefit associated with these regulations. The very limited data available to EPA indicate that the benefit might be in the 2 to 3 percent range for vehicles which presently have no altitude compensation. But many vehicles already have some type of altitude compensation or else altitude compensation options, so the fleetwide fuel economy benefit would be some fraction of the range quoted above. Based on the very limited data base and the uncertainties involved, EPA will not enumerate any fuel economy benefit and will not credit any monetary savings to better fuel economy. EPA does expect, however, that there will be a small fuel economy benefit from better high-altitude emissions performance.

Recommendation

Although EPA does expect a slight fuel economy benefit as a result of these regulations, it is recommended that EPA not attempt to quantify any fuel economy benefit nor any resulting monetary savings.