FINAL

REGULATORY ANALYSIS

ENVIRONMENTAL AND ECONOMIC IMPACT STATEMENT
FOR THE 1982 AND 1983 MODEL YEAR
HIGH-ALTITUDE MOTOR VEHICLE EMISSION STANDARDS

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

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REGULATORY ANALYSIS AND ENVIRONMENTAL IMPACT OF

FINAL EMISSION REGULATIONS FOR 1982 and 1983

MODEL YEAR HIGH-ALTITUDE MOTOR VEHICLES

PREPARED BY

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 Regulatory Analysis 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 costs and benefits of the high-altitude regulations are not significantly reduced. For this reason, 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.

Note

This document has been prepared in satisfaction of the Regulatory Analysis required by Executive Order 12044 and the Economic Impact Assessment required by Section 317 of the amended Clean Air Act. This document also contains an Environmental Impact Statement for the Final Rulemaking Action.

DEFINITION OF TERMS

Cars emit three major polluting gases - carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx).

Carbon monoxide is a colorless, odorless, poisonous gas produced by the imcomplete burning of fuels. CO reduces the oxygen available to the brain and body cells. In particular, CO puts an extra burden on the heart and lungs.

Hydrocarbons and oxides of nitrogen react together in the presence of sunlight to form photochemical oxidants (smog). Ozone, the main constituent of photochemical smog causes irritation to the eyes and mucuous membranes and aggravates existing respiratory illness.

Levels of carbon monoxide and oxidants in the atmosphere above the minimum health standards can cause severe health problems among children, the aged, and those with respiratory and heart ailments.

Current EPA 1/ regulations, and proposed regulations, define some key terms used in this analysis as follows:

Light-Duty Vehicle (LDV) - A passenger car or passenger car derivative capable of seating 12 passengers or less.

Light-Duty Truck (LDT) - Any motor vehicle rated at 8,500 pounds Gross Vehicle Weight (GVW) or less, and under 6,000 pounds vehicle curb weight which is designed primarily for the transportation of property, or for the transportation of people and has a capacity of more than 12 people, or is available with special features enabling off-street or off-highway operation and use.

Heavy-Duty Vehicle (HDV) - Any motor vehicle rated at more than 8,500 pounds GVW or more than 6,000 pounds vehicle curb weight.

Gross Vehicle Weight (GVW) - The loaded weight of a single vehicle as assigned by the manufacturer.

Vehicle Curb Weight - Actual, or the manufacturer's estimated weight of the vehicle ready for operation with all standard equipment, the weight of fuel at nominal tank capacity, and the weight of optional equipment.

High-Altitude - Any elevation over 1,219 meters (4,000 feet).

1/ Code of Federal Regulations, Title 40, parts 86.007-2 and 86.079-2.

High-Altitude Reference Point - An elevation of 1,620 meters (5,040 feet) plus or minus 100 meters (330 feet), or equivalent observed barometric test conditions of 82 kPa (24.2 inches Hg), plus or minus 1 kPa (0.30 inches Hg).

Table of Contents

CHAPTER I

INTRODUCTION

Conventionally carbureted motor vehicles will emit more grams per mile of hydrocarbons (HC) and carbon monoxide (CO) at high altitudes than at low altitudes. This phenomenon is attributable to the lower air density found at high altitude as compared to low altitude. A naturally aspirated gasoline-fueled engine draws air through the carburetor. It is the volume of this air flow as it passes through the venturi that regulates the flow of fuel. Since the volume of air drawn through the carburetor remains about the same at either low or high altitude, the flow of fuel remains the same also. However, the mass of air is less per unit volume at high altitudes than at low altitudes. Therefore, while the fuel flow remains constant, the amount of oxygen decreases with increasing altitude and a richer mixture results. In a rich mixture there is not enough oxygen to fully burn the fuel so emissions of HC and CO increase. Light-duty vehicles (LDVs) and light-duty trucks (LDTs) typically emit at least 50% more HC and at least 100% more CO at high altitudes than they do at low altitudes. These high emission rates significantly add to air pollution in high-altitude areas.

A. Public Opinion

A 1977 report1/ to EPA, Region VIII found that to the Denver region's residents "environmental problems taken collectively, constitute the major impediment to the enjoyment of the good life in Denver." The study found that:

> Air Quality is generally perceived as Denver's most severe environmental problem. Air and water pollution were indicated as the major regional problems in opinion surveys conducted by a Denver television station in the spring of 1973, and in the survey conducted in late 1973 for the United Bank of Denver.2/ The latter survey found that 47% of the sampled population believe air quality to be a major problem facing the Denver region; younger respondents (25-34 years old) were more likely than other age groups to hold this view, while members of minority groups tended to find such problems as crime and the cost of living more severe than environmental problems. Nearly two-thirds of the respondents antiticipated further deterioration in air quality over the succeeding five years.

The 1976 voter surveys3/4/ also found air quality to be a major issue. The Denver Urban Observatory survey found 81% of the electorate believe air pollution was a very serious (52%), or fairly serious (29%) problem; services for the elderly was the only other issue of as great concern. The Denver Metropolitan Study reported that a total of 57% of the voters find air pollution a very serious problem, which was the highest level of concern reported for any problem.

These opinions of a random sample of residents/voters are supported in EPA's workshop and newspaper questionnaires. Air quality was the topic on which workshop participants were most likely to express dissatisfaction with current environmental programs, with over 77 percent expressing that view. As far as the likely future effects of regional growth are concerned, 87 percent of the citizens responding to a newspaper questionnaire found air quality to have a very significant growth impact, and about 40% found air quality to be the most important single influence on growth.

B. 1977 High-Altitude Program

In recognition of the air pollution problems in high-altitude areas, EPA promulgated regulations for 1977 which required all dealerships in high-altitude counties to sell only those LDVs and LDTs that were certified to meet the high-altitude standards. These standards were 1.5 g/mi HC, 15 g/mi CO, and 2.0 g/mi NOx for LDVs and 2.0 g/mi HC, 20 g/mi CO, and 3.1 g/mi NOx for LDTs (the same as the 1977 low-altitude standards).

As a result of these regulations automobile and light truck manufacturers did not certify approximately 50 percent of the low-altitude configurations for high-altitude sale. They apparently projected that the added expense to develop and certify these configurations for high-altitude would not be recovered due to the small sales volume. High-altitude sales average about 3.5 percent of national sales for LDVs and about 5.5 percent of national sales for LDTs. However, the high-altitude sales as a percent of national sales are much less for some configurations. These lower selling configurations were the ones not offered at high-altitude during the 1977 model year.

This lack of model availability caused some dissatisfaction among consumers and dealerships alike. High-altitude consumers found that the dealership(s) in their area did not carry some of the nationally advertised car models. Some of these dissatisfied customers bought another model. However, some bought the model they originally wanted from a low-altitude dealership, thus circumventing the intent of the 1977 model year regulation.

Dealerships complained that their customers were accusing them of bait-and-switch tactics and that it was difficult to explain to these customers the reasons why a nationally advertised model was not available in high-altitude areas. Because of this, the dealerships felt customer complaints increased and some sales were lost.

Another problem the dealerships complained about was that "dealer trades" suffered. Customers often prefer a certain color and options package when they buy a new vehicle. Many dealers trade with other dealers when they receive an order which can not be filled with a vehicle on their lot. If the other dealer was located at low-altitude, then trading between the dealers may have been preempted by the 1977 model year regulation.

A more detailed discussion of the problems and economic impact of the 1977 regulations can be found in Chapter IV of this document. Primarily because of the problems encountered by high-altitude dealers, Congress addressed the 1977 model year regulations in the Clean Air Act amendments of 1977.

C. Clean Air Act Amendments of 1977

With the passage of the Clean Air Act Amendments of 1977, the Congress vacated the Environmental Protection Agency (EPA) high-altitude regulations, but authorized EPA to reestablish high-altitude requirements no sooner than the 1981 model year in Section 202(f) of the amended Clean Air Act. The Congress further provided that any emission standards established in such regulations may not require a percentage reduction in emissions from the high-altitude baseline which exceeds the comparable percentage reduction in emission required by Section 202(b) for vehicles at low-altitude. This proposed regulatory action would establish the interim high-altitude emission standards, and corollary certification requirements, contemplated by Section 202(f) through model year 1983. (Beginning in 1984, the amended Clean Air Act requires that vehicles must comply with Section 202(b) standards at all altitudes.) This document is intended to fulfill the following requirements:

1. Clean Air Act Required Specific Findings - Section 202(f)(3)(A-C)

A. The economic impact on consumers, individual high-altitude dealers, and the automobile industry, including an economic assessment of the high-altitude regulations in effect during the 1977 model year.

B. The present and future availability of emission control technology capable of meeting emission requirements without reducing model availability.

C. The likelihood that adoption of a high-altitude regulation will result in any significant improvement in air quality in any significant improvement in air quality in any area to which it will apply.

2. Impact Statements - EPA Regulations Require An Environmental Impact Statement and Economic Impact Assessment

The severity of the air pollution problems in the larger, high-altitude cities dictates the need for the regulation. According to the Council on Environmental Quality, Denver was second only to Los Angeles in the number of days in 1975 when national ambient air quality standards were violated. Albuquerque was tied for third. Denver, Salt Lake City, and Albuquerque are rapidly growing, automobile-oriented cities. The meteorological conditions for these cities, frequent winter inversions and abundant summer sunshine, in combination with the high-altitude and extensive dependence on the automobile, results in air quality problems that belie the size of the cities. (Denver, largest of the three, is only the 24th largest metropolitan area in the nation.) It is important that the emission control systems used on high-altitude vehicles be designed and calibrated to operate as efficiently as possible to reduce the severity of high-altitude air quality problems.

References

1/ "Attitude of Denver Region Residents on Environmental Issues," Gruen, Gruen and Associates in cooperation with Engineering-Science, Inc., and EPA Region VIII, 1977.

2/ Bickert, Browne, Coddington and Associates' survey for United Bank of Denver. Personal interviews with 517 randomly selected residents of a five county region, 1974.

3/ Denver Urban Observatory survey by Warren Weston et al, of 1090 randomly selected voters, 1976.

4/ Denver Metropolitan Study, National Academy of Public Administration survey of 627 randomly selected voters in Denver, Adams, Arapahoe and Jefferson counties, September, 1976.

CHAPTER II

DESCRIPTION OF LDV AND LDT INDUSTRY

A. Definition of Product

A light-duty vehicle (LDV) is currently defined as a passenger car or passenger car derivative capable of seating 12 passengers or less.

A light-duty truck (LDT) is any motor vehicle rated at 8500 pounds (3546 kg) Gross Vehicle Weight Rating (GVWR) or less, has a vehicle curb weight of 6000 pounds (2722 kg) or less, has a maximum basic vehicle frontal area of 46 square feet (4.3 square meters), and is: a) designed primarily for purposes of transportation of property or is a derivative of such a vehicle, b) designed primarily for transportation of persons having a capacity of more than 12 persons or c) available with special features enabling off-street or off-highway operation and use.

B. Structure of the Industry (Production and Marketing)

U.S. manufacture of light-duty vehicles is almost entirely done by the five major motor vehicle manufacturers: General Motors, Ford Motor Company, Chrysler Corp., Volkswagen of America, and American Motor Corp. In 1979, sales of passenger cars totalled 10.7 million of which 8.3 million were of domestic origin, 0.7 million were from Canada, and 1.7 million were from foreign manufacturers. The major foreign importers were Toyota, Volkswagen, Nissan, Honda, and Fiat.

The manufacture of light-duty trucks sold in the U.S. is primarily accomplished by the major domestic passenger car producers. General Motors Corporation (Chevrolet and GMC divisions), Ford Motor Company, and Chrysler Corporation (Dodge Truck Division) all have separate truck divisions which produce light-duty as well as heavy-duty trucks. American Motors Corporation operates the Jeep division which manufactures light-duty trucks. The other major domestic manufacturer of LDT's is the International Harvester Corporation (IHC).

Some LDT's sold in the U.S. are imported. The majority of U.S. imports of trucks come from the Canadian plants operated by U.S. domestic producers. Some imports, primarily light pick-up trucks, under 4,000 pounds (1814 kg) GVWR, come from Japanese producers. The major importers are Nissan (Datsun), Toyota, Isuzu, and Toyo Kogyo. Both Toyota and British Leyland Company import utility vehicles under 6,000 lbs. (2722 kg) GVWR. Imports accounted for about 9% of all 1979 sales of trucks with a GVWR less than 8500 pounds (3856 kg) GVWR.

Table II-1 shows U.S. sales for LDV's and LDT's from 1974-1979. Most data available on LDT's are presented in a 0-10,000

Table II-1

U.S. New Car and Truck Sales, 1974-1979

Year	Cars	LDTs*
1979	10,700,000	2,900,000
1978	10,900,000	3,400,000
1977	10,800,000	2,900,000
1976	9,800,000	2,600,000
1975	8,300,000	2,000,000
1974	8,700,000	2,100,000

* Estimated.

Source: Automotive News, 1980 Market Data Book Issue; April 30, 1980.

pound (0-4536 kg) category. Since the definition of LDT's includes only vehicles up to 8,500 pound (3846 kg) GVWR, some adjustment to the 0-10,000 pound category was necessary for this analysis. The industry production data available to EPA indicates that about thirteen percent of all trucks with GVWR's less than 10,000 pounds (4536 kg) have GVWR's of more then 8,500 pounds (3856 kg). This thirteen percent figure is used in Table II-1 and throughout this analysis to adjust production data to fit the new LDT definition.

