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DEVELOPMENT OF MOTOR VEHICLE EMISSIONS INSPECTION AND MAINTENANCE PROGRAMS FOR THE STATE OF WASHINGTON

Final Report

by

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ABSTRACT

Recent ambient air quality data for the State of Washington indicate that certain National Ambient Air Quality Standards will not be attained in all areas of the State by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the State will request from U.S. EPA an extension of the compliance data beyond 1982. In order for this request to be considered, the State must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. Currently the State, through its Department of Ecology, is developing a set of control strategies, including I/M, for implementation in certain areas. Technical assistance was provided to the Department of Ecology by GCA/Technology Division through a contract sponsored by Region 10 of U.S. EPA. The primary purpose of the assistance was to provide the Department of Ecology with information regarding technical aspects of I/M on a quick response basis to aid in the continuing process of program development. This document provides a summary of the work performed by GCA under this contract.

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INTRODUCTION

BACKGROUND

The 1977 Amendments to the Clean Air Act established the requirement for all areas in the U.S. to be in compliance with the National Ambient Air Quality Standards for carbon monoxide (CO) and photochemical oxidants (O_x) by 31 December 1982. Further, these amendments required that State Implementation Plans (SIP) be developed and submitted to the U.S. Environmental Protection Agency indicating precisely what methods would be used to ensure compliance by the 1982 mandatory attainment date.

Several nonattainment areas have been identified in the State of Washington, therefore the State, through its Department of Ecology, has been involved with the development of a set of control strategies that will be applied in those areas requiring such control. One strategy that is currently proposed for implementation is the establishment of a motor vehicle inspection and maintenance (I/M) program for a portion of the Puget Sound Air Quality Control Region, and possibly for the Spokane area as well. The overall responsibility for developing the I/M program lies with the Department of Ecology.

The initial effort undertaken by the Department of Ecology focused on identifying and assessing various technical issues that will ultimately define the program format in terms of what vehicles will be included, how and where the inspections will be performed, who will perform the inspections, how much the inspections will cost, and others. Technical assistance was provided to the Department of Ecology by GCA/Technology Division through a contract sponsored by the Region X Office of the U.S. Environmental Protection Agency. Specifically, this assistance involved responding to requests by the Department of Ecology for information regarding technical aspects of I/M, both in a general sense and as applied specifically to implementation in the State of Washington. The primary purpose was to provide a quick response to the Department so that the information could be used in the continuing process of program development. In order to expedite this process, a technical memorandum was prepared for each task performed; this resulted in a more or less continuous flow of information to the Department throughout the contract period.

The purpose of this document is to provide a summary of the work performed by GCA under this contract. In this connection, a summary of each task performed is provided here.

SECTION 2

SUMMARY OF WORK PERFORMED

INTRODUCTION

During the contract period the Department of Ecology identified a total of six tasks related to the I/M development effort. Again, these tasks were accomplished in support of the overall process of developing the I/M program. Information developed as a result of these tasks was used either directly in the program planning effort, or as background data and therefore used in a more indirect fashion. The following paragraphs summarize the six tasks performed.

TASK 1 - REVIEW PROPOSED SIP REVISION FOR THE PUGET SOUND REGION

The objective of this task was to review the techniques used to develop the mobile source emissions inventory for the Puget Sound region. This review indicated that the SAPOLLUT and MOBILE1 models were used to generate emissions estimates based on the 1977, 1982, and 1990 highway networks. This modeling was conducted by the Department of Transportation. The SAPOLLUT model was modified by the Department of Transportation so that current emissions factors could be used. A number of assumptions were used in defining various input parameters; these are summarized in Table 1.

With regard to CO analysis in the Puget Sound SIP, SAPOLLUT was used to generate total emissions produced in various area configurations, among which were 2 km by 2 km UTM grid cells. Selected grid cells, then, define the activity centers that are considered CO hot spots. It is noted that all hot spots were designated as a result of long-term ambient monitoring activity; the absence of a monitoring station in a particular area precludes that area from consideration as a hot spot. The measured air quality data were used as the basis for determining the reduction in emissions necessary within the grid cell in order to comply with the NAAQS; the actual reduction was derived using a proportional rollback technique.

