Heavy-Duty Engine Rebuilding Practices

United States
Environmental Protection
Agency

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Manufacturers Operations Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

United States Environmental Protection Agency

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PREFACE

Section 202 (a) (3) (D) of the Clean Air Act (CAA), as amended in 1990, requires EPA to study the practice of heavy-duty engine (HDE) rebuilding and the impact of rebuilding on engine emissions. On the basis of this study and other relevant information, EPA may prescribe requirements to control rebuild practices.

This document, the first of a two part report, summarizes EPA's findings concerning rebuild practices and discusses, among other things, specific heavy-duty engine rebuilding practices, types of rebuilders, frequency and number of rebuilds, and model years of engine involved in rebuilds.

The emissions impact of rebuilding will not be determined until later in this study. The objective of this report was to gather information to develop an emissions test program for rebuilt engines. Since rebuild emissions data are virtually nonexistent, EPA will be required to conduct testing and the decisions as to which types of engines to test will be based on the findings set out in this report. The actual emissions data generated and the analysis of the relevance of that data will be included in a separate report.

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Chapter 1 - EXECUTIVE SUMMARY

1.1 Executive Summary

The Clean Air Act Amendments of 1990 required the Environmental Protection Agency (EPA) to study heavy-duty engine rebuilding practices and their impact on engine emissions. On the basis of this study and other relevant information, EPA may prescribe requirements to control rebuilding practices.

EPA determined that there are about 350,000 heavy-duty engines rebuilt each year representing about five percent of the estimated 7.5 million heavy-duty trucks in operation. Heavy heavy-duty diesel rebuilds account for about 250,000 of these rebuilds. Within the heavy heavy-duty diesel population, EPA estimates that these 250,000 rebuilds represents 16 percent of the fleet. Medium diesels account for approximately 70,000 rebuilds annually, or nine percent of the medium diesel fleet. EPA found that light diesels and gas engines are generally not rebuilt unless an engine failure has occurred early in the life of the engine.

A typical heavy heavy-duty diesel will be rebuilt three times before retirement. Removable cylinder liners facilitate the rebuilding process of heavy heavy-duty engines. Medium heavy-duty diesels are generally not sleeved and subsequently will usually undergo only one rebuild. Those light diesel and gas engines that are rebuilt are generally rebuilt with short or long blocks[1] .

EPA estimates that over 50 percent of all diesel rebuilds are in-frame rebuilds, which are performed with the engine still in the vehicle. Most of these rebuilds are performed by owners, fleets, and shops who use primarily original equipment (OE) or OE equivalent parts. Retrofitting older engines with new parts specifically to reduce emissions is currently not performed except on a small number of bus engines.

EPA will use the above information to design the emissions test program that will constitute the second phase of our study. We expect, based on this information, that the test program will be limited to large diesel engine testing as the number of gasoline engine rebuilds is insignificant.

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[1]Short block is an incomplete engine assembly usually consisting of the cylinder block, crankshaft, pistons and rings, oil pan and gaskets. Long blocks generally contain the same components as short blocks with the addition of cylinder heads, camshaft and timing gears.

Chapter 2 - INTRODUCTION

2.1 Clean Air Act Amendments Requirements

Section 202 (a) (3) (D) of the 1990 Clean Air Act Amendments requires the Administrator to study heavy-duty engine rebuilding practices.

> "REBUILDING PRACTICES.- The Administrator shall study the practice of rebuilding heavy-duty engines and the impact rebuilding has on engine emissions. On the basis of that study and other information available to the Administrator, the Administrator may prescribe requirements to control rebuilding practices, including standards applicable to emissions from any rebuilt heavy-duty engines (whether or not the engine is past its statutory useful life), which in the Administrator's judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare taking costs into account. Any regulation shall take effect after a period the Administrator finds necessary to permit the development and application of the requisite control measures, giving appropriate consideration to the cost of compliance within the period and energy and safety factors."[2]

The Act does not establish statutory deadlines for EPA's study and provides the Agency with no guidance in terms of the rebuilding practices EPA is required to study. Therefore, before EPA could proceed with the study, it first had to determine exactly what practices it should study.

EPA's current definition of heavy-duty useful life was

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[2]Clean Air Act Amendments of 1990, Sect. 201; amends Sect 202 (a) (3).

established in 1983[3], and was based on the mileage at which different categories of heavy-duty engines were generally rebuilt or replaced. For recall purposes, manufacturers of engines would then be responsible for in-use emissions based on 75 percent of the useful life. Once past this useful life, the manufacturer would no longer be subject to in-use compliance testing. Some engines, particularly heavy diesels, operate up to mileages five times or more their statutory useful life with rebuilds. These engines could be unregulated emitters for 80 percent of their lives.

EPA therefore determined that the appropriate focus for this study was those practices typically performed at or near the end of the useful life of an engine that are intended to substantially increase the actual life of that engine. While these practices do not include engine replacement or minor engine repair, they do include a variety of practices generally known as rebuild, remanufacture, and overhaul. These terms are discussed in Chapter 4.

2.2 Study Schedule

There are two phases to the required study as shown below:

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[3] <u>See</u> 40 C.F.R. 86.085-2, 48 Fed. Reg. 52170 (Nov. 16, 1983).

Phase I: Conduct a study of the current heavy-duty rebuild market, including identifying the key players in the rebuild industry, the rebuild practices currently employed by industry, and the frequency with which rebuilding occurs. This report is a summary of the findings of Phase I.

Phase II: Using the results of Phase I, conduct emissions testing of rebuilt engines. The information gathered in Phase I will help EPA to construct an emissions test program which will allow EPA to estimate the emission impact of the rebuilding practices occurring in industry. With these emissions data, EPA will determine the emissions impact of rebuilding.

Chapter 3 - DATA COLLECTION METHODS AND SOURCES

3.1 Methods

The key to meeting the broad charge that Congress gave EPA in studying the heavy-duty rebuild industry was to gather data on as many aspects of the industry as practical by involving as many industry sources as possible. EPA sought to obtain data that showed both general industry rebuild practices as well as the number of rebuilds that were being performed on a yearly basis. Data collection involved many different techniques and we reached a wide variety of sources.

The primary data collection method utilized was a Request for Information Concerning Heavy-Duty Engine Rebuild Study published in the April 4, 1991 Federal Register.[4] The Request is provided in Appendix A. This method enabled us to reach not only major trade associations and engine manufacturers, but any other interested parties as well. Response to the Request was voluntary, but EPA provided advanced notification to those industry members who had shown interest in the study or who we believed would want to provide comments.

Telephone interviews and follow-ups played an important role

[4]56 Fed. Reg. 13825 (Apr. 4, 1991).

in verifying and adding to data obtained through the Request for Information. Telephone interviews were also utilized in gathering data from parties that wished to provide input to the study but did not wish to submit any formal written response. Probably the most important aspect to this technique was that it provided a means to ask respondents clarifying questions that arose during the information gathering procedure which were not addressed in their response to the Request.

Facility visits were also used in our data collection. There are three main types of rebuilders; fleets, independents, and engine manufacturers. We visited one facility of each type. The facilities visited were Jasper Engine and Transmission Exchange (independent), Mack Trucks, Inc. (Mack) (engine manufacturer), and Preston Trucking (fleet). These sites were chosen as typical of each type in terms of their rebuild practices. In the case of Jasper and Mack, data gathered from the visits supplemented their formal responses to the Request.

3.2 Respondents to Federal Register

Twenty seven parties provided written responses to the Request for Information. These respondents, with a brief description of their functions, are listed in Appendix B. Responses ranged from general policy statements to detailed answers to all fifteen questions.

3.3 Truck Population Data Sources

Determining the number of rebuilds being performed in the heavy-duty industry required data that showed the number of heavy-duty trucks in use and, more importantly, quantifying when the engine rebuilds are occurring in the engines' lifecycle.

EPA used heavy-duty truck population figures from a variety of existing sources. These sources include the Bureau of the Census Truck Inventory and Use Survey (TIUS) for 1977, 1982, and 1987, EPA's MOBILE4.1 Motor Fuel Consumption and Emission Factor Model, Motor Vehicle Manufacturers Association's Facts and Figures for 1985-1990, and Energy and Environmental Analysis, Inc. (EEA's) 1989 Motor Fuel Consumption Model (MFC). MOBILE 4.1 data were used predominantly because it provided the number of trucks on the road by model year and fuel type. Also, MOBILE is EPA-generated, based on TIUS data, and has been in use for many years as a prediction model for emissions by the agency.

EPA relied on two main sources for data describing how often or under what circumstances engines are rebuilt. First, data gathered from the Request concerning rebuild practices frequently addressed the point at which heavy-duty engines were rebuilt, especially by each particular respondent. Second, we used data compiled as support for the useful life regulations promulgated in 1983[5].

[5]*See* note 3, Clean Air Docket No. A-81-11.

Chapter 4 - BACKGROUND

4.1 General Heavy-Duty Overview

EPA defines a heavy-duty engine as any engine which the manufacturer could reasonably expect to be used for motive power in a heavy-duty vehicle.[6] Typical heavy-duty vehicles include large pick-ups, construction vehicles, dump trucks, straight trucks, delivery vans, tow trucks, buses, and over-the-road tractors (semi's). These vehicles usually range in weight from 8,501 lbs. gross vehicle weight (GVW) to as high as 150,000 lbs. GVW or more and are generally powered by either gasoline or diesel fuel. Other fuel types such as compressed natural gas (CNG), liquid petroleum gas (LPG) and methanol are being used experimentally in some fleets.