These figures represent the numbers of both domestic and imported vehicles bought by U.S. consumers in those years. Data Resources1/ estimates that national sales of LDVs will be 10.1 million in 1982 and 11.3 million in 1983. National sales of LDTs are projected to be 2.8 million in 1982 and 3.2 million in 1983.

Sales of diesel powered light-duty vehicles and trucks are still a small fraction of total production, but are steadily increasing each year. Diesel penetration into the two markets by the late 1980's has been projected to be a high as 25%. Table II-2 shows past sales and 1979 projections of diesel sales in the U.S.

U.S. light-duty vehicle and truck manufacturers operate with a fair degree of vertical integration. As is typical of many capital intensive industries, the manufacturer seeks to assure itself of some control over the quality and availability of the final product. Thus, the major manufacturing companies have acquired subsidiaries or started divisions to produce many of the parts used in the manufacture of their cars and trucks. None, however, build their vehicles without buying some equipment from independent vendors.

The vertical integration typical of passenger car and truck manufacturers extends beyond the production of the vehicle into its sale. The manufacturers establish franchised dealerships to handle retail trade and servicing of their products. Most also produce and sell the parts and accessories required to service their vehicles. Many of the truck dealerships are coupled with the passenger car dealerships. As of January 1979, there was a total of 24,051 passenger car dealerships and 22,189 truck dealerships The total truck dealerships include dealerships for heavy-duty as well as light-duty trucks, and accounts for those dealerships operating jointly with passenger car sales offices.

Table II-3 provides a breakdown of all light-duty vehicle dealerships by manufacturer and Table II-4 provides this information for truck dealerships. The "Others" category in Table II-4 includes dealerships of manufacturers that produce only heavy-duty vehicles, and also 1,211 dealerships for Plymouth which introduced the 4-wheel drive Trail Duster (an off-road utility vehicle) in 1974.

Table II-2

U.S. Sales of Diesel-Powered Light-Duty Vehicles and Trucks

Model	1976	1977	1978	1979*
Mercedes-Benz 1/				
240D	9,024	9,770	6,600	8,600
300D	12,521	11,333	16,000	15,300
300SD	-0-	-0-	5,200	9,300
VW Rabbit 2/ and Dasher	-0-	7,500	36,386	110,000
Peugeot 504D 3/	4,549	4,914	5,547	8,100
General Motors 4/				
350 Oldsmobile	-0-	-0-	35,180	118,000
350 Pick-up	-0-	-0-	16,920	31,000
260 Oldsmobile	-0-	-0-	-0-	50,000
IHC Scout 5/	970	1,237	1,231	1,000
TOTAL	27,064	34,754	123,064	351,300

* Projections.
1/ Personal communication with Martin Emberger, Mercedes-Benz, April 3, 1978.
2/ Personal communication with L.L. Nutson, Volksagen, April 4, 1978.
3/ Personal communication with Richard Lucki, Peugeot, March 1978.
4/ Personal communication with A. Lucas, General Motors, April 7, 1978.
5/ Personal communication with T.A. Jacquay, IHC, March 1978.

Table II-3

Passenger Car Dealerships by Manufacturer

Manufacturer	Total Franchises as of Jan. 1, 1979	Dealers as of Jan. 1, 1979	Unit Sales Per Outlet 1978	Unit Sales Per Outlet 1977
American Motors	1661	1661	105	112
Chrysler Corp.	9174	4786		
Chrysler	3343		89	96
Dodge	2816		158	162
Plymouth	3015		133	143
Ford Motor Co.	10190	6639		
Ford	5564		326	335
Lincoln	1642		115	112
Mercury	2948		195	172
General Motors Corp.	17210	11565		
Buick	3050		256	245
Cadillac	1635		215	207
Chevrolet	5950		394	381
Oldsmobile	3330		302	294
Pontiac	3245		277	249
TOTALS:	38235	24651		
Minus Intercorporate Dealers		600		
Net Dealers:		24051		

Source: Automotive News, 1979 Market Data Book, pp. 62,71.

Table II-4

Truck Retail Outlets by Manufacturer

Manufacturer	Outlets as of Jan. 1,1979	Unit Sales Per Outlet 1978
Ford	5648	233
Chevrolet	5939	215
GMC	2721	121
Dodge	3284	141
IHC	1675	70
American Motors	1768	93
Others	2822	---
TOTALS:	23827	24651
Adjustment for Multiple Franchises	1638	
Net Dealers:	22189	

Source: Automotive News, 1979 Market Data Book, pp. 44, 98.

C. Employment

It is estimated that about three and a half million workers are employed in the manufacturing, wholesaling and retailing of motor vehicles (passenger cars, trucks, and buses) with a total of about $53 billion in wages paid to those employees. Most employment data are aggregated for producers of all classes of cars and trucks since some production facilities manufacture both cars and trucks. Statistics show that over 14 million workers were employed in 1973 by motor vehicle related industries. The total annual payroll of these workers amounted to over $119 billion (1973). Much of this employment is centered in California, Michigan, Ohio, New York, Indiana, Illinois, Missouri, and Wisconsin.

D. High Altitude Sales

EPA has determined that approximately 3.5 percent of national LDV sales occur in high-altitude areas. For LDTs this percentage is somewhat higher (5.5) reflecting the fact that a major factor in the economy of high-altitude areas is the extensive rangeland which requires the use of pickups and four-wheel drive vehicles. The above percentages were determined from 1979 data collected by the MVMA. Applying these percentages to expected national sales for 1982 and 1983 1/ gives high-altitude sales for 1982 and 1983 as follows:

	LDVs	LDTs	Total
1982	353,000	154,000	504,000
1983	396,000	176,000	572,000
Total	749,000	330,000	1,076,000

References

1/ Data Resources U.S. Long-Term Review, Lexington, Mass., Spring, 1980.

CHAPTER III

AIR QUALITY IMPACT

In order to evaluate the air quality impact of high-altitude emission standards, it was necessary to calculate the tons of each pollutant which would be emitted both with and without the standards. To calculate the mass of emissions, it is necessary to estimate the emission rates and deterioration rates of the vehicles. The information contained in Tables III-1 and III-2 was taken from AP-42 1/ and serves as a basis for the required calculations. It should be noted, however, that these tables use underlying assumptions which in some cases are not applicable for the comparisons required. Therefore, the emission rates for some model years were recalculated to reflect the scenarios which are to be evaluated.

A. Baseline Case

The baseline case assumed that there would be no high-altitude standards for model years 1982 and 1983, but that in model year 1984 and beyond, sea-level standards would be imposed at high altitude. The results of the following analyses are summarized in Table III-3 and III-4.

1. Baseline Light-Duty Vehicles (LDV)

The baseline case for emission factors, was developed from limited samples of data of 1981-plus systems tested at both low and high altitude. Table III-5 lists the available prototype results for two major manufacturers with three-way control systems. The averages for each manufacturer's data were then combined using an approximate sales weighting. Table III-6 lists results of tests for non-three-way control systems from two manufacturers and the California Air Resources Board. The test results from Table III-6 were averaged with weighting factors for the number of vehicles tested. The three-way and non-three-way emission rates were then combined using the projected relative production proportions of 70 percent and 30 percent, respectively, as weighting factors.

The changes in low-to-high emission rates were determined by using two separate methods and then taking their average. Table III-7 outlines the approach for the two methods. The first method assumes the difference in low-to-high emissions would be a predictor, and the second assumes the ratio of high-to-low emissions could be applied to low-altitude emission rates to predict high-altitude emission rates. For the difference method, the incremental change of emissions between low- and high-altitude test results were added to the low altitude emission rates as specified by AP-42. The high-altitude emission rates, using the ratio method were determined by multiplying the ratio of the average high-to-low emission test data times the low-altitude emission rates. The final high-altitude emission rates used for subsequent analysis

Table III-1

Exhaust Emission Rates

Light-Duty Vehicles
For All Areas Except California and High Altitude

Pollutant	Model Year	A (g/mile) New Vehicle Emission Rate	B (g/mile) Deterioration Rate (per 10,000 miles)
HC	pre-1968	4.45	0.58
HC	1968-1974	2.43	0.53
HC	1975-1979	1.13	0.23
HC	1980+	0.13	0.23
CO	pre-1968	68.30	3.06
CO	1968-1974	31.14	6.15
CO	1975-1979	18.60	2.80
CO	1980	3.00	2.30
CO	1981+	1.40	2.00

The exhaust emission factor is calculated from the linear equation; $C = A + BY$, where C is the exhaust emission factor for a vehicle with cumulative mileage M, A and B are the factors listed in the above table, and $Y = M/10{,}000$.

Table III-2

Exhaust Emission Rates

Light-Duty Trucks: Both Weight Categories
For All Areas Except California and High Altitude

Pollutant	Model Year	A (g/mile) New Vehicle Emission Rate	B (g/mile) Deterioration Rate (per 10,000 miles)
HC	pre-1968	4.76	0.58
HC	1968-1969	3.25	0.54
HC	1970-1974	2.56	0.53
HC	1975-1978	1.92	0.46
HC	1979-1982	0.94	0.41
HC	1983+	0.31	0.23
CO	pre-1968	70.38	3.06
CO	1968-1969	42.08	5.44
CO	1970-1974	31.48	6.15
CO	1975-1978	23.44	5.70
CO	1979-1982	14.50	5.34
CO	1983+	3.87	2.00

The exhaust emission factor is calculated from the linear equation; $C = A + BY$, where C is the exhaust emission factor for a vehicle with cumulative mileage M, A and B are the factors listed in the above table, and $Y = M/10{,}000$.

Table III-3

(AP-42 Table HI-I-1, Modified)
Exhaust Emission Rates

Light-Duty Vehicles
For High-Altitude Areas Only

Pollutant	Model Year	A (g/mi) New Vehicle Emission Rate	B (g/mi) Deterioration Rate (per 10,000 miles)
HC	Pre-1968	6.03	0.55
HC	1968-1974	4.07	0.55
HC	1975-1976	1.83	0.23
HC	1977	0.70	0.23
HC	1978-1979	1.83	0.23
HC	1980	0.32	0.23
HC	1981-1983	0.32	0.23
HC	1984+	0.13	0.23
CO	Pre-1968	110.04	2.81
CO	1968-1974	76.73	4.24
CO	1975-1976	38.31	2.80
CO	1977	10.30	2.80
CO	1978-1979	38.31	2.80
CO	1980	9.44	2.30
CO	1981-1983	6.24	2.00
CO	1984+	1.40	2.00

The exhaust emission factor is calculated from the linear equation $C = A + BY$, where C is the exhaust emission factor for a vehicle with cumulative mileage M, A and B are the factors listed in the above table, and $Y = M/10{,}000$.

Table III-4

(AP-42 Table HI-II-1)
Exhaust Emission Rates

Light-Duty Trucks: Both Weight Categories
For High-Altitude Areas Only

Pollutant	Model Year	A (g/mi) New Vehicle Emission Rate	B (g/mi) Deterioration Rate (per 10,000 miles)
HC	Pre-1968	6.45	0.55
HC	1968-1972	5.00	0.55
HC	1970-1974	4.28	0.55
HC	1975-1976	3.17	0.47
HC	1977	2.80	0.47
HC	1978	3.17	0.47
HC	1979-1982	1.52	0.41
HC	1983	0.89	0.23
HC	1984+	0.31	0.23
CO	Pre-1968	113.50	2.81
CO	1968-1979	88.36	3.91
CO	1970-1974	77.58	4.24
CO	1975-1976	54.19	4.84
CO	1977	44.81	4.84
CO	1978	54.19	4.84
CO	1979-1982	38.31	5.34
CO	1983	27.68	2.00
CO	1984+	3.87	2.00

The exhaust emission factor is calculated from the linear equation $C = A + BY$, where C is the exhaust emission factor for a vehicle with cumulative mileage M, A and B are the factors listed in the above table, and $Y = M/10{,}000$.

Table III-5

Three-Way Control System
Baseline Test Results

	HC		CO	
	Low Alt.	High Alt.	Low Alt.	High Alt.
Ford	0.21	0.485	2.29	14.66
	0.74	1.29	1.88	10.02
	0.11	0.29	2.5(ave 3)	8.87(avg. 3)
	0.27	0.65		
	0.17	0.62		
Ford Ave.	0.3	0.67	2.33	10.26
GM	0.18	0.25	2.0	4.2
	0.22	1.27	2.7	5.6
	0.28	0.39	3.2	4.3
	0.28	0.40	2.1	4.8
	0.23	0.24	2.0	2.4
GM Ave.	0.24	0.31	2.4	4.26
Sales-Weighted Average	0.26	0.45	2.37	6.66

Table III-6

Non-Three-Way (Ox. Cat. + Air)
Baseline Test Results

	HC		CO	
	Low Alt.	High Alt.	Low Alt.	High Alt.
Carb (Avg. 32 vehicles)	0.58	1.02	6.11	18.44
Honda (1 vehicle)	0.24	0.8	3.16	9.0
Ford (Avg. 5 vehicles)	0.673	1.25	5.4	23.82
Test Vehicle Weighted Average	0.58	1.04	5.94	18.90

Table III-7

High-Altitude Emission Rate Calculation
Light-Duty Vehicles

	HC		CO	
	Low Alt.	High Alt.	Low Alt.	High Alt.
Three-Way (70%)	0.26	0.45	2.37	6.66
Non-Three-Way (30%)	0.58	1.04	5.94	18.90
System-Weighted Average	0.36	0.63	3.44	10.33
Incremental Increase:	0.27		6.89	
Ratio Increase:	1.74		3.00	
Low-Altitude Emission Rate:				
1980 :	0.13		3.0	
1981+:	0.13		1.4	
1980 High-Altitude Emission Rate:				
(increment):	0.40		9.89	
(ratio):	0.23		9.00	
Average:	0.32		9.44	
1981-83 High-Altitude Emission Rate:				
(increment):	0.40		8.29	
(ratio):	0.23		4.20	
Average:	0.32		6.24	

were based on an average of the emission rates predicted by the two methods.