Our primary comments concern two issues. First, we are somewhat uncertain about the appropriateness of basing CO emissions reduction requirements for an area (i.e., the 4 km^2 grid cells that define the hot spots) on the apparent CO concentrations measured at only 1 or 2 sites within that area. Our concern is based on the fact that CO is an extremely localized pollutant, therefore, hot spots should be considered in terms of individual intersections or street links rather than a fairly large area (4 km^2, for instance). It is our opinion that the areawide approach is not necessarily sensitive enough to adequately

assess either the pervasiveness of individual hot spots, the root causes of the high ambient CO levels, or particular measures that may be effective in reducing CO emissions locally but not on an areawide basis (traffic signal improvements, for example). Currently, the SIP analyzes the impact of localized measures, such as signal interconnection, from the standpoint of their impact on total emissions produced in the grid cell. This means that the importance of CO emissions reductions realized from such a measure could be drastically understated if the reduction was considered from the perspective of total emissions produced in the grid cell. Moreover, the direct impact of measures that affect traffic flow are defined in terms of average travel speed. Other critical factors (again, relative to very localized areas such as individual intersections or street links), such as acceleration/deceleration time and rates, and delay (idling) time, are not reflected realistically when considering areawide CO production, owing primarily to the use of FTP-based emissions factors being applied rather than a more site-specific technique such as applying the Modal Analysis Model.

TABLE 1. ASSUMPTIONS USED IN DEVELOPING THE MOBILE SOURCE EMISSIONS INVENTORY FOR THE PUGET SOUND REGION

Parameter	Assumption used for CO inventory
Ambient Temperature	45°F
Vehicle Speed	One speed assumed for all vehicles using a specific link
Cold Starts	20.6% of Daily VMT; additional cold mode fraction included at origins and destinations.*
Hot Starts	27.6% of Daily VMT
Vehicle-type distribution	LDV = 83.3%; LDT_1 = 5.8%; LDT_2 = 5.8%; HDV-G = 4.5%; HDV-D = 3.1%; MC = 0.5%†
Vehicle age distribution	National average (as defined in MOBILE 1).
8-hour and 1-hour maximum emissions	60% and 10% of total daily emissions.

*Some question remains regarding the assumptions used for this additional component.

†It is noted that the total is 103%. This is assumed to be a result of a typographical error in the report.

Source: Attaining and Maintaining Air Quality Standards in the Central Puget Sound Region. Puget Sound Air Pollution Control Agency. November 1978.

Further, it is not clear that the monitoring site is actually measuring typical (average) ambient levels for the entire grid cell. One certainly would be tempted to ask if compliance at the monitoring site assures compliance elsewhere in the grid cell (similarly, does the monitor actually measure atypically high levels, with respect to the entire grid cell, because of unique traffic characteristics on the surrounding streets). These types of questions should be considered prior to committing various control measures, primarily to assure that the measures are: (1) adequate, and (2) required. It is our conclusion that the answers to these questions can be formulated only after a comprehensive, site-specific analysis is undertaken.

The second area concerns the assumptions used in developing the CO emissions inventory. In general, we agree with most assumptions used, however, we offer the following suggestions. First, one set of assumptions regarding the vehicle-type distribution is used for all functional classes of highway. It may be that a more precise estimate of the vehicle-type distribution as a function of roadway type (functional class) could be incorporated. This is particularly important in assessing CO since very local traffic characteristics dominate with respect to ambient levels at any particular site, and emissions characteristics vary widely by vehicle type. Vehicle-type distribution for various cities around the United States indicate that substantial differences can be expected among the different functional categories.

It is also suggested that the cold-start percentage be considered as a function of both general location (e.g., downtown zones, residential zones, etc.) and time of day. Again, since CO is of primary importance, it is appropriate that the analyses reflect both spatial and temporal variations in emissions in as much detail as is practical.

TASK 2 - ASSESSMENT OF THE IMPACT OF VARYING STRINGENCY FACTOR AND VEHICLE AGE CUTOFF ON CO EMISSIONS REDUCTION POTENTIAL

This task involved a detailed assessment of the sensitivity of emissions reduction potential as a function of the stringency factor used and the vehicle model years included in an I/M program. The objective was to provide sufficient data for the DOE to select the optimum stringency level and policy concerning vehicle exemptions. The results of this task effort were reported in Technical Memorandum No. 1, dated June 1979, entitled "Impact of Varying Stringency Factor and Vehicle-Age Cutoff on CO Emission Reduction Potential from I/M."

Motor vehicle emission inventories for CO were developed for several I/M scenarios that could be implemented in the Central Puget Sound Region, utilizing EPA's MOBILE1 computer model. Included were estimates of the emissions reductions achievable from the following I/M program configurations:

- No vehicle age exemptions, with stringency factors (failure rates) of 10, 20, 30 and 40 percent.
- Vehicles older than 15 years exempt, with stringency factors of 10, 20, 30, and 40 percent.
- Vehicles other than 12 years exempt, with stringency factors of 10, 20, 30, and 40 percent.

- Vehicles older than 10 years exempt, with stringency factors of 10, 20, 30, and 40 percent.

- Vehicles older than 8 years exempt, with stringency factors of 10, 20, 30, and 40 percent.