Gasoline heavy-duty engines were historically carburetted, with lighter GVW vehicles using catalyst technology for emission control. Since the implementation of the 1987 heavy-duty gasoline emissions standards, many heavy gasoline engines have utilized computer controlled fuel injection systems similar to those found in light duty passenger cars and trucks. In fact, many heavy-duty gasoline trucks are indistinguishable from their light duty counterparts except for their load-carrying

[6] 40 C.F.R. 86.082-02 (b).

capabilities. Heavy-duty gasoline engines are generally of the V-8 block design, but are not designed to be rebuilt. In 1990, there were no gasoline engines produced with removable cylinder sleeves to facilitate rebuilding.

Heavy-duty diesel engine and fuel system advances have also been required to meet ever tighter emission standards. Due to these tight standards and continuing pressure for increased fuel economy, changes have been implemented in piston design, fuel injector design, turbo matching, aftercooling, fuel system calibration, and now electronic controls are being used.

Many lighter diesels are of the V-8 design, but unlike other heavy-duty engines, very large diesels are six cylinder in-line engines. Most large diesel engines have pressed-in cylinder sleeves designed for easy rebuild. Medium and lighter diesels are generally not sleeved for rebuilding.

4.2 Engine Classes and Useful Life Definitions

There are five categories of heavy-duty engines as defined by EPA. These categories are meant to reflect the primary intended service class of an engine.

EPA classifications of heavy-duty engines are given below[7]:

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[7] 40 C.F.R. 86.085-2.

EPA Heavy-Duty Engine Category	Intended GVW Range
light heavy-duty gas (LHDG)	8,501-14,000 lbs.
heavy heavy-duty gas (HHDG)	14,001 lbs. and higher
light heavy-duty diesel (LHDD)	8,501-19,499 lbs.
medium heavy-duty diesel (MHDD)	19,500-33,000 lbs.
heavy heavy-duty diesel (HHDD)	33,000 lbs. and higher

Each of these categories has an associated useful life as follows[8]:

EPA heavy-duty Engine Category	Useful Life
light heavy-duty gas	8 years/110,000 miles
heavy heavy-duty gas	8 years/110,000 miles
light heavy-duty diesel	8 years/110,000 miles
medium heavy-duty diesel	8 years/185,000 miles
heavy heavy-duty diesel	8 years/290,000 miles

Many engines, particularly heavy heavy-duty diesels, are on the road for periods significantly in excess of their statutory useful lives, in large part because of engine rebuilding. As described in EPA's 1983 rules and Section 2.2 of this report, current EPA in-use enforcement programs only target engines up to 75 percent of their useful lives. Therefore, the emissions from many rebuilt engines are unknown and unregulated. Potential issues include whether or not rebuilding practices lead to excess

[8] 40 C.F.R. 86.085-2.

emissions, whether engines are on the road so long that even small emissions increases due to rebuilding are significant, and whether changes in rebuilding practices could reduce the quantity of pollutants being emitted.

4.3 Economics of Rebuilds - Why Rebuild?

EPA found that engines are rebuilt for a number of reasons including increased oil consumption, loss of performance, poor fuel economy and engine failure. However, the driving force behind an owner's decision to rebuild instead of choosing other options is economics. When the engine wears or experiences a major failure, owners must decide between rebuild, repair, purchase of a new engine, purchase of a new vehicle, or no action.

Diesel engines, specifically medium heavy-duty and heavy heavy-duty, can be rebuilt at a cost significantly less than the cost of a new engine or vehicle. Since these engines are sleeved and designed for rebuild, parts are readily available at competitive prices. An in-frame diesel engine rebuild can be performed for $5,000 or less, depending on which parts are replaced. (Component replacement will be covered in more detail in Chapter 5). Out of frame rebuilds, which are generally more extensive, can be completed for about $3,000 - $12,000, depending on the engine type. In most cases, rebuilding the engine costs substantially less than choosing an alternative to rebuild. For example, one can expect to pay over $10,000 for a new heavy heavy-duty diesel engine and as much as $120,000 for a new over-the-road truck.[9]

Medium and heavy diesel truck bodies will generally last much longer than the statutory useful life of the engine, meaning owners will rebuild an engine several times before replacing the truck. Not until the engine has significant miles and has been rebuilt at least once will the owner face the choice of engine replacement or vehicle trade-in versus further rebuild or repair.

Light diesel and gasoline engines present a less obvious choice to the owner. Because these engines are not sleeved, rebuilding requires engine removal from the truck. Removal is time consuming and costly. Also, unlike larger diesel truck bodies, light diesel and gasoline truck bodies usually do not last much more than one to two times the useful life (110,000 - 220,000 miles) of the engine. By the time the engine has enough mileage to warrant a rebuild, the truck body will likely also need to be replaced.

Most light diesel and gasoline rebuilds are performed as a result of engine failure. Engines that experience a major failure at low mileages will likely be repaired or rebuilt

[9] The Truck Blue Book, Maclean Hunter Market Reports, Inc., ©1989.

because the owner can still realize significant service life from the vehicle. If these same failures occur on a high mileage truck, the owner may not perform rebuild or repair, but may instead replace the entire vehicle. Rebuild costs on these engines range anywhere from about $1,000 for a short block up to $5,000 for a complete engine.

4.4 Rebuild Definitions

"Rebuild", "remanufacture", "overhaul" and "repair" are often used interchangeably and could all be considered "rebuild practices". The following summarize comments EPA received from various industry sources, and reflect the range of terminology used by the heavy-duty industry. EPA did not receive any comments which specifically defined the component replacements or combinations of component replacements that constitute a rebuild.

Rebuild: This operation generally involves the disassembly of the engine to a point where high wear components can be checked and measured against specifications, replaced or reconditioned as necessary, and reassembled. Often, certain components are replaced regardless of condition including engine bearings, piston rings and gaskets. This can be done with the engine still in the chassis. Some feel that a rebuild must be performed with the engine removed from the chassis so that certain components and measurements can be checked that cannot be inspected in-frame.

Overhaul: To some, this operation is indistinguishable from a rebuild as defined above, although an overhaul is almost exclusively done in-chassis. On the other hand, many consider an overhaul to be an engine disassembly to remedy a specific engine failure in which only the failed part or parts are reconditioned and/or replaced.

Remanufacture: Most agreed that remanufacture is a production-type process in which a core engine (owner trade-in) is completely disassembled and every part is checked against original equipment (O.E.) specifications for reusability. Parts that meet specifications are then inventoried and stocked in supply; parts that are not in specification are machined, if possible, or discarded. Engine reassembly is based on market demand and is performed using a combination of new and old parts. Customers usually purchase an engine of the same configuration engine they traded in, and the "new" product is generally dynamometer tested and warranted.

In a different context, EPA proposed the following definition of an engine rebuild for urban buses[10]:

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[10]56 Fed. Reg. 48350 (Sept. 24, 1991).

"Engine Rebuild" means an activity, occurring over one or more maintenance events, involving disassembly of the engine including the removal of the cylinder head(s) and the replacement or reconditioning of more than one major cylinder component in more than half of the cylinders."

where

"Major Cylinder Component" means piston, cylinder liner, connecting rod, or piston ring set."

Along with the definitions above, there are two other terms often used in the industry which can be considered a subset of rebuilding. These are:

Uprating: This process involves rebuilding, overhauling or remanufacturing an engine with parts such that the power output of the rebuilt engine is greater than that of the original engine. Engines are generally uprated to a certified configuration with a higher horsepower or torque rating.

Retrofitting: This involves rebuilding an engine with parts designed to increase the emissions performance (decrease emissions) from those of the original engine configuration.

4.5 Types of Rebuilders

Rebuilds are performed by three basic groups within the industry; Original Equipment Manufacturers (OEM's), independents and fleets. OEM's are exclusively production style remanufacturers who sell complete and partial engine assemblies, fuel systems, and other parts. In 1990 there were approximately twenty OEM's involved in the production of new assembly line engines. Although all twenty undoubtedly supply replacement parts which are used by rebuild shops and fleets to service and rebuild engines, EPA is aware of only six who perform or contract out assembly line type remanufacturing of engines. Fleets perform rebuilds and overhauls in and out-of-chassis on an as needed basis and may rebuild engines for other fleets. Thousands of fleet are currently operating in the U.S. so it is impossible for EPA to estimate the number which may actually be involved in engine rebuilding. EPA expects that most large fleet operations are involved in some form of engine rebuilding. Independent rebuilders can be either production type operations or small repair type facilities. Some larger independent rebuilders are under contract with OE manufacturers to rebuild for them., A subset of the independent rebuilder category includes franchised truck dealerships which are independently owned and operated under a franchise agreement with OE manufacturers. There are approximately 2,700 truck dealer outlets.

Major trade associations exist which represent each group of rebuilders. The Engine Manufacturers Association (EMA) represents OE manufacturers, the Automotive Engine Rebuilders Association (AERA) represents independent rebuilders and the American Trucking Associations (ATA) represents fleets. Membership is often held in more than one association.

In addition to the three major types of engine rebuilders, there are numerous individual engine component rebuilders and aftermarket parts producers. The products generated by these rebuilders and suppliers are used extensively in the engine rebuild industry and are discussed in this report.