2. Baseline Light-Duty Truck (LDT)

For the 1982 model year, LDTs must meet low-altitude standards of 1.7 g/mi, 18.0 g/mi, and 2.0 g/mi for HC, CO, and NOx respectively. EPA has estimated that 50 percent of the LDTs will utilize control systems which include oxidation catalysts plus air pumps while the other 50 percent will need oxidation catalysts only. The exhaust emission standards for 1975-78 model year LDVs were very similar to the above 1982 standards for LDTs. The 1975-78 standards for LDV were 1.5 g/mi, 15 g/mi, 2.0 g/mi, for HC, CO, and NOx, respectively. Furthermore, the emission control systems for 1975-78 LDVs were virtually the same as EPA's estimated control systems for 1982 LDTs which are given above. Therefore, 1975-78 LDV data will be used in lieu of 1982 LDT data.

A review of surveillance data from high-altitude LDVs from model years 1975-1978 (excluding 1977) was performed. The data were segregated between oxidation catalysts plus air pump (OC+AP) and oxidation catalyst only (OC) vehicles. The average initial emission rates for each group was determined. Then the OC+AP and OC only averages were weighted 50/50. This analysis resulted in emission rates very close to those in AP-42 for the 1975 and 1977 model years for LDVs. Namely, emission rates of 1.52 for HC, and 38.31 for CO. These values were then used to approximate the performance of the 1979-1982 LDTs in the analysis.

The light-duty truck high-altitude emission rates for 1983 were approximated by assuming that the same change in emission rates at low altitude between 1982 and 1983 would also occur at high altitude. Therefore, the absolute differences in low-altitude emission rates between 1982 and 1983 were subtracted from the 1982 high-altitude emission rates to find the 1983 high-altitude values. The deterioration rates were unchanged from those published in AP-42.

B. High-Altitude Control Case

The control case assumes that standards will be in force at high altitude in model years 1982 and 1983, while for 1984 and beyond, vehicles at high altitudes meet the low-altitude standards.

1. High-Altitude Controls for Light-Duty Vehicles (LDV)

For model years 1982 and 1983, the standards were assumed to apply at high altitude. For LDVs these are 0.57 g/mi HC and 7.8 g/mi CO. The ERs for these emissions at high altitude were calculated by assuming that the ratio of ER to the standard at low altitude, equals the ratio of ER to the standard at high altitude. Thus, the ERs at high altitude for HC and CO were calculated as follows:

$$\frac{ER_{HC\ high}}{0.57} = \frac{0.13}{0.41} \quad (5)$$

$$ER_{HC\ high} = 0.18 \quad (6)$$

$$\frac{ER_{CO}}{7.8} = \frac{1.40}{3.4} \quad (7)$$

$$ER_{CO} = 3.21 \quad (8)$$

Thus, for LDVs the following values were used:

	HC		CO	
Model Year	ER	DR	ER	DR
1982-83	0.18	0.23	3.21	2.00
1984 +	0.13	0.23	1.40	2.00

2. High-Altitude Controls for Light-Duty Trucks (LDTs)

For model year 1983, the HC values were adjusted to reflect the proper low-altitude standard based on the current proposal. Following that, the assumption that the ratio of ER to standard at low altitude equals the ratio of ER to standard at high altitude, was used to determine the high-altitude ERs for both HC and CO.

The applicable proportional reduction standards at high altitude for LDTs are:

1982 - 2.0 HC, 26 CO
1983 - 1.0 HC, 14 CO

Thus, the applicable ERs were calculated as:

HC - 1982

$$\frac{ER_{high}}{2.0} = \frac{0.94}{1.7} \quad (9)$$

$$HC\ ER_{high} = 1.11 \quad (10)$$

HC - 1983

$$\frac{ER_{high}}{1.0} = \frac{0.31}{0.8} \quad (11)$$

$$HC\ ER_{high} = 0.39 \quad (12)$$

CO - 1982

$$\frac{ER_{high}}{26} = \frac{14.5}{18} \quad (13)$$

$$CO\ ER_{high} = 20.94 \quad (14)$$

CO - 1983

$$\frac{ER_{high}}{14} = \frac{3.87}{10} \quad (15)$$

$$CO\ ER_{high} = 5.42 \quad (16)$$

The resultant values used for the high-altitude control case are thus:

	HC		CO	
Model Year	ER	DR	ER	DR
1982	1.11	0.41	20.94	5.34
1983	0.39	0.23	5.42	2.00
1984 +	0.31	0.23	3.87	2.00

The average-life-emission rates for light-duty vehicles and light-duty trucks can be determined by applying the assumed half-life miles to the deterioration rates (DR) from AP-42. The average half-life miles for LDVs is 50,000 miles, and for LDTs is 65,000 miles. The computed average-life-emission rates with and without the high-altitude standards are shown in Table III-8, along with the anticipated incremental reductions.

The high-altitude evaporative emission standard will provide assurance that the control systems will have sufficient capacity to handle the greater evaporative emissions at high altitude. The standard has been set at a level to account for proportionally higher emissions with increase in altitude (assuming the same technology with adequate capacity). EPA believes that the current systems have sufficient capacity and the standards are needed to assure future systems will also be designed with capacity for operation at high altitude. Because no additional controls are required, other than the design constraint to assure adequate evaporative control system capacity, no air quality benefit is being claimed for the proposed high-altitude evaporative emission standard.

Table III-9 shows the LDV, LDT, and all-vehicle fleet emissions, with and without the 1982 and 1983 high-altitude standards.

The overall impact on air quality may be estimated by looking at the overall change (including growth in traffic) from the base

Table III-8

Average Lifetime Emission Rate
Grams/Mile
1982 and 1983 Vehicles

	HC	CO
Light-Duty Vehicles		
Baseline	1.47	16.33
High Altitude Stds.	1.33	13.21
Reduction	0.14 (9.5%)	3.12 (19.1%)
1982 Light-Duty Trucks		
Baseline	4.19	73.02
High Altitude Stds.	3.78	55.65
Reduction	0.41 (9.8%)	17.37 (23.8%)
1983 Light-Duty Trucks		
Baseline	2.39	40.68
High Altitude Stds.	1.89	18.42
Reduction	0.5 (21%)	22.26 (55%)

Table III-9

Fleet Emissions With (w) and Without (w/o)
1982 and 1983 High-Altitude Emission Standards

Hydrocarbons (g/mi)

	1980	1982	1984	1987	1995
LDV w/o	6.59	4.85	3.59	2.50	1.84
LDV w	6.59	4.84	3.55	2.47	1.84
% Reduction	0	0.2%	1.1%	0.9%	0
LDT w/o	10.10	8.52	7.08	5.07	2.72
LDT w	10.10	8.48	6.96	4.99	2.71
% Reduction	0	0.5%	1.7%	1.6%	0.4%
All Vehicles w/o	8.30	6.48	5.05	3.55	2.34
All Vehicles w	8.30	6.42	4.99	3.50	2.33
% Reduction	0	0.3%	1.2%	1.4%	0.4%

Carbon Monoxide (g/mi)

	1980	1982	1984	1987	1995
LDV w/o	67.8	57.5	38.3	25.0	15.0
LDV w	67.8	51.2	37.4	24.3	15.0
% Reduction	0	0.6%	2.3%	2.8%	0.0%
LDT w/o	97.0	90.7	81.2	58.7	27.7
LDT w	97.0	88.9	75.9	55.0	26.9
% Reduction	0	2.0%	6.5%	6.3%	2.9%
All Vehicles w/o	83.4	69.7	56.1	38.3	21.1
All Vehicles w	83.4	69.0	54.2	37.0	20.9
% Reduction	0	1.0%	3.4%	3.4%	0.9%

year of 1980. The years 1982 and 1987 were chosen for the future years because the Clean Air Act requires attainment of the CO and oxidant standards by 1982. An extension of up to 1987 can be allowed if all reasonable control measures will not attain the standards by that date. The years 1984 and 1995 were chosen to indicate the time when the standards would have their greatest effect on air quality in Denver (1984) and when the effect of the standards would become minimal (1995).

For CO, the emission reductions can be directly compared to the needed air quality reductions since CO concentrations are almost entirely due to direct emissions from motor vehicles. Photochemical oxidants, however, are not directly emitted. They are the result of complex reactions between oxides of nitrogen (NOx) and hydrocarbons (HC) in the presence of sunlight. The NOx and HC are emitted by both motor vehicles and stationary sources. Transport of pollutants, and their mixing with unpolluted air, affects the concentration of both CO and oxidants.

The best means of relating emissions to air quality is through the use of complex dispersion models (photochemical dispersion models in the case of oxidants). However, for the purpose of determining the relative impact of the 1982 and 1983 high-altitude standards, a comparison of the reductions in CO and HC emissions is sufficient. High-altitude NOx emissions will not be affected by the 1982 and 1983 standards since NOx emissions at high altitude are less than at low altitude. Since Denver, Colorado had the highest measured CO and ozone concentrations of any of the high-altitude nonattainment areas in 1977, the estimated emissions for this city will be used to illustrate the relative impact of the standards on air quality.

Total emissions of CO and HC for Denver are shown in Table III-10. These are based on vehicle-miles-traveled per day (VMT) of 21 million for 1980, 22 million for 1982, 23 million for 1984, and 24 million for 1987, and fleet emission rates from Table III-9 (VMT/Day x Emission Rates = Daily Emissions). In calculating emissions with 1982 and 1983 high-altitude standards, light-duty vehicles and light-duty trucks are affected by the standards, heavy-duty trucks are not. Forty tons per day of stationary source hydrocarbon emissions are included in the hydrocarbon emission totals for all years.

Table III-11 shows the total pollution reduction expected from this regulation. This reduction was calculated from the average lifetime emission rates of Table III-8, useful lives of 100,000 miles for LDVs, and 130,000 miles for LDTs, and high-altitude sales estimate for LDVs and LDTs in 1982 and 1983 (Chapter II).

In conclusion, the 1982-83 high-altitude interim regulations will reduce Denver area HC emissions by 1.4 tons per day and CO emissions by 46 tons per day in 1984. By 1987, when the Denver area must be in compliance with the National Ambient Air Quality

Table III-10

Denver Area Emissions
(tons/day)

	1980		1982		1984		1987	
	HC	CO	HC	CO	HC	CO	HC	CO
Baseline	231.7	1927	196.8	1687	162.2	135.8	133.7	1011
With Stds	231.7	1927	196.3	1670	160.8	131.2	132.4	977
Reduction (tons/day)	0	0	0.5	17	1.4	46	1.3	34
(percent)	0	0	0.3%	1.0%	0.9%	3.4%	1.0%	3.4%

Table III-11

Total Pollution Reductions for 1982 and 1983
(thousands of tons)

	HC	CO
LDV	11.6	258
LDT	21.5	937
Total	33.1	1,195

Standards, the 1982-1983 high-altitude interim regulations will reduce HC emissions by 1.3 tons per day and CO emissions by 34 tons per day. Furthermore, all high-altitude counties will benefit from the HC reduction of 33,100 tons and the CO reduction of 1,195,000 tons resulting from this regulation. These reductions will help make Denver and other high-altitude cities healthier and more pleasant places to live.

References

1/ "Mobile Source Emission Factors," EPA, March 1978, EPA-400/9-78-005.

CHAPTER IV

ECONOMIC IMPACT ANALYSIS OF THE 1977 HIGH-ALTITUDE EMISSION STANDARDS

A. Introduction

The 1977 model year automobile high-altitude emission regulations applied to vehicles sold in a "designated high-altitude location," which was defined as: "counties located substantially above 1,219 meters (4,000 feet) in elevation." This included a total of 112 counties in 10 western states and excluded California. The complete list is contained in Figure IV-1.

Under the 1977 regulations, all dealerships in high-altitude counties could only sell those light-duty car-line configurations (both light-duty vehicles and light-duty trucks) that were certified by EPA to meet 1977 high-altitude emission standards of 15 grams/mile CO, 1.5 grams/mile HC, and 2.0 grams/mile oxides of nitrogen (NOx). The only exception was if the manufacturer had a substantial reason to believe an uncertified vehicle, sold out of a high-altitude dealership would be used principally at a low-altitude location. Similarly, manufacturers and low-altitude dealers were forbidden from selling any light-duty vehicle (gasoline or diesel) or light-duty truck that was intended for principal use at a high-altitude location, unless it was certified for high altitude. The 1977 emission standards were the same at both high and low altitudes.

The National Automobile Dealers Association (NADA) had 888 high-altitude dealer members in 1977. It is estimated that there were 100 to 150 additional high-altitude dealers that were not members of NADA. This means a total of approximately 1,000 high-altitude dealers were affected by EPA's 1977 model year regulations.

These 1,000 dealers were about 3 percent of the national total of dealerships. Similarly, sales by high-altitude dealers totaled about 3.5 percent of national automobile sales in 1979. However, LDT high-altitude sales were relatively higher at approximately 5.5 percent of the national LDT sales in 1977 (see Tables IV-1 and IV-2). Because of the relatively small market share of high-altitude areas and the certification requirements, many types of vehicles were not certified by manufacturers for sale at high altitudes.