Inventories were developed for 1987 indicating the impact that each program scenario would have in terms of both emissions from the affected vehicle population only (essentially light-duty cars and light-duty trucks), and emissions from the entire vehicle fleet. Summary matrices of the emission reductions achievable as a function of vehicle age exemption and stringency factor are provided for affected vehicles only and all vehicles in Tables 2 and 3, respectively.

Of particular interest are the reductions shown in Table 2, those achievable by affected vehicles for 1987. As stated in the Federal Guidelines for I/M programs, USEPA requires at least a 25 percent reduction in emissions in 1987 from light-duty vehicles (LDV's and LDT's) included in the program compared to the emissions which would have been produced by these same vehicles in the absence of I/M. In Table 2 it is shown that even the minimum program being analyzed here, (10 percent stringency, vehicles older than 8 years exempt), will just meet the minimum reduction criteria. The results given in Table 2 are graphically displayed in Figure 1.

Increasing either the stringency factor or age exemption cutoff will increase the emission reduction achievable. It should be noted, however, that the "law of diminishing returns" applies here. The additional reduction achievable by increasing the stringency factor from 20 to 30 percent is significantly less than that achieved by increasing the stringency level from 10 to 20 percent. Similarly, the additional reduction achievable by increasing the age exemption cutoff from 10 years to 12 years is significantly less than is achievable by increasing the age exemption cutoff from 8 years to 10 years.

Since the program scenarios evaluated reflect different numbers of inspected and failed vehicles, it is instructive to consider two additional statistics - the emissions reduction achieved per inspected vehicle, and the reduction achieved per failed vehicle. Table 4 shows that the emission reduction per inspected vehicle increases as the program is made more stringent, in terms of both failure rate and age exemption criteria. For any given age exemption cutoff, increasing the failure rate will yield greater reductions per inspected vehicle as the number of vehicles requiring maintenance increases with a constant inspectable vehicle population. Increasing the age exemption cutoff while holding the failure rate constant will also yield increased reductions per inspected vehicle as older vehicles will tend to realize greater benefits (in terms of emission reduction) from maintenance. Thus, despite an increased inspectable vehicle fleet, the emissions reduction per inspectable vehicle also increases. This may be better demonstrated in Table 5, emission reductions per <u>failed</u> vehicle.

TABLE 2. CARBON MONOXIDE EMISSIONS REDUCTIONS ACHIEVABLE BY 1987 (%), FOR THE CENTRAL PUGET SOUND REGION FOR AFFECTED VEHICLES ONLY AS A FUNCTION OF STRINGENCY AND AGE EXEMPTION*

Exempt vehicles older than:	Stringency (%)			
	10	20	30	40
8 years	25	29	32	34
10 years	30	36	40	42
12 years	33	39	44	46
15 years	36	43	48	51
No age exemptions	38	45	50	54

*Light-duty vehicles (LDV, LDT1, LDT2)

TABLE 3. CARBON MONOXIDE EMISSION REDUCTIONS ACHIEVABLE BY 1987 (%), FOR THE CENTRAL PUGET SOUND REGION, FOR ALL VEHICLES AS A FUNCTION OF STRINGENCY AND AGE EXEMPTIONS

Exempt vehicles older than:	Stringency (%)			
	10	20	30	40
8 years	19	22	24	25
10 years	23	27	30	32
12 years	25	30	33	35
15 years	27	32	36	38
No age exemptions	28	34	38	41