Chapter 5 - DIESEL REBUILD PRACTICES

5.1 Introduction

There is a marked difference between diesel and gasoline engine rebuild practices. While diesel engines in general make-up only forty percent of the heavy-duty engine population, heavy heavy-duty diesel engines (class 6-8) outnumber heavy heavy-duty gasoline engines three to one. Gasoline engines are used in more short route applications while diesels are used in long haul jobs. The different usages often translate into different rebuild practices.

5.2 Diesel Rebuild Practices

Diesel rebuild practices can be divided into two main categories; in-frame and out-of-frame rebuilds. In-frame rebuild practices are not as extensive as out-of-frame practices. In-frames generally do not include any machining of the block or crankshaft, but do include, among other items, replacement of the major stress-bearing engine parts such as pistons and bearings. Out-of-frames include all the above as well as the aforementioned machining.

In a normal sequence of engine rebuilding, an engine will have an in-frame rebuild before it undergoes the more-involved out-of-frame rebuild. This in-out series will continue until the engine is scrapped or suffers a major failure that requires it to be removed from the chassis prematurely and receive out-of frame service.

Engine owners look to several parameters when determining when to rebuild the engine, all of which have underlying economic reasons. The main signaling parameter used is oil consumption or oil analysis.[11] The need for rebuild is indicated when an engine is burning too much oil or when an oil analysis shows excessive contaminants or metal shavings in the oil. Engine manufacturers have oil analysis guidelines that signal the need for a rebuild.[12] Increased oil consumption is a signal that the piston rings are worn, the piston sleeve diameter has increased beyond its tolerance, or that bearings are out of specification.

The next category is loss of performance and/or decreased fuel economy. These criteria typify increased engine wear. However, decreased fuel economy does not necessarily mean that engine internal components have worn beyond their tolerances. Reduction in fuel economy could also be attributed to a worn or maladjusted fuel injection pump. Therefore, decreased fuel

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[11]Survey Data Research, A Study to Determine Engine Rebuild Criteria Among Owners of Diesel Powered Vehicles, 1981. This study was performed for EMA.

[12]Operation and Maintenance Manual, 3406B Truck Engine, Caterpillar, 1990.

economy is usually accompanied by one of the internal engine wear signals before a determination will be made to rebuild the engine.

Failure of a major internal engine component may also lead to rebuild if the engine is approaching rebuild mileage. The owner may rebuild the engine while replacing the broken part since the truck will be out of service for the least amount of time.

Engine miles, hours, or years in service are not generally used to schedule rebuilds. Fewer than one third of all fleets that commented stated that they used miles driven as a rebuild criteria,[13] and a similar fraction of the American Truck Dealers Division of the National Automobile Dealers Association (ATD/NADA) respondents mentioned these as criteria used in determining when to rebuild a HDDE.[14] Sound rationale exists as to why these factors are not used. Diesel engines are involved in a wide variety of applications and accumulate mileage and hours at varying rates. It would not be economical to schedule rebuilding at a set mileage or hour level because the engine might not need a rebuild at that point. Owners do sometimes look at mileage or hours as a criterion to determine engine condition;

[13] See note 11.

[14] ATD/NADA response, dated June 6, 1991, to EPA's Request for Information.

high miles, hours, or years may alert the owner to look for other signs of engine wear that signal the time for a rebuild.

5.2.1 Fleet Practices

Fleet heavy-duty engine rebuilding varies and is mainly dependent on the size of the fleet. Large fleets, such as Preston or Roadway, have centralized, mostly self-sufficient, maintenance facilities that do their own rebuild work. These facilities have full-time mechanics, machining equipment, and other support required to perform rebuilds and in many cases are authorized by OE's to work on their engines. These fleets also have local maintenance shops, but these shops do mainly preventive maintenance and emergency repairs in support of the local fleet. When it is determined that an engine needs a rebuild, the fleet either removes the engine from the truck and ships it to its rebuild facility or sends the truck there. If the rebuild requires that the engine be removed, an engine with the same configuration, which was previously rebuilt, is installed in the truck so that it is not out of service for an extended length of time. The removed engine will then be rebuilt and put into storage until it too is needed as a replacement engine.

At a typical fleet rebuilding facility, engines either receive an in- or out-of-frame rebuild. A parts depot on site provides mechanics with the proper replacement parts. In some cases, such as starters, the facility will rebuild worn parts. Fleets will generally replace with a new part or subcontract out to a specialty shop complex parts such as the fuel injection pumps and turbochargers because it is cheaper than maintaining the specialized personnel and equipment necessary to rebuild these items. Out-of-frame rebuilds are usually dynamometer tested to ensure that operating characteristics such as horsepower and fuel flow are in specification before the engine leaves the shop.

Smaller fleets generally will not have the resources necessary to perform out-of-frame rebuilds, so when an out-of-frame is required, these fleets will use either an independent or OEM assembly-line rebuilder or a local rebuild shop. In-frame rebuilds can be performed by these smaller fleets, but they may also have this service performed at a dealership or independent shop.

Engine emission and part number labels are generally not removed from fleet-rebuilt engines since the same core is used. However, new labels stating that the engine was rebuilt are not affixed to the engine. Instead, owner records or rebuild shop invoices must be referenced in order to determine if it has been rebuilt.[15]

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[15]ATA response, dated May 8, 1991, to EPA's Request for Information.

5.2.2 OE Rebuilders

Several OE's have their own assembly-line rebuild facilities. When a core engine is traded-in, it is stripped down and cleaned. At this point the engine loses its "identity" because all labels are removed and very often the serial number is ground off the block. Major components are inspected and checked to see if they are in specification or can be put into specification - otherwise they are scrapped. For example, one manufacturer scraps 50 percent of the crankshafts it receives. Fuel injection pumps and turbochargers are disassembled and rebuilt with new parts. Sometimes these components are returned to their original manufacturer in an exchange program with the rebuilder. Other components such as pistons, bearings, and valves are almost always scrapped.

Once disassembled and cleaned, the engine is ready to be reassembled. Unless the block is a unique and seldom used design, it is usable in different engine configurations. Very often, just changing the fuel delivery specifications will change the calibration of the engine. Once it is decided what configuration to build, the engine proceeds down the assembly line with a document attached to it that tells the assembler or machiner which specifications or parts are necessary for that engine configuration. As a means of documenting proper replacement of parts, mechanics are generally required to initial the engine build form.

When the engine has been completely rebuilt, a new metal label showing the engine rebuild date along with various engine settings is riveted to the block. This label replaces the original engine specification label that was removed in the cleaning process. The type of label and the information on it varies among manufacturers. The engine would also get a new serial number ground into the block at this time, if needed. The final step before shipping the rebuild is to test it on the dynamometer. No specific tests for emissions are done. These engines are warranted by the remanufacturer.[16] This entire process is generally known as remanufacturing.

In-frame OE rebuilding facilities do not exist as stand-alone shops. They are usually associated with dealerships and/or distributorships. These shops operate just like any car dealership, with the truck owner bringing his truck to the shop and having work performed on his truck on the premises. Rebuilt

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[16]Warranties on remanufactured engines generally run for one year with unlimited mileage, though some plans set the mileage limit at 100,000 miles. Some OE warranties require that OE parts be used. Examples of these programs are the Cummins National Overhaul Warranty (NOW) and Caterpillar Overhaul Protection for Trucks (OPT) plans. These two plans cover both in-frame and out-of-frame rebuilds and let the owner receive service on his engine at any factory authorized repair facility. Customers can also purchase extended warranty protection plans. However, warranties are seldom actually needed. According to AERA, only 2 percent of all rebuilt engines are returned for in-warranty service, with 40 percent of these repairs attributed to the customer installing the engine incorrectly or misdiagnosing the initial failure.

engines from these facilities are generally not labeled, nor are the original labels removed. Therefore, it is difficult to identify an in-frame rebuilt engine without invoices or other records. Also, if a fleet is authorized to perform service work on an engine by the manufacturer, then all servicing would be done at the fleet maintenance facility.[17]

5.2.3 Independent Rebuilders

Independent rebuild facilities exist in a variety of forms, from large assembly-line shops to small specialty shops that only rebuild one specific part of the engine, such as the cylinder head or turbocharger. Assembly-line facilities operate in a similar manner to OE assembly-line facilities. An engine owner goes to an distributorship where he exchanges his old engine for a rebuilt model that is in stock. In the event that the customer's engine is not a commonly-rebuilt engine, the owner's engine is removed, shipped to the plant, rebuilt, and returned. In this case, the owner receives the same block that he turned in. Otherwise, core engines are gathered from the distributorships and are shipped to a central rebuild facility. The engines are stripped, cleaned, and rebuilt to the required configuration. Again, the block is not necessarily used for the exact same engine if it is compatible with other configurations.

[17]Labor may be warranted by the dealer who performed the rebuild while parts are warranted by the manufacturer.

Specialty shops often rebuild certain components or systems in support of larger rebuilders. They also provide rebuilt parts to owner-operators who choose to do their own engine work.

5.3 Diesel Component Replacement

Parts replacement is the defining factor of a rebuild. By looking at what parts were replaced, one can usually tell the degree of rebuilding an engine has undergone, either in-frame or out-of-frame. However, a core group of components are replaced during all rebuilds. Frequently, only these parts, the main stress bearing and lubricating components, will be replaced during an in-frame rebuild. The EMA study listed piston rings, pistons, connecting rod bearings, main bearings, cylinder liners, injector and nozzles, and cylinder head assembly as parts that fleets replaced over 85 percent of the time during a rebuild.[18] The reported numbers were similar for owner/operators, although owners included other ancillary parts such as air compressors and turbochargers. This difference could be that owner/operators generally have less structured preventative maintenance plans than fleets and therefore find the need to replace more engine items at rebuild.