With the enactment of the Clean Air Act Amendments of 1977, Congress suspended the 1977 model year high-altitude regulations which had required separate certification of all high-altitude vehicles. The following is an analysis of the economic impact of the 1977 high-altitude regulations on automobile dealerships, manufacturers, consumers, and the general public.

Figure IV-1

Counties Located Substantially Above 1,219 Meters (4,000 feet) in Elevation

ARIZONA

Apache	Navajo		

COLORADO

Adams	Denver	Lake	Pitkin
Alamosa	Douglas	LaPlata	Pueblo
Arapahoe	Eagle	Larimer	Rio Blanco
Archuleta	Elbert	Las Animas	Rio Grande
Boulder	Fremont	Lincoln	Routt
Chaffee	Garfield	Mesa	Saguache
Clear Creek	Gilpin	Mineral	San Juan
Conejos	Grand	Moffat	San Miguel
Costilla	Gunnison	Montezoma	Summit
Crowley	Hinsdale	Montrose	Teller
Custer	Huerfano	Morgan	Washington
Colores	Jackson	Ouray	Weld
Delta	Jefferson	Park	

IDAHO

Bannock	Butte	Custer	Minidoka
Bear Lake	Camas	Franklin	Oneidaka
Bingham	Caribou	Fremont	Power
Blaineille	Cassa	Jefferson	Teton
Bonneville	Clark	Madison	Valley

MONTANA

Beaverhead	Gallatinn	Madison	Park
Deer Logde	Jerrerson	Meagher	Silver Bow

NEBRASKA

Banner	Kimball	Sioux	

NEVADA

Carson City	Esmeralda	Lander	Storey
Douglas	Eureka	Lyon	White Pine
Elko	Humbolt	Mineral	

NEW MEXICO

Bernalillo	Guadalupe	Mora	Sierra
Catron	Harding	Rio Arriba	Socorro
Colfax	Lincoln	Sandoval	Tacos
Curray	Los Alamos	San Juan	Torrance
De Baca	Luna	San Miguel	Union
Grant	McKinley	Santa Fe	Valencia

OREGON

Lake			

UTAH

Beaver	Emery	Piute	Tooele
Box Elder	Grand	Rich	Uintah
Cache	Iron	Salt Lake	Utah
Carbon	Juab	San Juan	Wasatch
Daggett	Kane	Sanpeto	Wayne
Davis	Millard	Sevier	Weber
Duchesne	Morgan	Summit	

Figure IV-1 (cont'd)

WYOMING

Albany	Hot Springs	Niobrara	Sweetwater
Carbon	Johnson	Park	Teton
Converse	Laramie	Platte	Unita
Fremont	Lincoln	Sublette	Weston
Goshen	Natrona		

Table IV-1

New Car Registrations, 1976-1979
For High-Altitude States
Showing Percentage of Each State to Total Registrations

State	1979 Registrations	% of National Total	1978 Registrations	% National Total	1977 Registrations	% of National Total	1976 Registrations	% of National Total
Colorado	134,369	1.30	128,539	1.17	121,335	1.13	107,846	1.11
Idaho	30,030	.29	32,695	.30	32,637	.30	26,284	.27
Montana	24,297	.24	29,963	.27	29,177	.27	28,317	.29
Nevada	42,632	.41	43,516	.40	39,419	.37	31,040	.32
New Mexico	52,267	.52	53,794	.49	52,410	.49	49,410	.51
Utah	50,305	.49	55,910	.51	52.544	.49	43,567	.45
Wyoming	20,682	.21	18,880	.17	18,220	.17	15,191	.15
TOTAL	354,582	3.46	363,297	3.32	345,742	3.20	301,655	3.10

High-Altitude States: The 7 western areas with a substantial number of counties over 4,000 feet.

Sources: Automotive News 1978 Market Data Book and MVMA Facts and Figures, 1980.

Table IV-2

New Light-Duty Truck Registrations 1/, 1974-1977 2/ (in thousands)
For High-Altitude States
Showing Percentage of Each State to Total Registrations

State	1977 Registrations	% of National Total	1976 Registrations	% of National Total	1975 Registrations	% of National Total	1974 Registrations	% of National Total
Colorado	44	1.50	44	1.71	35	1.72	41	1.81
Idaho	22	.75	20	.78	16	.81	18	.80
Montana	19	.64	21	.83	18	.86	19	.82
Nevada	14	.50	12	.46	10	.50	9	.43
New Mexico	26	.90	25	.96	20	.99	20	.92
Utah	25	.84	23	.88	20	.95	18	.53
Wyoming	16	.54	14	.57	13	.62	12	.53
TOTAL	166	5.67	159	6.19	132	6.15	137	6.09

1/ Redefined Light-Duty Truck Class 0-8,500 pounds GVW.

2/ Data for more recent model years are not currently available.

High-Altitude States: The 7 western areas with a substantial number of counties over 4,000 feet.

Source: Automotive News 1978 Market Data Book.

B. Dealerships

The light-duty vehicle (LDV) and light-duty truck (LDT) industries produce a wide variety of vehicles consisting of many significant variations in vehicle design, size, and configuration. The vehicles vary by manufacturers, model, engine size, axle range, transmission type, carburetor type, etc. During the 1977 high-altitude regulations, approximately 50 percent of domestic and foreign vehicle configurations were not available for purchase at the approximately 1,000 high-altitude dealerships in 112 western counties.

Of the configurations that were certified, some were certified but still not made available to high-altitude dealers because of drivability problems. Some others were later withdrawn by the manufacturer due to failure to meet performance standards. If the 1977 regulations had continued, other configurations of vehicles probably would have been certified in later years.

The amount of economic hardship incurred by individual high-altitude automobile dealers ranged from an insignificant to minor impact for most dealers, to a very significant impact for a minority of dealers. In 1977, NADA provided EPA with a list of high-altitude dealer members (both domestic and import) who had expressed difficulties due to the high-altitude regulations. This list is not a complete list of dealers who experienced problems, but does reflect the results of a 1976 NADA survey of their 888 high-altitude members regarding the impact of the 1977 regulations, and dealer complaints. The list includes 37 dealers from 8 of the 10 affected states. The two states not represented, Arizona and Oregon, contained only one high-altitude county each.

Eighteen dealers were chosen at random and visited during a 1977 EPA survey to determine the amount of economic impact incurred by dealers due to the 1977 high-altitude regulations. Meetings were also held in Salt Lake City and Denver with EPA representatives and groups of dealers and their state NADA representatives. Some of the types of problems that dealers expressed during those meetings are discussed below.

The unavailability of certain models and powertrain configurations appeared to be the most significant problem. Manual transmissions, smaller engine sizes, and certain axle ratios were frequently not certified for sale at high altitude. For example, the Honda Civic and the Pontiac "Iron Duke" engine, both of which had received heavy national advertising, were not available. Substantial sales losses were claimed as a result of these circumstances. It was also emphasized that subsequent parts and service work are also lost with each lost sale.

Fringe dealers most commonly complained that they were experiencing no air quality problems, and therefore could not understand the necessity for regulations which they felt were so discriminatory against them. They also indicated that a substantially larger number of low-altitude cars, belonging to tourists, hunters, students, and government installation employees operate in their counties than the resident vehicle population. In several sparsely populated fringe counties it was estimated that more vehicles travel on interstate highways through the counties on a single day, than the entire vehicle population of the counties. Several fringe dealers complained that neighboring counties with substantially more population at substantially higher elevations throughout most of the county were designated low altitude.

Dealers generally complained about the increased cost of high-altitude models. High-altitude kits on certain foreign models cost as much as $194. Although the high-altitude option cost on domestic vehicles is relatively low, the increased price associated with unavailability of manual transmissions and low-displacement base engines can add over $500 to the cost of a high-altitude model.

Many dealers, especially those located in fringe areas, indicated that their dealer trade activities had severely suffered. They indicated that dealer trades were daily occurrences and that the high-altitude regulations had eliminated their ability to trade with low-altitude dealers. Since customers frequently seek models with specific color, trim, and optional equipment, the inability of a dealer to readly obtain a given model from a nearby dealer frequently results in a lost sale. Small dealers are particularly hurt since they do not have the capital to stock a larger number of vehicles.

Fleet sales are another concern. Since such sales frequently involve tens to hundreds of cars, even a $20 price differential for high-altitude equipment can result in a lost sale. Although fleet vehicles sold for prinicpal use at high altitude are required to be certified at high altitude, dealers claimed that fleet owners frequently purchased low-altitude vehicles through their home office at a low-altitude location and then distributed them to both high- and low-altitude areas.

Many dealers stated that they felt there was no enforcement of the high-altitude regulations. They expressed instances where high-altitude residents, including their own previous customers, had come in for service with a low-altitude model purchased from a low-altitude dealer. They indicated that servicemen and students merely purchased low-altitude cars from their permanent residence and that local residents would have relatives in low-altitude areas purchase cars and immediately sell them to the high-altitude resident.

Poor fuel economy and driveability was also a common complaint. One Volkswagen dealer claimed that Budget Rent-a-Car Company turned down his bid for a fleet sale due to the higher cost and safety problems associated with the poor driveability of high-altitude models. One dealer claimed a higher customer dissatisfaction with 1977 high-altitude cars than any previous year.

Morale problems with dealer employees, as well as high turnover rates, were also indicated to be a result of increased customer complaints. Dealers claimed that their images were tarnished since they were frequently accused of "bait-and-switch" tactics relative to nationally advertised models and equipment which they could not offer to their customers. In addition, they found it difficult to explain to low-altitude tourists why they did not stock emission-related parts to repair their vehicles.

A survey sample of urban and rural NADA high-altitude members was conducted in August, 1978 in cooperation with EPA (see Figure IV-2). Of the 42 responses received from the states of Colorado, Montana, New Mexico, Nevada, Oregon, and Wyoming, 23 were from urban areas and 19 were from rural areas.

The results of the survey showed an average increase in sales from the 1976 model year to the 1977 model year of approximately 15 percent. Whereas, the national increase in automobile sales for the same period was approximately 6 percent. Thus, increases in sales from the high-altitude dealers who responded to the survey averaged two and one-half times higher than national automobile sales increases over the same period. This higher than national average sale increase may largely reflect the higher than national average population growth rates in high-altitude areas. It is possible that without the 1977 regulations, 1977 model year sales may have increased by even more than 15% over 1976 model year sales.

The respondents to the NADA questionnaire felt that they lost, on the average, around 15 sales as a result of the 1977 high-altitude regulations. This could have meant an additional average increase of 1977 model year sales over 1976 model year sales of 6%, for a total of a 21 percent average increase. The 21 percent average increase for high-altitude areas would have been substantially higher than the national average of 6 percent, for the same period.

Dealer respondents to the questionnaire felt that "taking into account the profit margin on a new vehicle, as well as the profit resulting on any resulting trade-in and service," their estimated profit loss was, on the average, $900 from each new car sale lost. This would have meant an average loss in revenues of approximately $13,500 per respondent because of the 1977 high-altitude regulations. However, the rapid growth in high-altitude sales during 1977 tends to indicate generally rising rather than falling profits.

C. Manufacturers

The primary reason given by the manufacturers for limited certification during the 1977 regulations is that the relatively

Figure IV-2

High-Altitude Regulations Quantitative Analysis of Economic Impact

NAME OF DEALERSHIP: ______________________________

ADDRESS OF DEALERSHIP: ______________________________

____

____

MAKE: ______________________________

TYPE OF DEALERSHIP: ( ) Urban ( ) Rural

(1) Please indicate the monthly car sales volume figures for the following months:

1975		
September	______	units
November	______	units
1976		
January	______	units
March	______	units
May	______	units
July	______	units
September	______	units
November	______	units

1977		
January	______	units
March	______	units
May	______	units
July	______	units
September	______	units
November	______	units
1978		
January	______	units
March	______	units
May	______	units

NOTE: If additional explanatory information is necessary, please attach on a separate sheet.

(2) During the 1977 model year, when the High-Altitude Regulation was in effect, how many sales would you estimate were lost as a result of the regulation:

None ( ) 10 - 15 ( )
1 - 5 ( ) over 15 ( )

(3) Taking into account the profit margin on a new vehicle, as well as the profit on any resulting trade-in and service, what would you estimate the profit loss to be resulting from each new car sale which is lost? ______________________________

____

(Please return by August 7, 1978, to NADA's Legislative Department, 8400 Westpark Drive, McLean, Virginia 22102.)

small significance of the high-altitude market relative to national markets (4 percent) did not justify the development costs involved in certifying all vehicle configurations. Therefore, only certain configurations were usually certified for a model. Manufacturers primarily determined which vehicles would certify based upon ability to meet standards, market considerations, and time constraints. At least one manufacturer was unable to certify some of its more popular 1977 model year high-altitude configurations because of lack of time in meeting certification. They, therefore, felt a greater relative impact on sales.

Except for the aforementioned instance, manufacturers generally did not feel they had suffered significant economic impact due to the 1977 regulations. In fact, generally when looking at their high-altitude sales for before, during, and after the 1977 regulation, no clear pattern arose and no adverse impact could be quantified. These results seem to partly reflect the "crossover" of sales that generally occurred. That is, usually when a consumer could not purchase a desired vehicle configuration, because it was not certified and therefore unavailable at high altitudes, he or she purchased another vehicle configuration that was certified and available, as opposed to deferring the purchase altogether. This "crossover" could have been within the same model configuration, between foreign manufacturers, between domestic manufacturers, or between foreign manufacturers and domestic manufacturers. Generally from the manufacturers' standpoints, it also seemed to average out fairly well. They picked up about as many sales due to "crossover" as they lost because of it. However, this crossing over or shifting of sales was significant at the more micro-dealer level in many instances.