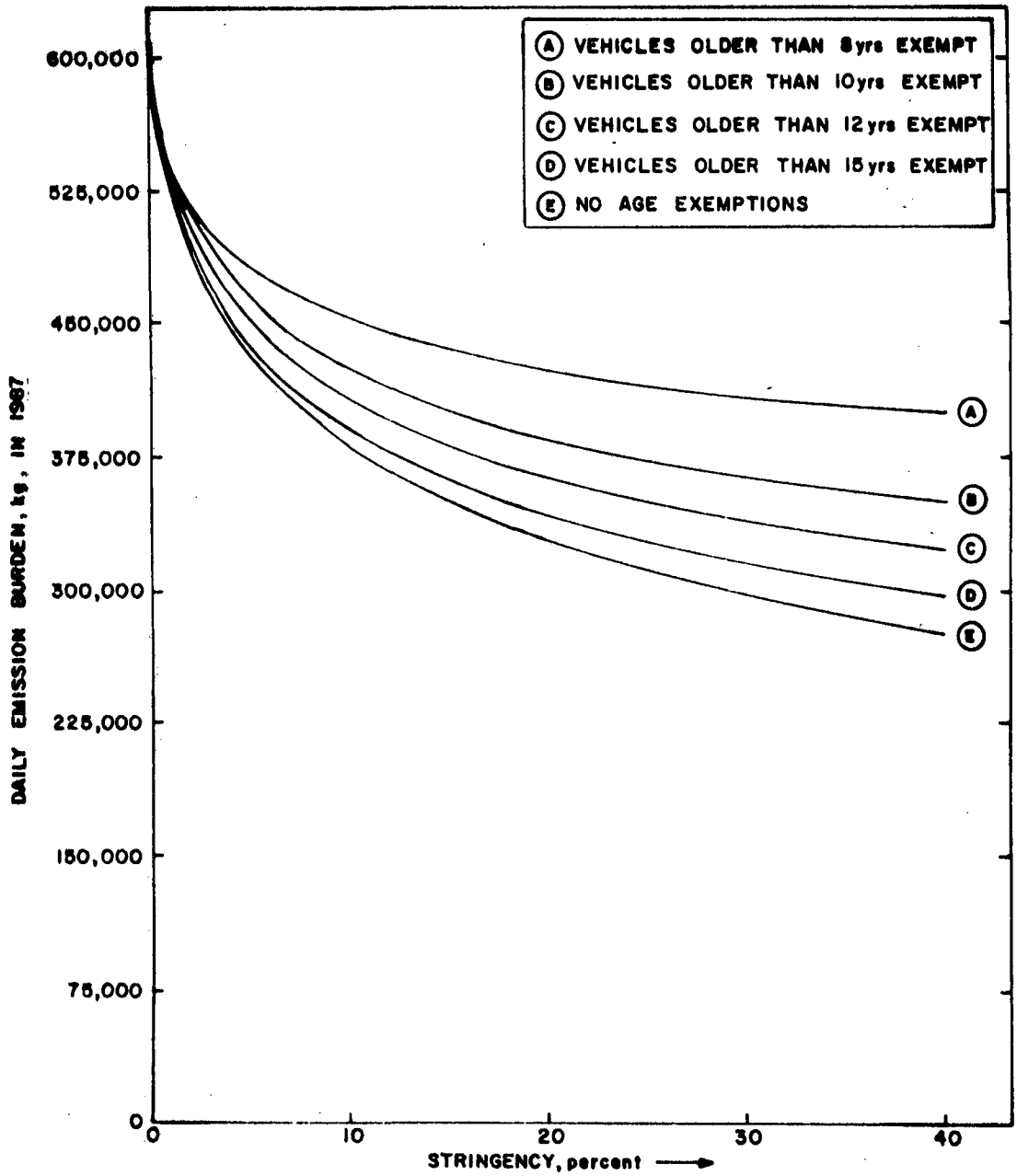

Figure 1. Projected 1987 CO emission burden from affected vehicles as a function of stringency factor, for various age exemption cutoffs.

TABLE 4. PROJECTED 1987 CO EMISSIONS REDUCTION PER INSPECTED VEHICLE (kg/day) FOR THE CENTRAL PUGET SOUND REGION, AS A FUNCTION OF STRINGENCY AND AGE EXEMPTION CUTOFF

Exempt vehicles older than:	Stringency			
	10	20	30	40
8 years	0.106	0.125	0.135	0.144
10 years	0.111	0.133	0.146	0.155
12 years	0.112	0.135	0.150	0.159
15 years	0.117	0.141	0.157	0.167
No age exemptions	0.121	0.145	0.162	0.173

TABLE 5. PROJECTED 1987 CO EMISSIONS REDUCTION PER FAILED VEHICLE (kg/day), FOR THE CENTRAL PUGET SOUND REGION, AS A FUNCTION OF STRINGENCY AND AGE EXEMPTION CUTOFF

Exempt vehicles older than:	Stringency factor (percent)			
	10	20	30	40
8	1.060	0.625	0.450	0.360
10	1.110	0.665	0.487	0.388
12	1.120	0.675	0.500	0.398
15	1.170	0.705	0.523	0.418
No age exemptions	1.210	0.725	0.540	0.433

While increasing the age exemption cutoff will yield greater reductions per failed vehicle, increasing the stringency factor will have the opposite effect. A low failure rate will identify only the "gross emitters," those vehicles which stand to achieve the greatest emission reduction with maintenance. By increasing the failure rate, total emission reductions and reductions per inspected vehicle will increase; however, vehicles standing to gain less emission reduction from required maintenance are now also failed, thus lowering the average reduction per failed vehicle.

The emission statistics reported above are based on the assumption that all vehicles operating in the study area will be included in the I/M program (with the exception of age waivers). Since the State is considering an I/M program that is limited to the most densely developed areas, the above assumption will probably be invalid. This does not reduce the value of the inventories presented here, however, for two reasons: first, the relative emission reductions between scenarios are of more value in selecting an I/M program than the actual magnitude of emission burden; secondly, the inventories presented here may be utilized in assessing the likely result of adding or eliminating certain areas to the program, given some indication of the magnitude of VMT in the study Region generated by vehicles registered in the areas in question.