Data gathered in our study supported the EMA figures. Overnite Transportation, a large fleet, stated that pistons,

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[18]See note 11.

rings, liners, bearings, and heads are replaced during their in-frame service.[19] The majority of survey respondents reported that six out of the seven parts are almost always replaced when they are rebuilding an engine.[20] There was a roughly even split between "always replace" and "replace when necessary" when it came to injectors and nozzles. The respondents who did not automatically replace this part said they performed functional testing and replaced if needed. Remember that ATD/NADA members are generally OE-authorized maintenance facilities and are performing virtually all of the in-frame work for the OE's. Appendix C shows reported in-frame and out-of-frame component servicing practices for fleets and rebuild shops as determined by a study of heavy-duty diesel rebuilding practices done for CARB in 1987.[21] These figures support EPA findings.

While the seven core parts are almost always replaced during an in-frame rebuild, this is not the only service work done on the engine at the time. Other systems and parts, such as turbochargers, camshafts, and connecting rods, are inspected and repaired or replaced if needed. In some instances, even these parts are rebuilt or replaced automatically. But generally,

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[19] Phone conversation with representative of Overnite Transportation, May 29, 1991.

[20] See note 14.

[21] "Survey of Heavy-Duty Diesel Engine Rebuilding, Reconditioning, and Remanufacturing Practices", Sierra Research, Inc, August, 1987. Prepared for California Air Resources Board (CARB), CARB contract #A4-152-32.

unless the owner has complained about a specific problem that can be traced to a part or the rebuilder notices excessive wear or maladjustment, these parts are not changed during an in-frame rebuild.

Almost all engines are rebuilt to a certified configuration regardless of the type of parts used. Some ATD/NADA respondents stated that a small percent of their customers want their engines uprated for more power. Uprating does have a practical limit, though. Core credit practices serve to narrow the uprating that is economically reasonable to adjustments made to equipment already on the engine. Requiring wholesale changes or using new parts would increase the rebuild cost. The resulting uprated configuration, therefore, generally uses the same parts as the original. However, the fuel system may be calibrated differently. Note that these uprated configurations are most always a previously certified configuration and new configurations are generally not created. In theory, uprating should have only a marginal emissions impact because engines are generally only changed from one engine configuration to a different, more powerful configuration within the same engine family. The emissions certification data for a heavy-duty engine family reflect the worst-case emissions configuration within that family. Therefore, in theory, the uprated configuration would at worst reflect the configuration used to determine certification emissions data.

5.3.1 Out-of-Frame Component Replacement

Out-of-frame rebuilding lends itself to more extensive component changes. Since the engine is disassembled, all components are checked and, if necessary, replaced. All rebuilders, including in-frame rebuilders, have a parts exchange credit policy that allows them to work with their customers in processing engines. Owners receive a monetary credit for various parts of old engines such as the crankshaft, block, and fuel injection pump. This core credit program exists because for many engine items, it would reduce profit or increase the price of a rebuild if the rebuilder had to replace all worn parts with new ones. The credit price is set so as to encourage the customer to include these parts with the engine. For example, Cummins charges 50 percent of the price of a new injection pump for a remanufactured unit when the old unit is exchanged, but this figure jumps to 70-75 percent of the new price without an exchange. Volvo charges $1,120 for a remanufactured crankshaft with exchange of one which may be remanufactured while a remanufactured crankshaft without exchange sells for $1,620.[22]

A core exchange program is critical to the business, operation of rebuilders because they need the old cores to actually rebuild. The rebuilder must take in more cores than he will rebuild due to the fact that not every incoming core will be

[22]Commercial Carrier Journal, November, 1990.

salvageable. The exchange program will also act as a signal to the owner when a rebuild no longer makes financial sense. The reduction in credit due to unsalvageable parts will make the cost of a rebuilt and new engine comparable.

These credit programs vary in scope and range from Mack's program where they have credit prices for almost every engine part[23] to one of Jasper's policies where the customer receives full credit if the Jasper representative determines that the core has not been previously disassembled, there are no visible holes or cracks in the engine, and the crankshaft turns at least 360 degrees in the direction of engine rotation.[24]

Due to the nature of assembly-line rebuilding, all engine parts are replaced with either new, remanufactured, or in-specification used parts. When the parts are removed from the engine, they are checked and either scrapped, rebuilt, or put into a central bin to be used in other engines. Generally this practice can be broken down into a general rule of thumb. Low-cost parts will be replaced while more expensive parts and systems, such as crankshafts and fuel pumps, will be rebuilt. This is illustrated by the list of replacement parts and components used by Jasper and is shown in Appendix D.

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[23]Data submitted to EPA during a May 8, 1991, visit to Mack Remanufacturing Center.

[24]Jasper sales literature, 1991.

New replacement parts can either be OE, aftermarket, or rebuilt parts. The type of part used in a rebuild is largely determined by the type of rebuilder. An OE assembly-line rebuilder is most likely to use strictly OE parts while his independent counterpart will probably use a mixture of OE and aftermarket parts. The majority of ATD/NADA respondents stated that they use OE parts. The Army uses aftermarket parts exclusively in their overhauls.[25]

The choice of what kind of part to use depends on price and quality. Rebuilt OE or aftermarket parts can provide up to a 40 percent cost savings over a new part[26], though the majority of rebuilt parts will use OE cores. Some rebuilders will use only OE parts, even if the aftermarket part is exactly the same and the OE part is twice as expensive. Others feel the same way about aftermarket parts. Parts availability is also a driving factor.

The majority of parts initially brought to market result from OE-sponsored development or coordination with their vendors. The aftermarket parts, usually with a small modification, are then introduced into the market. The market share between OE and aftermarket parts is uncertain, but OE or OE-design parts

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[25]Department of the Army response, dated May 22, 1991, to EPA's Request for Information.

[26]APRA response, dated May 13, 1991, to EPA's Request for Information.

probably constitute a majority. For example, Detroit Diesel Corporation (DDC) estimates that its own parts command 60-70 percent of its replacement parts market[27], and an OE fuel injection system supplier states that its market share for replacement parts is roughly 75 percent.

The comments received by EPA indicate that many OE and aftermarket parts are often very similar. In some cases, the part manufacturer makes both types and the only difference is the packaging. Federal Mogul stated that their engine bearings, pistons, and carburetors are the same for both OE and aftermarket use.[28] Similar comments were received from The Tucker Co., Inc. regarding valve seats.[29] Enginetech, Inc. went even further. They believe that in many instances the aftermarket part is better than the OE part because the aftermarket part is designed to alleviate some problem that developed with the OE engine.[30] This is not meant to imply that OE's do not upgrade their parts in a similar fashion. An example of a product improvement could be a different chamfer on a piston ring while a design shortfall upgrade could be a material replacement for a piston ring that

[27]DDC response, dated May 20, 1991, to EPA's Request for Information.

[28]Federal Mogul response, dated May 8, 1991, to EPA's Request for Information.

[29]The Tucker Co., Inc. response, dated May 17, 1991, to EPA's Request for Information.

[30]Enginetech, Inc. response, dated May 28, 1991, to EPA's Request for Information.

wears too quickly. The impetus for any upgrade will also depend on the demand for the part. In addition, not all aftermarket parts are of identical quality.

Statistical process control (SPC) is being used by OE and aftermarket parts manufacturers. This process employs statistical sampling of the product to verify that manufacturing tolerances and design specifications set by each parts manufacturer are being achieved. SPC has become used in the parts industry as a means to improve quality and provide assurances to the customer about the quality of the parts. The parts consumer, either an OE or independent rebuilder, will ask that SPC be applied to all facets of the vendor's process, not just the part the customer is buying. Total system satisfaction is required, meaning SPC can not be applied selectively. Companies using SPC have reported less than one percent of their parts are returned under warranty, and that a percentage of these returns are due to incorrect installation and not manufacturing errors on the part. Some rebuilders also employ another step in assuring themselves that the parts they are installing will fit their application. The rebuilders check the dimensions of the parts to ensure a correct match.[31] The motivation is to alleviate engine returns, which are costly to the rebuilder. AERA promotes this as sound business practice to its members.

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[31]Jasper sales literature.

Comments received indicate that consolidated, or "will-fit", parts are not prevalent ih the heavy-duty parts replacement industry. Generally, parts are application specific, meaning that a part is used on only one engine type of a specific manufacturer. Replacement parts are designed to meet the requirements for specific engines. At the same time, there are parts that can be used on several applications within a product line. Producing parts in this manner reduces proliferation, but is generally limited to items such as piston rings, injector nozzles, and gaskets. This process is incorporated by OE and aftermarket vendors.

5.4 Rebuild Frequency

There is no consensus in the industry regarding the number of rebuilds a typical diesel engine receives before the end of its lifecycle. This is partly a result of the varied diesel applications. For example, the 1981 EMA study[32] states that "[T]rucks used specifically for long haul driving run their diesel engines about 37 percent longer before reaching the first overhaul than trucks used for other purposes."