Another reason manufacturers felt little economic impact was the high-altitude market's small significance when compared to the total U.S. market, i.e., only about of only approximately 3% of national sales. However, as stated, manufacturers who were unable to certify certain important configurations due to lack of time in the certification process did feel more of an impact on sales, although it was still minor relative to national sales. This problem may have, in part, been due to poor management of time by the manufacturers. Eventually, this problem would have been resolved in future model years.

Another minor cost incurred by the manufacturers was the cost of the high-altitude equipment and its certification. The equipment costs were approximately $20 to $40 per vehicle. The incremental certification costs were approximately $10,000 per vehicle per engine-family, excluding developmental, administrative, and test-vehicle costs. Only one vehicle was required for testing per engine-family per emission-control-system combination. A small part of the test vehicle cost could be regained through resale. The $10,000 figure also assumes the necessity of having to accumulate 4,000 miles prior to testing. However, most modifications for high altitude could be performed on an existing 4,000 mile low-altitude vehicle, obviating the need and cost of running 4,000 miles on an existing data vehicle.

D. Consumers

The economic impact felt by consumers was primarily in four areas:

1. Reduced availability of desired vehicle configurations.

2. Increased vehicle costs because of the high-altitude emissions equipment.

3. Some losses in driveability and fuel economy.

4. Some misallocation of emission control costs between high-altitude and low-altitude consumers.

The first point, the reduction of product availability and differentiation, impacted the consumer in two ways. First, a consumer might not have been able to purchase the vehicle configuration that he or she felt best fulfilled his or her needs and desires. Secondly, if a desired product was not available, it may have been necessary for the consumer to pay an increased cost for a substituted vehicle configuration. An example of this is the unavailability of a manual transmission and low-displacement engine. This might require the consumer to spend an additional $500 for a certified automatic transmission and larger engine.

The second area of economic impact on the consumer was the cost associated with the purchase of high-altitude equipment. Although the high-altitude equipment cost on most vehicles was relatively low at $20 to $40 (approximately 1/2 of 1 percent of average sales price), high-altitude packages cost as much as $194 on certain foreign models.

Third, there were some problems in driveability and fuel economy associated with some certified configurations, although some vehicles improved in both areas. This problem would have also been reduced over time as more experience was gained by the manufacturers and the dealers, and appropriate adjustments made at the design and engineering level.

The fourth area of impact reflects the high degree of national mobility and the large number of low-altitude visitors (whose vehicles are often not as well adjusted for high-altitude conditions as those of residents) to high-altitude areas. In some high-altitude counties, the number of low-altitude tourists exceeds the number of high-altitude residents. The Colorado Vistors Bureau estimates that there were 9 million tourists to the State of Colorado in 1977 and approximately 10 million in 1978. Approximately 20 percent of these are winter visitors with the remainder visiting in spring, summer, and fall. The Colorado State Highway

Department estimates that there were approximately 18.6 billion vehicle miles traveled (VMT) in Colorado in 1977. An estimated 12 percent or 2.2 billion VMT's of the total were estimated by the Highway Department to be from out-of-state vehicles. This means that although the problem is caused by both high- and low-altitude residents, most of the cost was borne by the high-altitude residents in the form of higher vehicle prices. However, some of the cost was borne by low-altitude residents, because manufacturers often spread part of the cost of high-altitude equipment over their west coast or national sales.

E. Public

Although it appears increasingly that the automobile consumers and the public are becoming one in the same (1977 vehicle registrations were approximately 65 percent of 1977 U.S. population). There is a large number of nonautomobile owners in the general public. Among automobile owners there also is a broad range of use from several hundred vehicle miles traveled (VMT) per year to over 50,000 VMT per year.

The air quality problems in Denver, Salt Lake City, and many other high-altitude areas are severe. The main source of pollutants in these areas is the automobile. Pollution from the automobile is further compounded by natural conditions. Thus, the automobile user is largely responsible for the critical air pollution problem in most high-altitude areas. However, not only the auto consumer, but also the rest of the general public, must bear the burden and costs of air pollution.

To the extent the 1977 regulation reduced emission levels (minor as it may have been), costs which had previously been externalities of the automobile and borne by the general public were shifted back, in part at least, to the automobile consumer and manufacturer. Thus, the additional cost of new air pollution control devices and requirements are not really "new costs" but are in fact "existing costs" which are being shifted more equitably to the user and beneficiary of the automobile. This does not mean that any cost level for emission control is justified. Cost effectiveness considerations must guide emission control, and programs must be efficiently and equitably administered.

F. Summary

The economic impact of the 1977 emission regulations was felt by high-altitude automobile dealers, manufacturers, and consumers. The most significant impact appears to have been felt at the dealer level. High-altitude dealers were put at a competitive disadvantage relative to their low-altitude counterparts because of the 1977 regulation. This meant losses in sales and profits, and an increase cost of doing business. It also meant increased cost and reduced availability for the high-altitude consumer. Automobile manufacturers' sales generally were not affected by the regulations, but they did incur additional costs associated with the high-altitude equipment and certification.

The beneficiary of the regulations was the general public. The regulations were in effect only less than one year, so the improvements in air quality were minor. However, any improvement in air quality, no matter how small, is beneficial to the health and well being of the general public.

CHAPTER V

ECONOMIC IMPACT

This chapter examines the costs of complying with the 1982 and 1983 high-altitude standards. The cost of this regulation, as with other mobile source regulations, will primarily affect the producers and users of high-altitude light-duty vehicles and light-duty trucks. High-altitude dealers are also affected by these standards; therefore, the economic impact on their activities is also addressed in this chapter.

Manufacturers could potentially incur expenses in five major areas: development, certification, tooling, selective enforcement auditing (SEA), and hardware. Of course, these costs, as well as profit, will ultimately be passed along to the vehicle purchaser in the form of higher sticker prices. In addition, the purchasers or users of high-altitude vehicles could experience changes in operating costs because of the regulation. Each of the above cost elements will be discussed separately in the following sections.

EPA has estimated the emission control requirements and costs for 1982 and 1983 motor vehicles based on discussions with manufacturers' representatives, manufacturers' comments on the proposed rulemaking, confidential 1981 certification data, and confidential and non-confidential 1980 certification data. In particular, the cost analysis relies predominately on the 1980 certification data as being indicative of the number of engine families and their market shares for 1982 and 1983 motor vehicle fleets. This information was used because it is the most objective data available. The 1980 data adequately represents the motor vehicle fleets of the early 1980's because the impact of downsizing and dieselization for greater fuel economy will not have fully developed and, hence, will not significantly affect the results of this analysis.

A. Cost to Manufacturers

Manufacturers will incur costs in two broad categories: (1) variable and (2) fixed. Variable or recurring costs are associated with the materials and time it takes to produce each piece of pollution control hardware. This cost, therefore, depends on the type of hardware produced. Fixed or non-recurring costs are generally independent of the number of pieces produced. These costs include expenditures for development, certification, tooling, and SEA.

1. Variable Costs - Hardware

As discussed in the Summary and Analysis of Comments, the emission control technology that manufacturers will use to comply with the high-alititude standards can be grouped into five generic emission control systems. Each system is described below.

a. Unmodified Electronic Feedback System. Feedback electronic engine controls are used to continuously optimize engine parameters (e.g., spark timing, fuel metering, etc.) for various operating conditions. These systems have the inherent capability to compensate for the effects of altitude by metering less fuel into the combustion chambers as the air density changes. EPA has indentified at least two types of feedback systems which should be capable of meeting both the low- and high-altitude standards as they are currently designed. The first type is the GM "C-4" system for carbureted engines. This system is currently expected to be used on all GM and AMC 1982 and 1983 LDVs. The second type is the Bosch "Jetronic" system for fuel injected vehicles. This system is used on vehicles manufactured by Nissan, Volkswagen, Volvo, JRT, BMW, Puegeot, Porsche, Saab, and several other small European producers.

Vehicles using either the C-4 system or the Bosch Jetronic system will have no additional hardware costs because no changes are required.

b. Recalibrated Feedback Systems. As with other electronic feedback controls, these systems have the capability to automatically compensate for changes in altitude. However, these systems are unable to meet the high-altitude standards as originally designed. They will require additional emission reductions during the open-loop position of the operating regime. EPA expects that manufacturers using these systems will meet the high-altitude standards by using a differently calibrated electronic module on high-altitude vehicles than on low-altitude vehicles. As stated by Chrysler, once the specifications have been determined, there is essentially no difference in manufacturing low-altitude or high-altitude calibrated units. Therefore, the variable cost of a high-altitude feedback system is considered to be the same as a low-altitude feedback system. EPA assumes that special high-altitude calibrations will be used on all feedback vehicles not previously identified as using unmodified electronic systems.

c. Aneroid Non-Feedback Systems. An aneroid is a small pressure-sensing device that will be used in conjunction with the carburetor to automatically lean the fuel-air mixture at higher altitudes. EPA anticipates that most non-feedback LDVs and LDTs will use aneroids to comply with the standards. Aneroid equipped carburetors are currently available on some car/truck models; other models could easily change to existing aneroid controlled carburetors; still others could have their existing carburetors modified by machining in air bleed passages or through simple modifications to castings. The remaining non-feedback carburetors could be redesigned to accept aneroids only by more complex changes to die patterns. This type of change is considered to be a long leadtime modification and may not be accomplished in time to comply with the 1982 implementation date of the standard. Therefore, aneroids can not be used in all cases. In these instances, manufacturers will use less complex and less expensive fixed-carburetor calibrations for high-altitude vehicles. Rather than attempt to estimate the number of vehicles using fixed calibrations, EPA will be conservative and assume that all such vehicles will use a more expensive aneroid carburetor.

The incremental cost of an aneroid carburetor was estimated using the data and methodology contained in a cost estimation report prepared under contract for EPA. This methodology was altered by: (1) allowing for the effects of inflation, (2) using an economy of scale correction factor to approximate the low production volume of high-altitude vehicles and, (3) using more realistic profit and overhead margins at the corporate and dealer level. The inflation rate used to escalate prices from the base year of 1977 to 1980 dollars was 8 percent per annum. The economy of scale correction factor was 2.6. The overhead and profit margin used is the same as in the recent heavy-duty vehicles and the light-duty diesel particulate rulemaking (29 percent). Using this information, the incremental cost of an aneroid carburetor is calculated to be about $9.70 for manufacturing and $2.50 for corporate and dealer profit and overhead, or a total of about $12.00 per high-altitude vehicle.

d. Air Injection Non-Feedback System. In their comments on the high-altitude rulemaking, GM stated that air pumps would be required on their 2.2 liter, 5.0 liter 2-bbl, and 5.0 liter 4-bbl LDT engines sold at high altitude in the 1982 model year. In 1983, these same engine families will already possess air pumps in order to comply with the more stringent 1983 LDT standards at low-altitude. Although the Agency can not confirm that air pumps on these engine families will be required to comply with the 1982 high-altitude standards, EPA will be conservative and account for this prospect in the analysis. Using the same data and methodology as described above, but without a correction factor for economy of scale effects, the incremental cost of an air pump is calculated to be about $18.70 for manufacturing and $4.90 for corporate and dealer profit and overhead, or a total of about $24.00 per high-altitude vehicle. No correction for economy of scale has been included since GM stated that the air pump is the same as those currently used on other vehiles and, hence, the benefits of mass production have already been achieved.

e. Diesel Engine System. EPA expects that diesel-powered vehicles can comply with the standards by simple recalibrations of existing adjustable parameters. No additional hardware, such as an aneroid, appears to be necessary. Therefore, these vehicles will have no added hardware costs.

2. Average Hardware Costs

The sales-weighted hardware cost for LDVs and LDTs is calculated in Table V-1. This table includes EPA's estimate of the number of vehicles using each of the generic control systems discussed above. These vehicles are not identified by manufacturer

Table V-1

High-Altitude Hardware Costs

Vehicle Category	Total Sales	Fraction of Sales	System Variable Cost A $0	B $0	C $12	D $24	E $0	Sales-Weighted Cost	Cumulative Cost
LDV	403,000	0.54	X					0	
	121,000	0.16		X				0	
	203,000	0.27			X			$3	$3
	22,000	0.03					X	0	$3
Subtotal	749,000								$3
LDT	285,000	0.86			X			$10	$10
	35,000	0.11				X		$3	$13
	10,000	0.03					X	0	$13
Subtotal	330,000								$13

or engine family in order to protect the confidentiality of the manufacturers sales projections which are the basis of the estimate. For high-altitude LDVs, the average hardware cost increase is $3 per vehicle or a total of about $2.2 million. For high-altitude LDTs, the average hardware cost increase is $13 per vehicle or a total of about $4.2 million. These figures correspond to an average high-altitude vehicle cost increase of $6.00 or a total of about $6.4 million (undiscounted, 1980 dollars).

3. Fixed Costs

a. Developmental Costs. All vehicles except those using "unmodified electronic feedback systems" will require a unique calibration for high altitude. Calibrations are historically developed through a series of reiteration involving theoretical studies, carburetor flow bench testing, and FTP testing. FTP testing is by far the most expensive portion of any calibration effort; therefore, development costs can be adequately characterized by conservatively estimating the average number of FTP tests required per engine family.

Estimating the number of FTP tests required for compliance with the standards is problematic. In reality the number is likely to be different for each engine family because of the variety of emission control systems and because calibrations within an engine family will require different degrees of development effort.