TASK 3 - EXAMINE AND SUMMARIZE THE PROVISIONS OF SECTION 207(b) OF THE CLEAN AIR ACT AMENDMENTS OF 1977

Under this task the provisions of Section 207(b) were analyzed and an explanatory document was developed and submitted to the State. This document provided discussion of several issues connected with Section 207, including:

- Background of emission control warranty, its purpose and justification;
- Emission control components covered and duration of coverage;
- Vehicles covered by warranty;
- Emission tests capable of activating the warranty and relationship of these tests to I/M programs;
- Warranty claim procedures (manufacturer and vehicle owner responsibilities and obligations); and
- Summary of benefits of warranty.

The U.S. Environmental Protection Agency considers the emissions performance warranty, along with inspection/maintenance (I/M), as primary strategies for ensuring that in-use motor vehicles continue to meet the emission standards for which they were designed. The 207(b) warranty provisions and I/M are directly related in that the claims under the 207(b) provisions can only be made as a result of failing an emissions test conducted as part of an I/M program. The warranty, then, is an important safeguard for consumers affected by I/M, and therefore is also an important inducement for manufacturers to build long lasting, effective emission control systems and components.

Under provisions of the warranty, the vehicle owner is responsible for performing routine maintenance on the control devices, while the manufacturer is responsible for replacing or repairing components or systems that fail within the warranty period if proper maintenance has been performed by the vehicle owner

During the initial period of 24,000 miles or 24 months the 207 (b) warranty covers any system, assembly, or device, or component thereof which affects emissions. From this period until the warranty expires at 50,000 miles or 5 years, the coverage is somewhat more limited. It only includes "a catalytic converter, thermal reactor or other component installed in or on a vehicle for the sole or primary purpose of reducing emissions, which was not in general use prior to the model year 1968." This more limited coverage does include modification to parts (other than calibration changes) made for the sole or primary purpose of reducing motor vehicle emissions.

The warranty will be applicable only to those vehicles manufactured in the model year subsequent to EPA promulgation of the regulations establishing the emission performance warranty. EPA has developed short tests (discussed below) for light-duty vehicles, and it has been indicated that the regulations concerning these tests and the warranty will be promulgated prior to model year 1981. It is expected, therefore, that 1981 and later model year light-duty vehicles would be covered by these regulations. EPA also anticipates that appropriate short tests will eventually be developed for other types of vehicles, so that the warranty provisions will eventually extend to include all vehicle types.

The following excerpt describes the warranty claims procedures in the proposed regulations:

> "(a) A claim under the Emissions Performance Warranty may be raised immediately upon failure of an EPA-approved emission test if, as a result of that failure, an owner is required to take action of any kind in order to avoid imposition of a penalty or sanction. An owner need not suffer the loss of the right to use a vehicle, be fined, incur repair expenses, or actually bear any penalty or sanction to satisfy the requirement of Section 85.2103(a)(3). That requirement shall be met if a test failure sets a procedure in motion under which the owner will bear a penalty or sanction if a vehicle is not brought into conformity, or repaired to some specified extent."

There are two important points to note here. The first concerns the definition of an EPA-approved test. As required in Section 207(b), the U.S. EPA has developed short tests for light-duty vehicles that correlates adequately with the lengthy Federal Test Procedure (FTP). These tests include:

- the idle test
- the Federal 3-mode

- the Clayton Key mode
- the Federal Short cycle
- the New York/New Jersey short cycle.

It is anticipated that the tests will be approved prior to 1981. Existing inspection/maintenance programs around the country use both the idle and loaded tests which are essentially identical to the tests developed by EPA and therefore are capable of activating the warranty.

The second point is that, in order to involve a claim under 207(b), a vehicle owner need not actually suffer the penalty of a fine or denial of registration but simply that the failure of the emission test sets in motion a procedure under which he ultimately would be fined or otherwise penalized if the vehicle was not subsequently repaired.

Significant potential exists for motorists to expeirence difficulties in obtaining warranty-related repairs on emissions control systems. In view of this, claim procedures have been included in the proposed rules that require the manufacturer to prove that the owner does not meet the warranty requirements if a warranty claim is challenged. Under this proposal, the manufacturer is required to inspect the vehicle to determine if there is objective evidence that the owner had not performed the proper maintenance of the emission-control devices as set forth in the owners manual (what constitutes objective evidence will presumably be defined later, probably in agreements between EPA and each auto company). Finding objective evidence, a manufacturer may then ask the owner to see his repair records or maintenance logs (warranty book) to demonstrate that he was following proper maintenance instructions.