5.4.1 LHDDE Rebuild Frequency

A light heavy-duty diesel engine would typically be

[32]*See* note 11.

installed in a class 2-5 truck, which would likely be used in local service as a short delivery or service vehicle. Mileage accumulation on this truck will be relatively slow, will involve many short trips, and it will take approximately eight years to reach the engine's useful life limit. The gradual aging of the truck and engine means the truck body would normally deteriorate at a point that is not significantly greater than the engine's useful life.

Ford, GM, and Navistar engines make up the overwhelming majority of the light heavy-duty diesel market. Both Ford and GM have stated that there is no real demand for light diesel rebuilds. GM has no rebuild facility for diesels, and has not authorized any facility to perform this service.[33] Ford has authorized a limited number of independent businesses to be Ford Authorized Remanufacturers[34], but it is unclear how many of these facilities rebuild diesel engines. Rebuild work on each manufacturer's engines does occur at their respective dealerships.

Most OE manufacturers commented that very little rebuilding that extends the useful life of the engine occurs on light heavy-duty diesels. Instead, rebuilt sections of the engine,

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[33]Phone conversation with GM representative on April 15, 1991.

[34]Ford Motor Co. response, dated May 23, 1991, to EPA's Request for Information.

specifically short and long blocks, are used, and this only occurs when there has been a major engine failure. Therefore, EPA believes that light heavy-duty diesel engines undergo at most one out-of-frame rebuild, probably around 150,000 miles. However, the vast majority of these engines are never rebuilt, as will be discussed in Section 7.5.

5.4.2 MHDDE and HHDDE Rebuild Frequency

The vast majority of diesel engine rebuilding occurs with the class 6-8 engines. These engines typically experience long operation times and high mileage, providing a strong economic incentive to have an efficient engine. Caterpillar estimates that approximately 80-85 percent of the operation and maintenance costs associated with a 1990 3406B engine can be attributed to fuel costs.[35] As discussed in Chapter 4, truck body and chassis useful life is not the limiting factor that it is with light heavy-duty diesel trucks. Medium and heavy-duty engines are used much more frequently (seven times as often) in long-distance operating models than are light-heavy engines.[36] This figure includes both gasoline and diesel engines. The actual split is higher because gasoline engines make up the majority of lighter-class vehicles while diesels predominate in the heavy-duty class.

[35] See note 12.

[36] Truck Inventory and Use Survey, 1987, p. US-34.

The length of time before an engine is retired from use may vary within the medium and heavy diesel classes due to operator and usage differences. The EMA study states that class 8 trucks operate seven percent longer before first rebuild than do class 6-7 engines. It also states that diesel engines in fleets of 50 trucks or more run more than nine percent longer than do similar engines in smaller fleets. EPA has no data showing these figures have changed substantially within the past ten years. However, these variations fall within the range of miles between rebuilds, and therefore are not significant.

Industry surveys done in support of EPA's heavy-duty useful life regulations provide a good start point for determining frequency of rebuilds for MHDDE's and HHDDE's. The EMA study reported that 74 percent of all fleets and 81 percent of all owner operators performed their first rebuild in-frame and these figures hold true today.

Ten years ago there was a definite distinction in mileage between rebuilds of medium and heavy-duty heavy diesel engines, especially in cases where the medium-duty engine was not sleeved. Only 57 percent of non-sleeved engine owners stated then that they rebuilt their engines, and that this service occurred at an average of 175,000 miles.[37] This does not mean that 57 percent of MHDDE's are rebuilt, because this figure reflected individual

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[37] Fleet Maintenance and Specifying, Vol. 7, No. 5, May 1981, p. 41.

fleet responses and is not adjusted to account for the number of engines in each fleet. However, it did reflect the relative frequency of MHDDE rebuilding. The EMA report stated the average rebuild mileages for class 6 and 7 diesels was 203,000 and 280,000 miles respectively.[38] However, this report did not make any distinction between sleeved and non-sleeved engines, which could account for the difference in values. It is also not unusual to find a HHDDE in a class 7 truck because the owner might desire more power and also because there can be some overlap between the classes. This could account for the reported difference in miles before rebuild.

The owner of a non-sleeved MHDDE faces a more difficult decision when determining whether to rebuild his engine than does a sleeved engine owner since rebuilding a non-sleeved engine requires that it be out-of-frame. Owners will be more hesitant, due to economic concerns, to remove the engine from the truck, especially if the engine is used in low-mileage service. Without sleeves, the cylinder must be bored out and a new sleeve or oversized piston must be installed into the engine. Boring a cylinder can only be done a few times because removing too much metal from the cylinder can weaken it and cause the cylinder to crack. MHDDE's that are sleeved can easily be rebuilt in-frame more than once, just like HHDDE's. However, sleeved medium diesel engines do not make up a large part of the market. Only

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[38] <u>See</u> note 11.

25-30 percent of the 1990 MY production was sleeved. EPA estimates that of the remaining 70 percent of the market, roughly 50 percent of these engines will be rebuilt. This figure is supported by the Fleet Maintenance & Specifying survey stating that only 57 percent of non-sleeved engine owners rebuild their engines when faced with the option of rebuild or replace.

In any event, EPA expects that a MHDDE will be rebuilt at most twice in its lifetime, with a significant percentage not rebuilt at all. The extended mileage accumulation period and design features that complicate engine rebuild are the basis for this determination. The mileage at which MHDDE's are rebuilt is approximately 200,000-250,000 miles. This figure is based on our determination that non-rebuilt engines are driven for roughly 200,000 miles before trade-in[39] and eventual rebuild. The majority of one manufacturer's MHDDE rebuilds in 1990 were performed on engines of the 1981/82 MY.

The rebuild picture is much clearer with heavy-heavy diesels. Since these engines are designed to be rebuilt, they make up the bulk of all rebuilds. EPA believes that HHDDE's are rebuilt on average every 300,000-400,000 miles. This is about every four years, however the interval varies because as the engine gets older, it accumulates mileage at a slower rate. The

[39]Memo from Robert Johnson, SDSB, to Docket # A-81-11, "Derivation of Heavy-Duty Diesel Engine Average Usage Period", July 1, 1983.

miles-between-rebuild interval should remain fairly constant over the life of the engine.

These figures apply for both in-frame and out-of-frame rebuilds and are based on a variety of data obtained in the course of the study. In contrast, EPA primarily looked at miles until the first major overhaul in the useful life rulemaking. First, the EMA report gives an average mileage until rebuild of 280,000 miles for class 8 engines while the Fleet Maintenance & Specifying article gives an average of 281,000 miles for sleeved engines, which were predominantly class 8's in 1981. Over half the respondents in the ATD/NADA survey stated that mileage between rebuilds was three to four years and 300,000 - 400,000 miles.[40] It should be noted that over 72 percent of these rebuilds are in-frame rebuilds. One OE manufacturer stated that an out-of-frame remanufactured engine runs between 300,000 - 500,000 miles before it needs another rebuild while another recommends to its owners that the engine be rebuilt at 500,000 - 600,000 miles. Jasper stated that large engines are rebuilt around 300,000 - 400,000 miles and follow the in-frame, out-of-frame sequence. Jasper also said that theoretically, a rebuilt engine should last as long as a new engine does.[41] Many other respondents throughout the industry made similar statements.

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[40] See note 14.

[41] Statement from Jasper representative on April 3, 1991, during facility visit in Jasper, IN.

The typical HHDDE will follow the in-frame, out-of-frame sequence over its lifetime. It will probably only receive a total of three rebuilds, meaning it will get two in-frames and one out-of-frame. This figure is based on the fact that trucks simply will not last long enough in order to get four rebuilds. Trucks that accumulate mileage quickly, such as coast-to-coast line haulers, will be the exception. However, offsetting these trucks will be the engines that are involved in fleet trade-in programs with the OE's. Some of the engines will be traded in, for a new or rebuilt engine, before the engine gets even a second rebuild. Yellow Freight trades their over-the-road engines in to Cummins after five years and generally only one rebuild.[42] Another factor indicating that HHDDE's will only be rebuilt three times is that Jasper and Mack both stated that they very rarely see any of their rebuilt engines return for a second out-of-frame.

[42]Phone conversation on May 28, 1991, with representative of Yellow Freight.

Chapter 6 - GASOLINE REBUILD PRACTICES

6.1 Introduction

Heavy-duty gasoline engine rebuilding is performed for different reasons than heavy-duty diesel rebuilding. Neither LHDGE's nor HHDGE's are rebuilt to increase operational life. Instead, gasoline engines rebuilds generally occur when the engine has experienced a catastrophic failure and, in these instances, generally a short or long block rebuild replacement is used to alleviate the problem. Very few complete engine rebuilds occur in the HDGE industry.

There are only three HDGE manufacturers; Ford, GM, and Chrysler. Chrysler produces a small number of engines per year compared to the other two and did not provide any comments. For this study our analysis will be based on comments provided by Ford and GM.

EPA will treat LHDGE's and HHDGE's as one in this study because there is no major difference, from a rebuild standpoint, between these two classes. Any reference to HDGE, therefore includes both LHDG and HHDG engines.

6.2 Rebuild Practices

There are major differences between HDGE and HDDE rebuilding. For example, there are no OE assembly-line type rebuild shops for HDGE's. Instead, Ford and GM both authorize outside facilities to perform rebuild work on their behalf. These outside facilities include both dealerships and independent businesses to which the manufacturer provides rebuild specifications. Ford uses a small number of businesses while GM has just begun a rebuild program and is currently using only one outside supplier. These independent rebuilders sell rebuilt engines to dealerships, for eventual use by the final purchaser. The OE's act as distributors and the engines are listed with part numbers like any other stock item.