The difficulty of estimating the necessary development was not diminished by manufacturers' comments. Despite the fact that many manufacturers made repeated claims that high-altitude testing facilities were inadequate, a statement that should have been based on an estimate of the requisite development testing, only one manufacturer provided specific information. Therefore, in order to estimate the quantity of development testing, EPA relied primarily on its own experience with development programs at the Motor Vehicle Emissions Laboratory and on the past experience of its technical staff while they were employed in development areas of the automobile industry.

Ford estimated that 52 high-altitude calibrations would be needed and that 150 FTP tests would be required per calibration. EPA's independent estimate is in basic agreement with Ford. Historically, developing a low-altitude calibration can indeed take 150 tests. However, it is unlikely that such a great number of tests would be required to develop a suitable high-altitude calibration. EPA reasons that calibrating high-altitude hardware will be less difficult for several reasons.

Typically, low-altitude calibrations are determined simultaneously. Such a development program provides no opportunity to learn from prior experience with similar calibrations within the same engine family. Because special durability and emission-data vehicles will not be required, manufacturers will develop high-altitude calibrations after the low-altitude hardware has been determined. The experience and information that were generated in producing low-altitude calibrations can then be used to reduce the effort required to develop high-altitude calibrations for the same vehicle configurations. Also, the overall technical problem is greatly reduced since the basic changes that must be made to compensate low-altitude hardware for the effects of higher altitude are generally well known.

Furthermore, the actual number of calibrations per engine family may be lower for high-altitude vehicles than for low-altitude vehicles. Manufacturers may develop many more low-altitude calibrations than are actually required because the potential low-altitude market is so great that the resulting small improvements in driveability and fuel economy (CAFE) justify the additional development costs. This amount of optimization may not be needed or justifiable for the smaller high-altitude market, i.e., one calibration may suffice for several low-altitude calibrations. In this situation the "worst case" calibration for several vehicle configurations within an engine family will be developed first, and, if suitable for other similar configurations, will be used unless time, financial resources, and perceived benefit dictate otherwise. Even though manufacturers may provide fewer calibrations and, therefore, less optimization at high altitudes as compared to low altitude, high-altitude consumers will still benefit from the development work which will be done. High-altitude vehicles should perform better and give better fuel economy than unadjusted low-altitude vehicles operated at high altitudes with richer fuel-air mixtures.

Although no details were given, Ford may have based their estimate of 52 high-altitude calibrations on the fact that less optimization would be required for the high-altitude market than the low-altitude market. In 1980, Ford certified 20 light-duty motor vehicle engine families. This figure and Ford's estimate of high-altitude calibrations translates into about 2.5 calibrations per engine family. This is in contrast to Ford's 1980 certification data which shows an average of perhaps 10 calibrations per engine family. Therefore, it is reasonable to conclude that Ford expects significantly less optimization at high altitude than at low altitude.

i. Light-Duty Gasoline Vehicles. EPA estimates that, on the average, 100 FTP tests per engine family should be sufficient to calibrate a light-duty, gasoline-fueled vehicle. This, of course, assumes that some calibrations will be more difficult to develop than others and some will be less difficult. It appears that feedback systems should generally be easier to calibrate than many non-feedback (aneroid) systems. Additionally, some non-feedback systems are also expected to be quite easy to calibrate. Manufacturers' comments indicated that some vehicles could comply with the standards by manipulating adjustable parameters on existing low-altitude hardware. However, to be conservative, EPA will use 150 tests per engine family to determine the manufacturer's development costs due to this regulation. The additional 50 tests will allow for expenses that are not explicitly accounted for in this analysis. These expenses include costs for additional engineering support at the manufacturers' headquarters, building prototype hardware, and bench testing.

ii. Light-Duty Diesel Vehicles. As previously discussed in the section entitled, "Variable Costs - Hardware," EPA expects that diesel-powered vehicles will comply with the standards by simple recalibrations of existing adjustable parameters. The testing requirements for these types of adjustments should be minimal. EPA estimates that not more than 20 FTP tests will be required to calibrate a diesel engine family to comply with the high-altitude standards.

The number of LDV engine families to be certified for 1982 and 1983 is, of course, unkown at this time. EPA has assumed that approximately the same number engine families will be certified each year in 1982 and 1983 as was certified in 1980. In 1980 there were 117 non-California LDV 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.

There is, of course, the possiblity of carryover of emission data results from 1982 to 1983, thereby reducing the amount of development testing required in 1983. However, in order to maintain the conservative nature of this analysis, EPA will not account for this prospect.

iii. Light-Duty Trucks. EPA estimates that the amount of testing required to calibrate light-duty trucks in compliance with the regulations should be approximately the same as for light-duty vehicles, i.e., 150 FTP tests for LDTs and 20 FTP tests for LDDTs. Generally, it can be argued that many light-duty truck engine families have more configurations than a light-duty vehicle engine family and, therefore, the number of tests should be greater for LDTs. However, for 1982, the LDT standards are significantly less stringent than those for LDVs. This means that testing should also be significantly reduced. Overall, EPA believes that the leniency of the standards will more than compensate for the additional calibrations, but, to be conservative, we will use the LDV testing figures. For 1983, the LDT standards are more stringent than they are in 1982, but this should not cause the testing requirements to exceed 150 and 20 tests for gasoline and diesel trucks, respectively. Also in relation to the LDV standards, the LDT standards remain somewhat less stringent. The LDV standards represent a 90 percent emission reduction from partially controlled vehicles, whereas the 1983 LDT standards represent a 90 percent reduction from uncontrolled vehicles. Because LDVs were already partially controlled their standards are relatively more stringent. This tends to moderate the LDT requirement in relation to LDVs. Therefore, EPA believes the LDV testing figures are adequate for the 1983 LDV calibration effort.

As with LDVs, the number of non-California LDT engine families to be certified in 1982 and 1983 is unknown at the time of this writing. In 1980, 39 non-California LDT engine families were certified and EPA will assume that this many will be certified each year in 1982 and 1983 as well.

Now that the testing requirement has been estimated, the price per test remains to be determined before the cost of development can be found. Information obtained from commercial testing facilities located in Denver, Colorado, indicate that a manufacturer may run a development quality FTP test for about $375. Of course, the cost for manufacturers with their own private facilities will be less. In calculating the cost of development, EPA will use $500 per test. This will provide an adequate allowance for engineering and technical support, and prototype vehicle shipping expenses.

Table V-2 shows the development costs for the families with unique high-altitude calibrations. Development costs are estimated to be $8.9 million for LDVs and $5.5 million for LDTs, or a total of $14.3 million.

b. Certification. Under the high-altitude certification rules, manufacturers will be required to certify a high-altitude counterpart for each low-altitude configuration within an engine family. EPA has prescribed the high-altitude certification process in such a manner that the cost of the program is minimized, while still providing adequate assurance that high-altitude vehicles are complying with the standards. Manufacturers will not be required to build and accumulate mileage on special high-altitude certification vehicles. Deterioration factors (DF) for high-altitude vehicles will be the same as those developed with low-altitude, 50,000 mile durability vehicles. In EPA's emission factor program deterioration rates of in-use vehicles at high and low altitudes were compared. No statistically significant difference was found between the vehicles. Therefore, the assignment of high-altitude DFs based on low-altitude DFs is justified.

Manufacturers will be allowed to use their low-altitude, 4,000-mile data vehicles by modifying these vehicles into the selected high-altitude configuration. The new selection criteria requires the manufacturer to choose one emission-data vehicle per engine family which is expected to have the worst emissions when tested under high-altitude conditions. This emission-data vehicle 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.

Table V-2

High-Altitude Development Costs

Vehicle Category	Recalibrated Engine Families	Total Tests 1/	$ Total 2/
LDV	116	17,400	8,700,000
LDDV	16	320	160,000
Subtotal LDV	132	17,720	8,860,000
LDT	72	10,800	5,400,000
LDDT	6	120	60,000
Subtotal LDT	78	10,920	5,460,000
Total	210	28,640	14,320,000

1/ 150 and 20 FTP tests for gas and diesel vehicles, respectively.
2/ $500 per FTP development test.

The certification costs are estimated to be $842,000. This includes $631,800 for LDVs and $210,600 for LDTS. As shown in Table V-3, EPA estimates that 156 engines families will be certified for high-altitude sales. If a "worst case" is assumed where manufacturers do not carryover emission data results from year to year, the maximum possible certification burden will include testing 156 engine families for each of two years, or a total of 312. The estimated cost per test is $1,800. This figure includes $1,000 for high-altitude testing and $800 for vehicle transportation. The estimated testing cost may be high for manufacturers with their own high-altitude facilities. These manufactuers have one less profit center to account for than do manufacturers who contract for certification testing at commercial facilities. EPA will be conservative however, and not include this potential cost saving in the analysis.

c. Selective Enforcement Auditing (SEA). The promulgation of high-altitude standards will not significantly change the costs of existing SEA test program. First, the high-altitude standards will not increase the overall number of SEA audits a manufacturer must perform, assuming that the audited vehicles pass their respective tests. High-altitude audits count toward a manufacturers annual quota. Therefore, high-altitude audits are merely substituted for low-altitude audits and do not increase the quota. Second, as described in the "Summary and Analysis of Comments," manufacturers should experience little or no cost increase in transporting vehicles to SEA test sites or in testing. Therefore, EPA expects that the additional cost to the industry of high-altitude SEAs will be insignificant.

4. Total Cost to Manufacturers

As a result of the high-altitude standards, manufactures will experience increased costs in three main areas: development, certification, and emission control hardware. These costs are summarized in Table V-4. The total cost to maufacturers is $11.66 million for LDVs and $9.87 million for LDTs, or a combined total of $21.53 million (undiscounted, 1980 dollars).

B. Costs to Users of High-Altitude Vehicles

1. First Price Increase

The added cost to manufacturers for development, certification, and emission control system hardware will be passed on to purchasers of high-altitude vehicles. The amount a manufacturer must increase the price to recover its expenses depends on the timing of the costs and of the revenues from sales, as well as on the cost of capital to the manufacturer. Table V-G showed the manner in which the manufacturers' costs are distributed over the period 1981-1983. The cost of capital is 15 percent per annum and all fixed costs are recovered by the end of the 1983 model year. Based on the above information, the average first price increase

Table V-3

High-Altitude Certification Costs

Vehicle Category	Number of Families	Number of Tests/Family	Number of Model Years	$ Test	$ Total Cost
LDV	117	1.5	2	1,800	631,800
LDT	39	1.5	2	1,800	210,600
Total	156				842,400

Table V-4

Total Cost to Manufacturers
for the 1982 and 1983 Model Years

Vehicle Category	Year	Development Cost 1/	Certification Cost 1/	Hardware Cost 2/	Total
LDV	1981	4.43M	315,900		4.75M
	1982	4.43M	315,900	1.1M	5.81M
	1983			1.1M	1.1M
Subtotal		8.86M	631,800	2.2M	11.66M
LDT	1981	2.73M	105,300		2.84M
	1982	2.73M	105,300	2.1M	4.94M
	1983			2.1M	2.1M
Subtotal		5.46M	210,600	4.2M	9.87M
Total		14.32M	842,400	6.4M	21.54M

1/ Fixed costs.
2/ Variable costs.

for a high-altitude vehicle is about $23. This is comprised of $16 for development, $1 certification, and $6 for emission control hardware. This overall average figure represents a $20 increase for LDVs and a $36 increase for LDTs. Expressed differently, the cost increase for only those vehicles that require modifications, i.e., some feedback LDVs, all non-feedback LDVs and all LDTs, is $42 for LDVs and $36 for LDTs.

2. Operating Costs

a. Maintenance. EPA expects no change in the maintenance costs of high-altitude vehicles. Air pumps and aneroids are the only additional pieces of hardware that will be required on some vehicles to comply with the regulations. The remaining vehicles will not have additional hardware, although some will require special high-altitude calibrations. Such calibrations should not change the existing maintenance characteristics of high-altitude vehicles.

b. Fuel Economy. The high-altitude standards could potentially affect the fuel economy of low-altitude vehicles and high-altitude vehicles. With respect to low-altitude vehicles, we are convinced that these regulations will have no effect whatsoever. The availability of exemptions for certain low-power vehicles will enable the manufactuers 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 possiblity that a manufacturer would be prohibited from selling vehicles at low altitude because of an excess cost for high-altitude modifications.

For high-altitude vehicles, in general, it appears that these regulations will have a benefical effect on fuel economy. Manufacturers are expected to recalibrate many engines to compensate for the effects of high altitude on the combustion process. In particular, the fuel-air mixture for controlled engines will be leaner than for uncontrolled engines. The very limited data which are available to EPA indicated that the benefit for special high-altitude calibrations 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 from better high-altitude emissions performance.

3. Total Costs to Users

As a result of this regulation, users of high-altitude motor vehicles can expect to pay an average of $20 more for LDVs and $36 more for LDTs in 1982 than in 1981 (1980 dollars). Stated as a combined average, the increase for a high-altitude motor vehicle would be $23 (1980 dollars). Furthermore, there will be no change in maintenance costs, but there will be a small positive effect on fuel economy.

C. Aggregate Costs.

The aggregate cost to the nation of complying with the 1982 and 1983 high-altitude standards consists of the sum of increased costs for development, certification, and emission control hardware. These costs occur at different times within the period 1981-1983. Because of the time value of money, these costs can only be compared by determining their present value in some base year. For this analysis, the base year is arbitrarily chosen as the implementation date of the standard, 1982. A discount rate of 10 percent is used to approximate the social cost of capital.