In summary, there are three basic areas where the warranty program would be particularly effective. First, it would provide an incentive for vehicle owners to undertake proper, routine maintenance in order to meet warranty requirements. Second, the program would provide an incentive for motor vehicle manufacturers to design and build vehicles with emission control systems and devices capable of lasting for the useful life of the vehicle. And, finally, the warranty provisions may encourage states and localities to ensure the quality of repair work through repair facility certification or licensing.

TASK 4 - ASSESSMENT OF POLICIES REGARDING VEHICLE EXEMPTIONS AND WAIVERS

The objective of this task was to assess the implications of various policies affecting the vehicle population included in the I/M program and the granting of waivers under certain circumstances. The focus of the effort was to define the impacts in terms of air quality benefits, consumer attitude, and repair cost distribution; these issues were presented in Technical Memorandum No. 3 - "Exemptions and Waivers," dated July 1979.

One of the more crucial factors that determine the success or failure of any I/M program concerns public acceptance. In order for any I/M program to be accepted by the public, it must be perceived as fair and equitable. In this regard, it is important that the program provide exemptions for certain

circumstances. Issues such as vehicle age and repair costs for compliance, and matters of practicality such as vehicles that present difficulties in the actual performance of inspections, must be considered since arbitrarily including all vehicles (in general or even within any particular category) may jeopardize the success of the entire program.

At this point, the term *"exempt"* will be defined to mean not affected by the program. An exempt vehicle, therefore, would not be required to become involved in any facet of the I/M program. *"Waivers"* are considered to be different from exemptions in that waivers apply to individual vehicles or subsets of particular vehicle categories.

Specific requirements for the implementation of motor vehicle I/M programs were established under the Clean Air Act Amendments of 1977. By mandate, only light-duty vehicles (LDV) must be included in the program.

The I/M program in Washington will exempt the following types of vehicles:

- New motor vehicles,
- Vehicles that are more than 14 years old,
- Electric vehicles,
- Motorcycles,
- Diesel vehicles,
- Farm vehicles, and
- Vehicles given special consideration by the Director of the Department of Ecology.

The question of heavy-duty truck (gasoline or diesel-powered) exemptions is often controversial. Many view trucks as "the real polluters," since, occasionally, visible particulate emissions are emitted from these types of vehicles (generally, diesel-powered trucks). An examination of an emission profile for the mobile sources in the Central Puget Sound Region, provided in Table 6, shows that by 1987, 69.9 percent of the carbon monoxide emissions and 81.4 percent of the hydrocarbon emissions will be generated by the light-duty fleet while the heavy-duty diesel fleet will contribute only 2.4 percent and 3.5 percent, respectively, to the total carbon monoxide and hydrocarbon emissions within the region. It is quite clear from Table 6 that exempting heavy-duty, diesel-powered vehicles will probably be of minimal consequence in terms of total emissions reduction. On the other hand, it can be concluded that the contribution from heavy-duty, gasoline-powered vehicles is significant enough to warrant these vehicles being included in the program.

Several additional issues must be considered with regard to including heavy-duty vehicles of any type in an I/M program. One issue, for example, concerns the need for information on the present state of routine maintenance practices in the heavy-duty vehicle sector. It is quite likely that there would be a tendency for commercial fleet owners to maintain their vehicles more adequately than do individual vehicles owners, primarily because the higher operating costs associated with an improperly-maintained vehicle are generally more

TABLE 6. EMISSIONS PROFILE FOR THE CENTRAL PUGET SOUND REGION - 1987 EMISSIONS (kg/day)*

Pollutant	LDV†	HDV-G	HDV-D	MC	Total
	kg/day (% total)	kg/day (% total)	kg/day (% total)	kg/day (total)	kg/day (% total)
CO	461,980 (69.9)	182,013 (27.6)	15,899 (2.4)	711 (0.1)	660,603 (100)
HC‡	47,047 (81.4)	8,546 (14.8)	2,043 (3.5)	135 (0.2)	57,771 (100)

*Emissions in 1987, without I/M, T = 75°F.

†Includes LDV's, LDT1's, LDT2's.

‡Reactive (nonmethane) hydrocarbons only.

Source: GCA calculations, 1979.

visible and considered more crucial to commercial fleet operators. This could mean that the actual potential for reducing emissions from heavy-duty vehicles is somewhat less than might be indicated otherwise.

A second issue concerns the fact that commercial vehicles typically accumulate mileage at very high rates (it certainly would not be unusual for a long haul unit to average over 100,000 miles annually, or for a delivery truck to travel over 40,000 miles yearly). One could question, then, the effectiveness of an annual emissions inspection. Related to this is the issue of where the commercial vehicle travel occurs. Long haul and certain private carrier operations are likely to involve travel almost exclusively outside a relatively small area (such as the Central Puget Sound Region), therefore, if I/M requirements were imposed, most of the benefits might be realized outside of the area.