Fleet rebuilding of gasoline engines is not nearly as prevalent as with heavy diesel engines. Large line haul fleets generally do not use gasoline engines, and those that do use them for pick-up and delivery routes. Certain types of fleets use a large number of gasoline engines including truck rental companies such as Ryder, and delivery services such as UPS. The majority of fleets contacted indicated that they run their gasoline engines until there is a failure or performance has decreased such that a tune-up or parts replacement will not significantly improve engine performance. If this occurs at a point when the vehicle is still in good condition, the engine is replaced with a remanufactured short or long block while the bolt-on emissions control components are reused. Otherwise, a new truck is purchased.

HDGE rebuilding is infrequent. When performed, rebuild practices for HDGE's are essentially the same as those in the HDDE segment of the industry, with a few notable differences. First, since no HDGE's are sleeved, in-frame rebuilding is non-existent. Engine work done in-frame on a HDGE will take the form of a repair, such as cylinder head or fuel system repair, and not a rebuild. The majority of respondents to the ATD/NADA survey who performed HDGE rebuilds replied that these rebuilds were performed out-of-frame. Secondly, since relatively few complete HDGE rebuilds are done, dynamometer testing is not performed on the vast majority of remanufactured gas engines. Data received from Ford and GM highlights the lack of complete engine rebuilds.

6.3 Component Replacement

Parts and components are treated basically the same way in HDGE rebuilds as they are in HDDE rebuilds. The main stress bearing and lubrication parts, including pistons, rings, and bearings, are replaced when the HDGE undergoes an out-of-frame rebuild. But there are some notable differences. Since the vast majority of rebuilding is with short and long block rebuilds, the fuel system (either carburetor or injection) is not included in rebuilding. This is especially true in assembly-line rebuilding where the engine owner would remove his fuel delivery system before rebuild and then reinstall it onto the newly rebuilt partial engine assembly. The only time the fuel system is checked is when the engine is rebuilt at a dealership or fleet facility. In these cases, the fuel system is inspected and replaced with an OE or rebuilt OE part only if a problem is found or the owner complained of a performance problem traceable to the fuel system. Very few of the ATD/NADA respondents stated that they automatically rebuild or replace a carburetor when rebuilding an engine. Uprating a HDGE during rebuild is virtually non-existent because it would involve changing parts, which would be expensive and difficult, since there are no easily adjustable parts involved in a HDGE rebuild.

Gasoline engine rebuilds do not include catalytic converters. Assembly-line rebuilders, both OE and independent, do not rebuild converters because they do not receive these items from the owners. An owner who has had his engine rebuilt, whether it be a short block or complete engine rebuild, will simply bolt the rebuild back into the truck without changing the converter. A few of the ATD/NADA respondents said they checked catalysts when they were performing a rebuild. No direct operational test exists for catalytic converters but an idle carbon monoxide test may point to possible catalyst deterioration. Therefore, the emissions impact of HDGE rebuild practices are likely to be minimal since the catalyst, the key emission control component in a gasoline engine, is generally not changed.

Replacement parts are either OEM or aftermarket. As with heavy-duty diesels, the more complex the component, the more likely it is going to be rebuilt rather than replaced with a new part. The choice to use aftermarket or OE parts will be a question of price and availability. Ford, GM, and the majority of ATD/NADA members said that they use OE parts, but this is not surprising given the fact that ATD members are affiliated with the OE's and might use OE parts in order to assure that the warranty remains valid on the rebuild. One utility company, on the other hand, said they use either type of parts in their rebuilds. The choice as to which type of parts to use will be treated by the rebuilder in the same way as it is with HDDE's.

6.4 Rebuild Frequency

The overwhelming majority of HDGE rebuilding consists of rebuilding short and long blocks. HDGE's are generally treated the same as LDV and LDT engines, namely they are run until the engine or truck experiences a major failure and then, if cost effective, the broken part is fixed. The decision to rebuild a HDGE is not automatic like it is for HHDDE's. Frequently, the owner decides to replace the engine. In a 1981 Fleet Maintenance & Specifying (F M & S) survey, 42% of fleets stated that they would replace a gasoline engine rather than perform an overhaul, and respondents who said they would overhaul said that their decision would be case-by-case.[43]

It is difficult to state a mileage range at which gas engines will be rebuilt because owners do not schedule rebuilds. Ninety-five percent of HDGE owners perform rebuilds only when engine performance dictates.[44] The statutory useful life of these engines is 110,000 miles. The data we have concerning HDGE rebuilding show that when it does occur, the mileage will generally be near useful life mileage. The F M & S survey gave an average of 99,600 miles to overhaul. Only two ATD/NADA respondents specified when they rebuilt gas engines, and those numbers were 65,000 and 100,000 miles. A power company said they rebuilt gasoline engines in their fleet at 100,000 miles. Therefore, it is reasonable to believe that gas engines are rebuilt generally around 100,000 miles. Rebuilds will occur at different ages because of the varied mileage accumulation rates within the HDGE class. Few, if any, of these engines will be rebuilt a second time because these trucks will wear out prior to the mileage necessary for a second rebuild.

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[43] Fleet Maintenance and Survey, March, 1981.

[44] Id.

Chapter 7 - REBUILD MARKET

7.1 Truck Populations

EPA used three sources of information to determine the most reliable estimate of the current heavy-duty truck fleet; MOBILE 4.1[45], 1989 Energy and Environmental Analysis, Inc. (EEA) Motor Fuel Consumption Model (MFC) as prepared for the Department of Energy[46], and MVMA Facts and Figures[47]. The various reports are not consistent in the way they group light, medium and heavy trucks and only MOBILE 4.1 separates data up by fuel type and model year.

A summary of MOBILE 4.1 registration data for the various classes of engines is shown in Table 7.1 below.

See Appendix E for a model year breakdown of registrations by fuel type and EPA classification.

Table 7.2 shows the EEA MFC estimates for heavy-duty truck populations in 1991 and 2000.[48]

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[45] MOBILE 4.1 Motor Fuel Consumption Model.

[46] 1989 EEA Motor Fuel Consumption Model.

[47] MVMA Facts 'N Figures 1986-89.

[48] See note 45.

light heavy diesel (8,500-19,500 lbs.)	1,140,000	trucks
medium heavy diesel (19,501-33,000 lbs.)	820,000	trucks
heavy heavy diesel (33,001 lbs. and higher)	1,630,000	trucks
light heavy-duty gas (8,500-14,000 lbs.)	2,500,000†	trucks
heavy heavy-duty gas (14,001 lbs. and higher)	1,500,000	trucks

†Light gas data are estimated.

Table 7.1 - MOBILE 4.1 Truck Registration for 1991

	1991	2000
light heavy diesel (8,500-14,000 lbs.)	910,000	1,675,000
medium heavy diesel (14,000-50,000 lbs.)	1,000,000	1,500,000
heavy heavy diesel (50,000 and higher)	1,460,000	1,770,000
light heavy gas (8,500-14,000 lbs.)	4,100,000	4,450,000
medium heavy gas (14,000-50,000 lbs.)	1,300,000	860,000
heavy heavy gas (50,000 and higher)	12,000	1,000

†EEA does not group weight classifications the same as MOBILE 4.1

Table 7.2 - EEA MFC Diesel Registrations for 1991 & 2000

EPA will use the MOBILE 4.1 data to predict fleet composition because MOBILE data can be broken down by age and fuel type as shown in Appendix E. This fleet registration data will be used in conjunction with other data to estimate the number of rebuilds occurring annually.

7.2 Heavy-Duty Truck Mileage Accumulation

EPA used two sources of information to determine mileage accumulation rates: MOBILE 4.1 and EEA's analysis of the 1987 Truck Inventory and Use Survey (TIUS)[49]. Mileage accumulation data is shown in Appendix F. EEA data was only available for medium and heavy diesels. Note that the weight classifications are not the same for each source.

EPA will use the EEA data when available because it is based on the 1987 TIUS while MOBILE 4.1 is based on the 1982 TIUS. For those categories in which EEA data is not available, EPA will use MOBILE 4.1. This mileage accumulation data will be used in conjunction with other data to estimate the number of rebuilds occurring annually.

MOBILE 4.1 vehicle miles traveled (VMT's) are shown in Appendix G. The data are shown as a percentage contribution of each model year within a given weight class.

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[49]EEA mileage accumulation data derived from 1987 TIUS.