The present value of the costs of this regulation are shown in Table V-5. The aggregate cost of $22.03 million is equivalent to a lump sum investment made at the beginning of 1982.

D. Socio-Economic Impact

1. Impacts on Manufacturers

a. Capital Expenses. Capital expenditures (fixed costs) are basically equal for each of the two years the standard is in effect Table V-5). Since the analysis assumes a "worst case" where there is no carryover of emission data results from 1982 to 1983, each year's investment must basically be recouped through each year's sales. Because the capital expenditure at the beginning of each of the two years is the same, the real burden of the standard can be viewed as raising the first year's fixed costs before vehicle sales begin to repay the investment.

The first year's fixed cost, or investment, is calculated to be $8.8 million. This cost is based on the assumption that every engine family a manufacturer sells at low altitude will be properly developed and certified for sale at high altitude as proscribed by the regulations. Furthermore, a capital cost for the industry of 15 percent was used in the analysis.

The capital requirements for some manufacturers will be greater than for others. The $8.8 million investment will be incurred primarily by manufacturers whose vehicles will require modification and, therefore, development testing to meet the standards. The investment cost for development testing can be apportioned to manufacturers as shown in Table V-6, based on their 1980 engine families.

Manufacturers should have little trouble financing the required investment. The investments are small when compared to the total capital requirements of the manufacturers in this period.

Table V-5

Aggregate Cost to the Nation for
1982 and 1983 High-Altitude Standards 1/

Year	Development Cost 2/	Certification Cost 2/	Hardware Cost 3/	Total	Discount Factor	Discounted Total
1981	7.16M	421,200		7.58M	1.10	8.34M
1982	7.16M	421,200	3.2M	10.78M	0.00	10.78M
1983			3.2M	3.2M	0.91	2.91M
Total						22.03M

1/ Present value in 1982, 1980 dollars, 10 percent discount rate.
2/ Fixed cost.
3/ Variable cost.

Table V-6

Manufacturers Expenditures
for the High-Altitude Standards

Manufacturer	$ Investment (thousands) 1/
Alfa Romeo	180
AMC	540
Aston Martin	90
Audi	30
Avanti	90
BMW	90
Jaguar/Rover/Triumph	450
Checker	270
Chrysler	890
Fiat	180
Ford	1790
Fuji	270
GM	470
Honda	180
Lotus	180
Maserati	90
Mercedes	50
Mitsubishi	450
Nissan	360
Peugeot	20
Porsche	10
Renault	90
Rolls Royce	90
Saab	10
Toyo Kogyo	450
Toyota	720
Volkswagen	310
Volvo	20
IHC	270
Isuzu	90
Suzuki	90

1/ Investment to meet the standards including a 15 percent capital cost.

b. Effects on the Demand for High-Altitude Vehicles. The average cost increase per high-altitude vehicle is estimated to be $23. This assumes that manufacturers will assign additional costs incurred solely to the high-altitude vehicles. However, it is possible that the costs of the high-altitude standards will be spread partly or entirely across the national market. This could significantly reduce the cost of high-altitude vehicles but would slightly increase the cost for all other vehicles. For example, spreading the costs over the national market would increase the cost of the average vehicle by about $1.

The impact of sales can be estimated by using the higher estimate of $23 per high-altitude vehicle. The average vehicle cost in 1982 and 1983 is assumed to be roughly $7,000, the cost of these standards represent a 0.3 percent increase. This can be used in conjunction with the following equation to estimate the impact on sales.

% in vehicle sales = [price elasticity][.5 (% change in vehicle price)]

Assuming the estimated 1982 and 1983 price elasticity for vehicles is 0.35 and that high-altitude total 1.1 million, the impact of this regulation will be to reduce vehicle demand by about 580 over the two year period, or less than one tenth of one percent of the total projected sales for the nation. Sales by some small manufacturers may decline more than those of larger manufacturers due to their reduced sales volume over which the development and certification can be amortized. However, the very small decrease in total industry sales, due to these regulations, will be more than overcome by normal sales growth. For this reason, the regulation is expected to have no noticeable effect or any single manufacturer's sales.

It is not expected that the promulgation of the regulation will have any impact on employment or productivity in the industry.

2. Impact on High-Altitude Dealers

The potential economic impact of these standards on dealerships can be divided into two general areas: reduced model availability and higher vehicle prices. Adverse changes in either area could affect vehicle sales and, hence, dealership profitability.

a. Model Availability. As previously discussed in Chapter IV, the 1977 high-altitude regulation's resulted in the unavailability of many models and optional engine configurations in high-altitude areas. Manufacturers chose to limit model availability in high-altitude because the small percentage of the market represented by high-altitude sales (about four percent) did not justify the development costs required to certify the emission control capabilities of all their vehicle configurations. Some high-altitude dealers alleged that this resulted in lost sales.

To avoid model availability problems with the 1982/1983 interim regulations, EPA will require that all models, regardless of where they are to be sold, shall meet, or shall be capable of being modified to meet, the high-altitude standards. Since almost all new vehicles will be certified for sale at high altitude, each manufacturer will be more likely to make its full product line available to high-altitude purchasers. Conceivably, a manufacturer might comply with the regulations by certifying all models for high altitude sale but choose not to offer certain models to high-altitude purchasers. The Agency believes, however, that manufacturers will make almost all models available once those models have been certified. An exception might involve certain low-power vehicles which perform poorly at high-altitude. Because the sale of such vehicles at high altitude would be unlikely, EPA has developed exemption criteria to certify them for principal use at low altitude. Furthermore, although 1982 LDTs will be given a 30 percent sales-based exemption because of leadtime considerations, these exempted vehicles may be offered for sale at high altitude. Thus, model availability at low altitudes should be ensured, while model availability at high altitudes will be maximized.

We believe that this control strategy, combined with manufacturers' increased experience with altitude-compensating emission control system, will keep availability problems well below the 1977 level. Thus, the overall economic impact of the interim high-altitude regulations should be minimal.

b. Higher Vehicle Prices. The incremental cost of a high-altitude vehicle depends on whether the dealer acquires the new vehicle by ordering it as original equipment from the factory or through a "dealer trade" with a low-altitude dealer. Some low-altitude vehicles acquired in dealer trades must be modified into the proper high-altitude configuration before they are sold.

The cost of factory built high-altitude vehicles depends on the manufacturers pricing strategy. If manufacturers choose to amortize the cost of this regulation across their national production, the average vehicle increase would be less than $1. This is indeed more than an interesting possibility, since it is likely that, at a minimum, manufacturers may recover at least some high-altitude costs through national sales. The largest single cost of this regulation is for development. Often times such non-recurring costs are pooled and then amortized across a manufacturers product line as the anticipated market and other variables, including competition, permit. Although the high-altitude market represents only a small percentage of total sales, this small amount may be more significant for manufacturers during their ascent from recent economic difficulties and as the entire market shifts to more competitive smaller cars than was the case in 1977 model year. Therefore, competition for high-altitude sales among manufacturers could be quite intense. Additionally, the industry's historical price leader, General Motors, will incur very little additional cost because of this regulation and will not require any significant cost increase even if all costs were recovered through high-altitude sales. This is most true for GM's LDVs. Therefore, because of competition with such companies as GM, other manufacturers may indeed raise high-altitude vehicle prices very little if at all in order to remain competitive.

If manufacturers do choose to recover their costs only on high-altitude sales, the estimated price increase for the average LDV is about $20 and for a LDT is about $36. The overall average will be about $23 per high-altitude vehicle. This represents approximately 290 lost sales per year, or 580 over the two year life of the standards. As stated in Chapter IV, there are about 1,000 high-altitude dealerships. However, only those dealers representing manufacturers whose vehicles must be recalibrated to meet the high-altitude standards will be impacted by significantly higher vehicle prices. As previously discussed in this chapter, the manufacturers building LDVs that generally will not require recalibration are GM, AMC, Nissan, Volkswagen, Volvo, JRT, BMW, Peugeot, Porsche, and Saab. The actual number of high-altitude dealers selling recalibrated vehicles is not readily available. Nevertheless, it is possible to reasonably estimate the number of high-altitude dealerships selling vehicles with significantly higher prices ($42 and $36 for recalibrated LDVs and LDTs, respectively), based on the national fraction of dealer outlets representing manufacturers which build recalibrated LDVs. Using this analogy, EPA estimates that 50 percent of the 1000 high-altitude dealers may be impact by significant first price increases. If equally impacted, each of these 500 dealerships would lose about one sale during the two year period. Therefore, the potential price increase for original equipment vehicles should have no significant economic impact on individual high-altitude dealerships.

In some cases, dealer trades may be adversely affected by the interim high-altitude standards. The impact on sales, however, remains conjecture. Dealer trades generally involve small rural dealers who cannot stock a wide variety of vehicles and must trade with large metropolitan area dealers to satisfy customer demand. Dealer trades were estimated by the Colorado Automobile Dealers Association to involve from 10 to 15 percent of sales by small rural dealers. Therefore, the potential impact will predominately apply to high-altitude dealerships which are isolated from high-altitude metropolitan areas. EPA is unable to estimate the number of such isolated dealerships, but believes it is reasonable to postulate that the number is relatively small since most high-altitude areas are within "trading" distance (a few hundred miles) of a high-altitude metropolitan area. Also not all manufacturers will have special high-altitude vehicles, so some dealers should not have any problem. Nevertheless, even though the number of high-altitude dealerships which may trade with low-altitude metropolitan dealerships may be relatively small, the potential impact on these dealers needs to be explored further.

First, while all LDTs may have special high-altitude emission controls, approximately one half of the LDVs sold will not require such special controls. The LDVs which do not need special controls will be identical to their low-altitude counterparts, as is currently the case; therefore, there is no potential to interfere with trading these vehicles between dealerships. The remaining vehicles should be available from the factory, so dealers will have access to all high-altitude models. But, if models are available from the factory, why be concerned about dealer trades at all?

High-altitude dealers have stated that their primary concern is being able to obtain vehicles that are in high demand. Apparently, in 1977 when most vehicles involved factory installed high-altitude modifications, there were sometimes long delays in obtaining vehicles and sales were lost. EPA has addressed this problem by requiring all vehicles that don't automatically comply with the standards, to be capable of being modifiable to do so. This will help ensure that the small number of isolated, rural dealerships which trade with low-altitude dealers can obtain vehicles on a timely basis and modify them into the proper configuration before sale. The only potential barrier could be that the modification might be expensive. The Colorado Automobile Dealers Association estimated that modifications costing perhaps up to $150 per vehicle would not affect sales. As discussed in the Summary and Analysis of Comments, EPA expects many vehicles will be modifiable for less than that amount. Since dealer trades appear to be most critical for high demand vehicles for which long ordering delays may be experienced, the real potential impact of the high-altitude standards is whether or not dealers will lose sales for those few vehicles that are in high demand and are expensive to modify.

Assuming that by the time a prospective customer contacts a dealerships the customer has previously decided that a specific new car is necessary and that a substitute, i.e., one that is more available, is not suitable, there are two fundamental problems in the "worst case". First, the vehicle of choice must be ordered from the factory but there will be a delay. Second, the vehicle of choice may be available sooner but must be modified at an extra cost of a few hundred dollars.

Since it will be illegal for a prospective customer to purchase a low-altitude vehicle elsewhere, a decision based primarily on economics must be made, i.e., is it worth the extra cost to have the specific vehicle sooner, or is it better to wait and, in the process, save money. No matter which choice is made, the sale is not lost in this example.

Of course, a prospective customer may not have previously decided on a particular high demand vehicle that is in short supply. If this is the case he may shift to another more available, vehicle from the same manufacturer. In this case the sale would not be lost. The customer may also decide to purchase a comparable vehicle from another dealer. In this case the potential sale would be lost. Or, the customer may have only been marginally interested in the particular "problem" vehicle and decides not to buy any vehicle. In this case the potential sale would also be lost.

In summary, the regulations should not significantly affect overall high-altitude sales. The potential for adversely affecting sales is limited to relatively isolated, rural high-altitude dealerships which must "modify" low-altitude vehicles acquired in dealer trades with low-altitude dealerships. For these isolated dealers, the potential problem should be limited to the relatively few "high demand" vehicles which are expensive to modify into the proper high-altitude configuration. Even in these instances, however, only a portion of such potential sales would be lost. Therefore, it is reasonable to assume that any single high-altitude dealership will not be greatly affected by high-altitude standards.

3. Impact on User

Users will be affected by higher new vehicle purchase prices. The averge price increase of $23, $20 per LDV and $36 per LDT should not substantially impact the owner's ability to pay for new vehicles. These standards should cause no increase in fuel or maintenance costs.

CHAPTER VI

COST EFFECTIVENESS

Cost effectiveness is a measure of what might be termed the economic effieiency of some action directed toward achieving some goal. Expressed as cost per unit of benefit achieved, cost effectiveness can be used to compare various alternative methods of achieving the same goal. In the context of improving air quality, the goal is to reduce emissions of harmful pollutants, and cost effectiveness is expressed in terms of the dollar cost per ton of pollutant controlled.

To evaluate cost effectiveness, two pieces of information on the alternative being evaluated are needed. These are the cost of the alternative and the benefits to be gained. The costs used in this chapter will be the total aggregate cost to the nation, discounted to the implementation date of the standards. These costs will be allocated equally between the pollutants being controlled. The benefits will be the total lifetime emission reductions resulting from the standard. The resulting cost effectiveness value will then be compared to other control strategies to determine its relative cost efficiency.