The basic inspection requirements for heavy-duty vehicles are different from those for light-duty vehicles. Larger inspection facilities and special equipment are required for heavy-duty vehicles therefore the program cost is increased. All of these issues must be considered in the context of heavy-duty vehicle exemption policies.

Waivers are generally granted on the basis of costs associated with complying with the standards. Usually, states set specific limits, generally $50 to $100, on the amount of money that has to be spent on necessary repairs before a waiver is granted releasing the vehicle owner from compliance.

Also, waivers can be granted to owners of either new vehicles being registered for the first time, or vehicles that, for some technical reason, cannot be tested easily. For instance, testing full-time, four-wheel drive vehicles on a dynamometer (loaded-mode) may not be practical; a waiver could be granted or an idle test could be prescribed for these special vehicles.

The I/M Legislation for the State has established a mandatory repair cost limit of $50. Analyses were performed to determine the impact of this $50 repair limit on the expected emissions reduction achievable with the I/M program. The results of this analysis are summarized in Table 7.

TABLE 7. AGGREGATED 1972-1977 FTP EMISSION REDUCTIONS AS A FUNCTION OF REPAIR COST CEILING

	Percent reduction*			
Cost ceiling ($)	FTP HC	(Percent of total reduction potential)	FTP CO	(Percent of total reduction potential)
No limit	41	(100)	43	(100)
150	40	(98)	42	(98)
100	32	(78)	41	(95)
75	29	(71)	38	(88)
50	26	(63)	34	(79)
25	16	(39)	27	(63)

Source: GCA Calculations, 1979.

*Assumes a 20 percent failure rate.

As shown in Table 7, the establishment of a $50 repair cost ceiling will result in the realization of only 63 percent of HC and 79 percent of the CO emissions reduction possible without a repair cost limit.

Table 8 describes the CO emission reductions associated with the I/M program as a function of repair cost ceiling and stringency factor. The same analysis was performed for hydrocarbon emissions; this matrix is provided in Table 9.

As shown in Table 8, the $50 repair cost ceiling will enable the State to utilize a stringency factor as low as 10 percent and still assure more than a 25 percent reduction in carbon monoxide emissions from the projected 1987 level without I/M. However, hydrocarbon emissions reduction, as shown in Table 9, requires both additional stringency and/or a higher repair cost ceiling. Even without a repair cost ceiling, a 10 percent stringency factor will be best yield at 34 percent HC emission reduction.

TABLE 8. I/M-RELATED* CO EMISSIONS REDUCTION ACHIEVABLE BY 1987 (PERCENT) FOR THE CENTRAL PUGET SOUND REGION, AS A FUNCTION OF STRINGENCY FACTOR AND REPAIR COST LIMIT

Repair cost ceiling ($)	Stringency (percent)			
	10	20	30	40
No limit	36	43	48	51
150	35	42	47	50
100	34	41	46	48
75	32	38	42	42
50	28	34	38	40
25	23	27	30	32

*Light-duty vehicle (LDV, LDT1, LDT2) emissions only, I/M begins in 1982, vehicles older than 15 years exempt.

Source: GCA Calculations, 1979.

Currently it is proposed that the maximum failure rate for the program be 30 percent. Realistically, then, it can be expected that the actual failure rate would be in the range of approximately 20 to 30 percent, which, as indicated in Table 8, would likely achieve the minimum reduction with a $50 repair cost limit. It must be remembered, however, that the repair costs shown here are in constant 1978 dollars, therefore the real issue is the types of repairs performed rather than merely repair costs.

TABLE 9. I/M-RELATED* HC EMISSIONS REDUCTION ACHIEVABLE BY 1987 (PERCENT) FOR THE CENTRAL PUGET SOUND REGION, AS A FUNCTION OF STRINGENCY FACTOR AND REPAIR COST LIMIT

Repair cost ceiling ($)	Stringency (percent)			
	10	20	30	40
No limit	34	41	44	48
150	33	40	43	47
100	27	32	35	38
75	24	29	31	34
50	22	26	28	31
25	13	16	17	19

*Light-duty vehicle (LDV, LDT1, LDT2) exhaust emissions only. I/M begins in 1982, vehicles older than 15 years exempt, nonmethane hydrocarbons only.

Source: GCA Calculations. 1979.

The reader is also cautioned that the data used to develop the above analysis were somewhat tentative, therefore the most appropriate conclusions are those that consider the relative rather than absolute implications of repair cost, stringency, and program effectiveness.

TASK 5 - ANALYSIS OF ISSUES RELATED TO GEOGRAPHIC COVERAGE

This task required that detailed assessments be made of various proposals for defining the geographic coverage of the I/M program. Considered were issues such as EPA requirements, regional travel patterns, public attitude, enforcement, and specific boundary definitions. The results of the assessment were reported in Technical Memorandum No. 4 - "Geographic Coverage," dated August 1979.