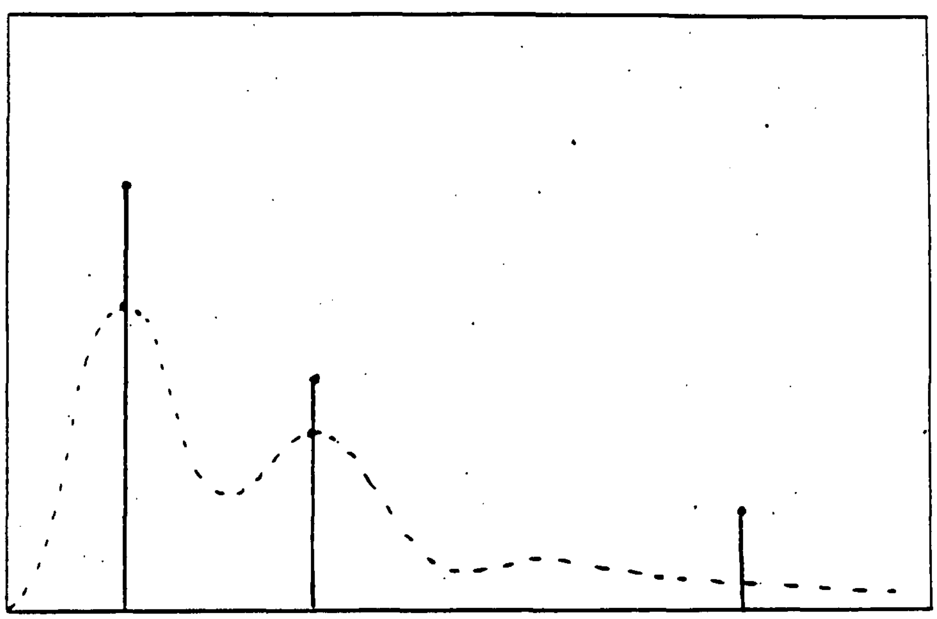
7.3 Estimated Annual Rebuilds - HHDDE's

Method 1

EPA determined that HHDDE's are rebuilt approximately every 300,000 - 400,000 miles. Using the EEA data in Appendix F, trucks will typically undergo their first rebuild beginning at age four. The second set of rebuilds will generally begin when the engine is nine years old. The third rebuild will occur sometime after 15 years. While some engines will accumulate mileage faster and will be rebuilt more than three times, and some will be rebuilt less, the average truck should follow this cycle.

EPA recognizes that not every four, nine and 15+ year old engine is rebuilt each year and that engines of other ages will also be rebuilt. While the exact profile of HHDDE rebuilds per year is unknown, it is reasonable to believe it looks something similar to Figure 7.1. This figure is intended to represent a general distribution of HHDDE rebuilds and is not meant to reflect the exact shape of the curve. The exact curve is unknown. The point demonstrated by this figure is that most first rebuilds will occur at around four years old, second rebuilds around nine years old and third rebuilds after 15 years old. Also, there should be a greater number of first rebuilds than second rebuilds, and more second rebuilds than third

Figure 7.1
HHDDE Rebuild Distribution



(NOTE: This figure is intended to show a possible distribution of rebuilds. The actual distribution is unknown.)

rebuilds.

Since there is no accurate method to determine the exact shape and values of the curve in Figure 7.1, an approximation will be made to estimate the actual number of rebuilds. This is shown as the solid line spikes in Figure 7.1. The height of each spike is estimated to be the number of trucks on the road of that particular age because, on average, the four, nine and 15+ year old trucks are most likely to be rebuilt. The number of trucks of ages 15-25+ were averaged and the spike located at the midpoint (20 years). For HHDDE, MOBILE 4.1 estimates that in 1990 there were about 120,000 HHDDE's which were four years old, 65,000 which were nine years old and an average per year of 30,000 which were 15+ years old. Thus, the total estimate of HHDDE rebuilds per year is about 220,000. This analysis assumes that every HDDE will eventually be rebuilt. Industry comments indicate that most first and third rebuilds will be performed in-frame by owners or fleets. In-frame rebuilds account for more than 50 percent of all estimated HHDDE rebuilds.

Method 2

A second way to estimate rebuilds is to apply survival probability and mileage between rebuilds to average annual production figures. According to MVMA Facts and Figures '88, there have been an average of 135,000 HHDDE's produced per year since 1973.

We know that, on average, the first set of rebuilds will begin occurring when the engine is about four years old, the second at nine years old, and the third set after 15 years old. According to MVMA survival probabilities, 97 percent of HHDDE's produced in a given year will still be on the road at age four to five years, 71 percent at age nine years, and 21 percent after age 15 years.[50] (Note: EPA chose the midpoint probability when a range of years was given). Applying these probabilities to the 135,000 per year production, we see that 131,000 are still on the road at the time of first rebuild, 93,000 at the time of second rebuild and 28,500 at the time of third rebuild for a total of 253,000 rebuilds per year. The approach is illustrated in Table 7.3.

Average Engines Produced Per Year	Age at Rebuild	Likelihood of Survival†	Surviving Engines	Number of Rebuilds Per Year
135,000 per year	4 yrs.	97%	131,000	131,000
	9 yrs.	71%	93,000	93,000
	15+ yrs.	21%	28,500	28,500
				~253,000

†This figure is the likelihood of survival of the midpoint year. For example, the midpoint of 9-15 years is 12 years. Fifty percent (50%) is the likelihood of surviving 12 years.
Note: MVMA probabilities are for 26,000 lbs. and higher GVW.

Table 7.3 – Estimating Rebuilds Using Survival Probabilities

[50] See note 46.

Both methods used to estimate HHDDE rebuilds assume these engines will continually be rebuilt every 300,000 - 400,000 miles until retired from use. Although these rebuilds will occur over 15 or more years, they should average out to 220,000 - 250,000 per year. It should be noted that some engines will receive four or more rebuilds. On the other hand, some engines will undergo fewer than three rebuilds or will be exported or used in off-road applications and thus lower the number of on-highway rebuilds. Based on industry supplied export figures, we do not feel the numbers are significant enough to affect the estimate of rebuilds.

Using the expected increase in truck registrations predicted by the EEA MFC model, we can make a rough estimate as to the number of rebuilds which may occur in the year 2000. For heavy diesels, EEA shows about a 21 percent increase in HHDDE population by 2000. Similarly, a 21 percent increase in the number of rebuilds could be expected, thereby increasing the total to 260,000 - 300,000 rebuilds per year. This assumes that mileage between rebuilds as described in this report is still valid in 2000.

Using VMT data from Appendix G, we see that 50 percent of all HHDV VMT's in 1990 were from four year old and newer trucks. This means that the other 50 percent of HHDV VMT's came from trucks whose engines have likely been rebuilt at least once.

Similarly, 85 percent of HHDV VMT's in 1990 were from nine year old and newer trucks. The remaining 15 percent of VMT's are from trucks whose engines have likely been rebuilt twice. Finally, we see that only 3 percent of all HHDV VMT's are from trucks whose engines have likely been rebuilt three times (15+ year old trucks).

In summary, about one-half of all HHDDE VMT's are from trucks whose engines have undergone at least one rebuild, are past their statutory useful lives, and whose emissions characteristics are unknown.

7.4 Estimated Annual Rebuilds - MHDDE's

Estimating MHDDE rebuilds cannot be made using the same two methods used to estimate HHDDE rebuilds because not all medium diesels are continually rebuilt until retired from use.

In order to make an estimate of MHDDE rebuilds, a few points need to be reiterated. As discussed in Chapter 5, all sleeved MHDDE's that survive until rebuild age will be rebuilt, however these engines account for only 30 percent of the population. The other 70 percent are non-sleeved engines of which an estimated 50 percent will be rebuilt when worn.

EPA determined that rebuild age for MHDDE's is about 200,000 miles. Appendix F EEA data shows that MHDDE's reach 200,000 miles after about nine years. MVMA data shows that only 71 percent of MHDDE's will live to be nine years old.[51] Using these percentages along with average annual production figures, an estimate of MHDDE rebuilds can be made.

EPA production reports show that an average of 145,000 MHDDE's were produced per year[52] over the past three years. (MVMA data was not used because no distinction can be made between gas and diesel sales as could be done with HHDDE's). Each year's production introduces about 43,500 sleeved MHDDE's and 101,500 non-sleeved MHDDE's into commerce. At nine years old (age of rebuild), about 31,000 sleeved engines and about 72,000 non-sleeved engines will still be on the road. As discussed in Chapter 5, most, if not all, sleeved engines will be rebuilt and only 50 percent of the non-sleeved engines will be rebuilt. The total estimate for MHDDE's rebuilds is then 67,000. This approach is outlined in Table 7.4.

Using the expected increase in population predicted by the EEA MFC model, we estimate roughly a 50 percent increase in the number of MHDDE rebuilds by the year 2000, thereby increasing the total to 100,000 per year. This assumes that the ratio of sleeved vs. non-sleeved engines remains fairly constant and that

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[51]<u>See</u> note 46.

[52]Based on 1987, 1988 and 1989 EPA heavy-duty production reports.

mileage between rebuilds as described in this report is still valid in 2000.

Using VMT data from Appendix G, we see that 85 percent of all MHDV VMT's in 1990 were from nine year old and newer trucks. This means that the other 15 percent of MHDV VMT's came from trucks whose engines may have been rebuilt at least once.

Average Engines Produced Per Year	Age at Rebuild	Likelihood of Survival†	Number of Surviving Engines	Likelihood of Rebuild	Rebuilds Per Year
43,500 (sleeved)	9 yrs.	71%	31,000	100%	31,000
101,500 (non-sleeved)	9 yrs.	71%	72,000	50%	36,000
Total					67,000

† MVMA probabilities are for 26,000 lbs. and higher GVW

Table 7.4 - Estimating MHDDE Rebuilds

7.5 Estimated Annual Rebuilds - LHDDE's

According to MOBILE 4.1 (Appendix E), there were approximately 1,140,000 LHDDE's in operation in 1990. MOBILE 4.1 mileage accumulation for these engines is shown in Appendix F. Comments were received from several OE manufacturers regarding LHDDE rebuilding.