Table VI-1 summarizes the total pollutant reductions, total cost, and cost effectiveness of the interim high-altitude standards. These cost effectiveness values of $330 per ton of HC and $10 per ton of CO compare favorably to the values for other emission control strategies. As shown in Table VI-2, the values for these other strategies range up to about $1,000 per ton of HC and $50 per ton of CO.

Table VI-1

Cost Effectiveness for the High-Altitude Control Strategies

Pollutant	Reductions1/ (thousands of tons)	Cost2/ (million dollars)	Cost Effectiveness (dollar/ton)
HC	33	11.02	330
CO	1,195	11.02	10

1/ From Table III-11, divided equally between the pollutants.
2/ From Table V-5, divided equally between the pollutants.

Table VI-2

Cost Effectiveness for Other Control Strategies

Control Strategy	Cost Effectiveness ($/t) HC	CO
Degreasing 0-48%	-230 1/	
Gravure 0-98%	-60 1/	
Gas Terminal 0-67%	0 1/	
Miscellaneous Chemicals 0-35%	0 1/	
Dry Cleaning 0-80%	10 1/	
GHDV Evap. 5.8-0.5 g/mi.	20 1/2/	
Degreasing 41-90%	100 1/	
Industrial Finishing 76-97%	110 1/	
Gasoline Handling 16-50%	110 1/	
Miscellaneous Chemicals 35-53%	220 1/	
Gasoline Distributions 67-99%	300 1/	
Coke Ovens 0-80%	490 1/	
LDV Exhaust 0.9-0.41 g/mi.	530 1/	
Gas Handling 51-91%	780 1/3/	
GHDV 90% of Baseline	300 4/	8 4/
DHDV 90% of Baseline	162 4/	
LDV I/M	955 5/	49 5/
LDT 1.7-0.8 g/mi.	139-201 6/	
Motorcycles 9 to 8-22.5 g/mi.	420 7/	
Motorcycles 34.67-27.4 g/mi.		neg. 7/
LDV 15-3.4		48 1/

1/ U. S. DOT (1976)

2/ A more recent EPA analysis, which supports a regulation yet to be published as a proposal, yields numbers in the range of $70 to $250 per ton (yet to be released).

3/ Agrees reasonably well with a more recent EPA analysis (yet to be released).

4/ U. S. EPA (1978b).

5/ O'Rourke (1979).

6/ U. S. EPA (1979).

7/ U. S. EPA (1976).

CHAPTER VII

ALTERNATIVES

The following alternatives are analyzed in this impact statement.

1. Take no further action.

2. Reinstate the 1977 model year requirements with new *emission standards*.

3. Require that all vehicles meet high-altitude emission standards at high altitude and low-altitude standards at low altitude.

4. Require all vehicles to meet emission standards at the altitude at which they are sold, and to be capable of being modified to meet standards at other altitudes.

5. Implement standards as in number 4 above, but promulgate the less stringent standards that were recommended by the Motor Vehicle Manufacturers Association.

A. No Action

The Clean Air Act does not require that the Environmental Protection Agency establish high-altitude standards until the 1984 model year. High-altitude standards may be established no earlier than the 1981 model year, and only after the impacts addressed in this document justify the standards.

As shown in this document, the air quality impact of the 1982 through 1983 high-altitude emission standards will be significant and the economic impact will be acceptable. EPA has identified 13 areas as not attaining the national ambient air quality standards for carbon monoxide or photochemical oxidants which are above 4,000 feet in elevation (see Table VII-1). The Clean Air Act requires that the states provide for the implementation of all reasonably available control measures as expeditiously as is practical in such areas. Considering the severity of the air quality problems in high-altitude cities, EPA would be remiss if it did not promulgate high-altitude standards for the 1982 and 1983 model years.

Inspection/Maintenance (I/M) and implementation of Section 215 of the Clean Air Act, High Altitude Performance Adjustments, would help to offset the adverse air quality impacts of the no action alternative, but a much greater positive impact will be achieved if high-altitude emission standards are implemented in addition to both of these programs. Section 215 regulations have several problems:

Table VII-1

Environment Affected: High-Altitude Nonattainment Areas

Area	Pollutants	Altitude Meters	Altitude Feet
Tahoe Air Basin (California, Nevada)	CO, Ox	1,897	6,225
Fort Collins, Colorado	CO, Ox	1,421	4,663
Greeley, Colorado		1,519	4,984
Denver, Colorado	CO, Ox, NO2	1,609	5,280
Colorado Springs, Colorado	CO, Ox	1,832	6,012
Reno, Nevada	CO, Ox	1,368	4,490
Ely, Nevada	Ox	1,957	6,421
Albuquerque, New Mexico	CO, Ox	1,507	4,945
Famington, New Mexico	CO	1,200+	4,000+
Salt Lake City, Utah	CO, Ox	1,338	4,390
Bountiful, Utah	CO, Ox	1,338	4,390
Ogden, Utah	CO, Ox	1,309	4,295
Provo, Utah	CO, Ox	1,387	4,550

1. They would not achieve the same degree of per vehicle emission reduction as standards.

2. They would only require that adjustments be available, not that adjustments actually be made.

B. Separate High-Altitude Vehicles

Under this alternative, only vehicles initially sold for use at high altitude would meet or be capable of meeting the high-altitude standards. During the 1977 model year, when this approach was used, the manufacturers typically certified for sale at high altitude only high volume models and options. Many more fuel efficient, though less popular options were not made available, such as vehicles with manual transmissions and lower numerical axle ratios.

The result of the limited availability of different models and options was that at least some consumers purchased low-altitude vehicles, adversely affecting both air quality and high-altitude automobile dealers. A vehicle purchased at low altitude, and taken to high altitude could not be easily modified to meet emission standards. This presents a serious shortcoming in our mobile society, particularly in a high growth area such as Denver, Colorado.

The adverse impacts of the 1977 model year high-altitude regulation on high-altitude consumers and dealers caused Congress to withdraw that requirement for future model years. The adverse impact on consumers and dealers, and the adverse impact on air quality which would be caused by low-altitude vehicles which have been moved to high altitude, removes this alternative from consideration for the 1982 and 1983 high-altitude standards. These adverse impacts are discussed in more detail in Chapter IV.

C. All Vehicles Meet High- and Low-Altitude Standards

This alternative would impose a similar requirement as in the 1984 model year when all vehicles must meet the statutory emission levels regardless of the altitude at which they are sold (206(f) of the Clean Air Act). The only difference between this alternative and the 1984 requirement would be in the stringency of the emission standard at high altitude.

This alternative would have the greatest effect on air quality of any of the alternatives. All vehicles would have to be equipped with devices which would automatically compensate for altitude, regardless of whether they would ever be used at high altitude. The added cost of equipping all vehicles with altitude compensation devices would make this option more expensive than requiring all car to be capable of being modified to meet the standards if they don't already do so. The increased effectiveness of this option would be that transient low-altitude vehicles operating at high altitudes would meet the emission standards. If low-altitude residents permanently move to high-altitude areas, their cars would also meet the emission standards. However, high air pollution values are largely the result of rush hour traffic, which is overwhelmingly resident vehicles, so the air quality benefit of compensating such vehicles would be expected to fairly small. Another potential benefit of this alternative is that there should be absolutely no interference with either dealer trades or model availability because all vehicles will be originally built to meet both standards.

The alternative of requiring all vehicles to meet high-altitude standards at high altitude and low-altitude standards at low altitude is rejected for this two year standard because the leadtime necessary to implement such a control strategy is not available and because the air quality benefits are low relative to the increased cost.

D. Vehicles Modifiable to Meet High- or Low-Altitude Standards -- Proposed Action by EPA

This alternative would require that vehicles offered for initial sale for use at high altitudes meet emission standards at that altitude. It would also require that a vehicle sold for initial use at low altitude would be capable of being modified to meet standards at high altitudes. Vehicles offered for sale would have both a high-altitude and low-altitude configuration. All vehicles could be sold at either altitude as long as they are equipped with the modification applicable for the altitude of principal use. The modification would be required to be capable of being applied in the field (e.g., by the dealer), but could also be applied by the manufacturer prior to shipping. It would be the responsibility of the manufacturer that vehicles (properly maintained, operated, and equipped with the proper altitude modification) meet emission standards at any altitude over a specified range.

Vehicles sold at altitudes below 1219 meters (4000 feet) must comply with the low-altitude standards presently specified in 40 CFR Part 86. Vehicles sold above 1219 meters (4000 feet) must be capable of complying with high-altitude standards when tested at a reference point of 1,650 meters (5,400 feet). At the 1,650 meter reference point, the LDV high-altitude standards are 0.57 grams per mile HC, 7.8 grams per mile CO, and 1.3 times the low-altitude standards for evaporative emissions. The low-altitude oxides of nitrogen (NOx) standard applies at all altitudes.

Vehicle model availability will not be affected by this alternative. Vehicle models and options for sale at sea level will also be available at high altitude. Dealers at high altitude will be able to trade with dealers at low altitude for models they do not have in stock, as long as they equip the vehicle with the proper modification prior to sale.

Only those vehicles sold for use at high altitude will need to be built initially as high-altitude vehicles. This will greatly lower the economic impact of the high-altitude standards, since 96 percent of national sales will not be built as high-altitude configurations. Without a program such as State Inspection/Maintenance (I/M) there will be no requirement for vehicles moving from low to high altitude to be properly equipped. However, a State I/M program is necessary to insure that in-use vehicles continue to meet emission standards even at low altitude. Most high-altitude areas with severe CO or oxidant problems (all those with populations in excess of 200,000 not attaining standards by 1982) are required to have I/M programs by the Clean Air Act anyway.

Beginning with model year 1981, it is expected that 70 percent of the light-duty vehicles produced will have three-way feedback type emission control systems. These systems will have the inherent capability to automatically adjust for changes in air density with altitude. In some cases, the three-way systems will be capable of operation at the desired high-altitude emission levels without any changes in the emission control system. In other cases, a special high-altitude calibration may be required for vehicles sold at high altitude. The remaining 30 percent of the light-duty vehicles, with non-three-way type emission control systems, will be amendable to altitude compensation with the addition of special modifications such as aneroid-type devices or recalibrated carburetors. All light-duty trucks are expected to require the addition of compensation devices. Manufacturers would also automatically comply with the requirements of Section 215 of the Clean Air Act, (ie., high-altitude performance adjustments) through this option. This option also represents a reasonable interim program in preparation for the requirements which start with the 1984 model year under Section 206(f) of the Clean Air Act, when all vehicles must meet emission standards regardless of the altitude at which they are sold.

E. Vehicles Modifiable to Meet High- or Low-Altitude Standards - Proposed Action or MVMA

In response to EPA's proposed high-altitude regulations, the Motor Vehicle Manufacturers Association (MVMA) recommended an alternate technique for deriving the levels of the high-altitude standards. MVMA stated that their approach was more valid than that used by EPA. In analyzing the MVMA comments,1/ the Agency concluded that although both approachs to defining the standards were valid, EPA's methodology was preferred. Since MVMA's methodology can also be considered to be conceptually valid, their suggested standards should be considered as an alternative.

MVMA and EPA standards are compared in Tables VII-2 and VII-3. In relation to the EPA standards, MVMA standards would be less expensive and provide a smaller benefit. However, the cost reduction is not as great as the reduction in benefits; hence, the

MVMA standards are not as cost effective as the EPA standards. Especially troubling is the very low reduction in CO emissions which is the major pollutant in high-altitude areas. This causes the cost of reducing one ton of CO emissions with the MVMA standard to be 18 times as expensive as with the EPA standards.

The low reduction in CO emissions is primarily caused by the MVMA standard for 1982 LDTs. As shown in Table VII-3, this alternative standard is, in effect, no standard at all. In the 1982 model year LDTs would actually be allowed to pollute more at high altitude then if there was no "standard" (i.e., about 10 grams/mile more). This, of course, cannot be tolerated by EPA. It is also very unlikely that manufacturers would produce special vehicles that pollute more at high altitude. Nevertheless, there would certainly be no reduction in CO emissions and only a miniscule reduction in HC emissions at high altitude (Table VII-3). Currently, this situation would occur in the 1982 model year only; however, if the 1983 LDT low-altitude standards are postponed until 1984, there would be effectively no regulation of LDT emissions at altitude for either the 1982 or 1983 model years.

The MVMA alternative standards should not be promulgated in place of EPA's standards because the lower cost of the standards is not justified by the small overall reduction in emissions that would result. In particular, the MVMA LDT standard for 1982 would provide little or no emissions reduction at high altitude. EPA standards effectively control high-altitude emissions and, while more expensive, they are more cost effective, i.e., a lower cost per ton of pollutant reduced.

References

1/ "Summary and Analysis of Comments to the NPRM: High-Altitude Emission Standards for 1982 and 1983 Model Year Light-Duty Motor Vehicles," EPA, OANR, OMSAPC, 1980.

Table VII-2

Comparison of MVMA Standards v. EPA Standards

	LDV Std		LDT Std		Total	Emission Reductions		Cost Effectiveness	
	HC	CO	HC	CO	$	HC	CO	HC	CO
EPA	.57	7.8	2.0	26	22.54M	33K	1,195K	330	10
MVMA	.64	10.7	2.7	57	11.44M	19.8K	340K	310	180

Table VII-3

% Reduction in Lifetime Emission Rates -- MVMA v. EPA

	LDV		LDT	
	HC	CO	HC	CO
EPA	9.5	17.1	9.8	23.8
MVMA	8.2	11.8	0.7	-10.4