There are several factors to be considered by the State when defining the geographic coverage of the I/M program. The urban areas with populations of 200,000 or more plus the adjacent fringe areas are the EPA-suggested minimum boundaries. For the Puget Sound Region, the urban plus fringe areas constitute considerable portions of greater Seattle, Everett, and Tacoma.

Since some flexibility in boundary definition has been provided in the EPA policy guidance ("Boundaries of the area affected may be adjusted if an equivalent emission reduction is achieved."), Washington should utilize this flexibility to define boundaries that will:

- enable the program to achieve at least minimum reduction criteria;
- be logical in terms of equity;
- be enforceable; and
- be acceptable to the public.

In addressing these issues several factors must be considered in addition to the formal urban area definitions. These include: travel patterns, public reaction, enforcement considerations and the need to utilize some readily identifiable means for defining the I/M area (city or county lines, or ZIP code zones, for instance).

In order to calculate the potential emissions reduction within the nonattainment area, the percentages of total VMT attributable to "affected" and "nonaffected" vehicles must be considered. If a significant portion of vehicles from a non-I/M area travel to I/M areas, then it would be appropriate to consider extending the I/M coverage to include those emission contributing areas.

To identify specific "emission contributing areas," analyses should be conducted using the region's transportation planning data base to identify specific trip interchange characteristics. These analyses would identify the approximate fractions of VMT within the nonattainment area that are generated by vehicles registered in each "emission contributing area." With this information, additional analyses can be conducted to determine the potential impact (in terms of emissions reduction) of adding or eliminating each of the areas. The basis for determining the appropriateness of any coverage scenario would be whether or not a 25 percent reduction in 1987 LDV CO and HC emissions within the nonattainment area is achieved with the particular scenario.

Since Washington has expressed the desire to minimize the geographic coverage of the I/M program, the boundaries will likely be defined on a subcounty level. While any less-than-statewide program is bound to foster some controversy owing to the public feeling of inequity, the problem will be compounded if the boundaries are perceived as ambiguous. For this reason, the minimum unit area considered in defining the boundaries should be a readily recognizable entity such as a municipality or a ZIP code zone. Further, a specific rationale should be developed for including a particular area, such as the significant contribution of VMT in the nonattainment area, considerable growth potential, etc. Serious public relations problems could arise if residents of one portion of a municipality were required to participate in the program, while the remaining residents were not. This type of reaction could also occur if one municipality is included in the program while a similar, bordering municipality was not.

A municipality, then, should be the absolute minimum unit area considered in the boundary definition. The I/M area should also be as contiguous as practicable. Finally, the public should be <u>well informed</u> on the rationale used in boundary selection.

As indicated in Washington's I/M legislation, the program will be enforced by requiring owners of affected vehicles to provide a certificate of compliance as a prerequisite to annual motor vehicle registration. In any program involving less than statewide coverage, a means for identifying vehicles that are covered by the program is imperative to enable enforcement of the regulations. This concept must be considered in defining the geographic coverage of the program. There are no significant problems associated with registration enforcement, provided that the geographic boundaries are selected in a manner that will enable easy identification of these vehicles based on the information normally provided on the registration form. To incorporate one portion of a town in the program while excluding another portion of the same town, for instance, may complicate the identification of covered vehicles. Utilization of an identifiable unit area, like ZIP code zones would facilitate the identification of those vehicles requiring certificates of compliance at registration time.

TASK 6 - REVIEW THE DRAFT REQUEST FOR PROPOSAL AND SUPPORTING DOCUMENTATION

Under this task the draft Request for Proposal (RFP) being prepared by the Department of Ecology was reviewed. Also, some of the technical support documentation was reviewed, as well.

The draft RFP was found to be very similar in both scope and language to the RFP used by the State of California to solicit bids for a contractor to operate a network of centralized inspection lanes. Generally, only minor comments or questions resulted from our review of both the RFP and the supporting documents. These were discussed with Department of Ecology officials at a meeting held in Olympia on 30 August 1979; no documentation was prepared in connection with this task.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT Recent ambient air quality data for the State of Washington indicate that certain National Ambient Air Quality Standards will not be attained in all areas of the State by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the State will request from EPA an extension of the compliance data beyond 1982. In order for this request to be considered, the State must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. Currently the State, through its Department of Ecology, is developing a set of control strategies, including I/M, for implementation in certain areas. Technical assistance was provided to the Department of Ecology by GCA/Technology Division through a contract sponsored by Region 10 of EPA. The primary purpose of the assistance was to provide the Department of Ecology with information regarding technical aspects of I/M on a quick response basis to aid in the continuing process of program development. This document provides a summary of the work performed by GCA under this contract.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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