As discussed earlier, EPA determined that most LHDDE's are rebuilt because of engine failure. This claim is supported by the fact that manufacturers sell far more short blocks than complete engines. In fact, some OE manufacturers do not sell or authorize anyone to sell complete LHDDE's. These OE's feel there is no market for complete engines. Sales figures supplied by OE's indicate that very little LHDDE rebuilding actually takes place.

One major OE did not submit any comments on rebuilding of it's products, however, it is expected that the total number of LHDDE rebuilds would still be very small even with this additional data.

Because LHDDE's are generally not rebuilt, it was not possible to quantify the age or mileage at which rebuild is likely to occur. Therefore, estimates of annual rebuilds using the methods of the previous sections will not be made.

Due to the small number of rebuilds on LHDDE's and the relatively low mileage accumulation rate for these vehicles as shown in Appendix G, EPA feels the VMT's traveled by rebuilt LHDD engines is very small.

7.6 Model Years of Heavy Diesels Being Rebuilt

Heavy-duty engines from the 1970's, 1980's, and 1990's are currently being rebuilt. Diesel engines of the early 1980's are currently the most frequently remanufactured engines while diesel engines of the mid-late 80's are the most frequently rebuilt by owners and shops. Similarly, by the year 2000, EPA expects that engines of the early-mid 90's will be rebuilt most frequently.

EPA received data from OE's, independents, trade associations and fleets regarding the model years of engines currently being rebuilt. In large part, these data agree with EPA's findings concerning the age at which the various categories of engine are rebuilt.

Large groupings of HHDDE rebuilds are currently being performed by OE's on engines of the early 1980's vintage which corresponds to when the first out-of-frame rebuild is likely to occur (at around nine years old). Fleets showed a similar pattern but with more late 1980's engines being rebuilt. This agrees with our finding that most first rebuilds are performed on engines which are around four years old. Independent rebuilders showed an almost flat distribution of rebuilds among model years. It should be noted that all groups reported rebuilds of engines as far back as the 1960's and 1970's vintages.

For MHDDE's, large groupings of OE rebuilds were reported for engines of the early 1980's. This agrees with EPA's findings that MHDDE's are rebuilt at about nine years old. Data specific to MHDDE rebuilding were not provided (or at least broken down) by other industry groups.

7.7 Estimated Annual Rebuilds - HDGE's

We estimate, based on MOBILE 4.1, that there are approximately 4,000,000 heavy-duty gas trucks in operation in 1990 (light heavy-duty and heavy heavy-duty combined). The mileage accumulation profile for HDGE's is shown in Appendix F. EPA received comments from major OE's and trade associations relating to rebuilding of heavy-duty gasoline engines.

As discussed earlier, HDGE's are generally rebuilt because of engine failure. This claim is supported by the fact that manufacturers sell far more short and long blocks than complete engines. In fact, some major OE's do not sell any complete remanufactured gasoline engines.

AERA, as well as a major OE, stated that aside from the OE's and their authorized remanufacturers, not much HDGE rebuilding or remanufacturing occurs. The majority of rebuilds are performed by OE dealers or others using OE parts. Based on the available data, EPA estimates only 40,000 HDGE's are rebuilt each year (about one percent of the total population of HDGE's).

Because of the small number of rebuilds on HDGE's and the relatively low mileage accumulation rate for these vehicles as shown in Appendix G, and the lack of emissions critical parts affected by rebuild, EPA feels the emissions impact of HDGE rebuilding is small, and any further study should center on heavy-duty diesel engines.

7.8 Model Years of Heavy Heavy-Duty Gasoline Engines Being Rebuilt

The only data EPA received relating to model years of HDGE's being rebuilt was supplied by an independent remanufacturer. The data supports the claim that gas engines and partial blocks are rebuilt primarily to replace failed units, especially when the failed unit has not accumulated significant mileage. The highest number of rebuilds occur in the 1986-1990 timeframe, and according to MOBILE 4.1, HDGE's will only have 20,000 - 80,000 miles accumulated.

Chapter 8 - Emissions from Rebuilt Engines

8.1 Emissions Impacts of Rebuilt Gasoline Engines

No emissions data relating to rebuilt gasoline engines was provided in response to EPA's Federal Register Request for Information. However, EPA believes any emissions impact that may result from rebuilding heavy-duty gasoline engines to be very small. This conclusion is based on two key qualitative factors.

First, very few heavy-duty gasoline engines are rebuilt. These engines comprise the majority of the on-highway heavy-duty market, yet by far account for the fewest number of rebuilds. See Chapter 6 for a discussion of gasoline rebuilding practices. Further, gasoline engines accumulate mileage slowly relative to the larger diesel engines, so any excess emissions which result from rebuilding would make a small annual contribution to air pollution. EPA did not attempt to determine the vehicle miles traveled by rebuilt heavy-duty gasoline vehicles, however, we believe the mileage to be very low.

Second, the components most often replaced during rebuild (short and long block) are not considered key emissions control components of a gasoline engine. Those components, such as carburetors and catalysts, are usually reinstalled on the engine during rebuild without servicing. EPA believes that the emissions after rebuild should be similar to the pre-rebuild emissions.

8.2 Emissions Impacts of Rebuilt Diesel Engines

Only one respondent, an OE manufacturer, supplied data relating to emissions from rebuild heavy-duty diesel engines. Five high mileage engines were subject to a basic engine tune-up and baseline tested for HC, CO, NOx, and smoke emissions. The as-received mileage on each engine ranged from 220,000 - 570,000 miles. After the baseline test, each engine was remanufactured by the OE using new emissions related components (fuel pump, cylinder kits, turbocharger, and puff limiter) and a combination of new and rebuilt parts for other engine systems. After a 25 hour break-in period, each engine was retested. Results varied for each engine and each pollutant; some engines produced less emissions after rebuild while other produced more. However, emissions from each engine remained below the 1985 Federal standards after rebuild. The highest mileage engine (570,000 in-use miles) showed the only across-the-board reduction in emissions.

A basic assumption within the heavy-duty industry is that a properly rebuilt engine will have emissions similar to those of a new engine of the same model year. This belief is widespread among rebuilders and stems from the theory that if every part of an engine is brought back into specification with OE or OE-equivalent parts, there is no reason why the engine should not have like-new emissions.

A 1987 CARB study on engine rebuilding also assumed "that a properly rebuilt engine will emit at levels close to" new engine levels[53] and the rate of emission deterioration will be the same for new and rebuilt engines. The exception to this would be from incorrect rebuilds in which the emissions immediately after rebuild would be higher than those of a new engine and would deteriorate at approximately the same rate.[54] In this case, "incorrect rebuild" meant either incorrect part replacement (i.e. wrong part number) or incorrect parameter settings.

The information available to EPA suggests that incorrect part replacement should not be a significant problem. As discussed in Chapter 5, most rebuilders build to original calibration using proper replacement parts. Although CARB did determine rates at which certain parts are incorrectly replaced, the rates were very low. It was determined that although incorrect rebuild practices <u>may</u> have an impact on emissions, this impact is not estimated to be significant.[55] CARB determined

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[53]<u>See</u> note 21.

[54]<u>Id</u>.

[55]<u>Id</u>.

that 80 percent of HC increases and 66 percent of Nox increases[56] from rebuilds were attributable to improper calibration of components by installers and owners and not a direct result of poorly manufactured parts or of the actual rebuilding of engines.

The notion that maintenance and calibration play a large role in actual engine emissions was also raised by AERA. Comments received from AERA stated that high levels of emissions can be "directly related to on-going engine, engine management and fuel system maintenance".[57]

The OE information and the data described in the CARB report are useful; however EPA feels that because of the large number of heavy-duty diesel rebuilds that occur and the high mileages these vehicles accumulate, more emissions data are needed. Data which show comparisons between rebuilds performed by different sectors of the industry, as well as data which show the impact of in-frame rebuilding practices, will better serve to determine the effect of rebuilding on engine emissions.

8.3 EPA Testing

Because of the lack of available emission data pertaining to

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[56] Id.

[57] See note 28.

rebuilt engines, EPA will conduct limited testing of these engines. EPA testing will focus on HHDDE's and MHDDE's, as these engines are rebuilt most frequently. Furthermore, rebuilt engines within these categories account for a substantial portion of all vehicle miles traveled by these groups.

[illegible] the regulations in 10 CFR [illegible]. Protests, motions to intervene, notices of intervention, requests for additional procedures, and written comments should be filed with the Office of Fuels Programs at the address listed above.

It is intended that a decisional record on the application will be developed through responses to this notice by parties, including the parties' written comments and replies thereto. Additional procedures will be used as necessary to achieve a complete understanding of the facts and issues. A party seeking intervention may request that additional procedures be provided, such as additional written comments, an oral presentation, a conference, or trial-type hearing. Any request to file additional written comments should explain why they are necessary. Any request for an oral presentation should identify the substantial question of fact, law, or policy at issue, show that it is material and relevant to a decisioin in the proceeding, and demonstrate why an oral presentation is needed. Any request for a conference should demonstrate why the conference would materially advance the proceeding. Any request for a trial-type hearing must that that there are factual issues genuinely in dispute that are relevant and material to a decision and that a trial-type hearing is necessary for a full and true disclosure of the facts.

If an additional procedure is scheduled, notice will be provided to all parties. If no party requests additional procedures, a final opinion and order may be issued based on the official record, including the application and responses filed by parties pursuant to this notice, in accordance with 10 CFR 590.316.

A copy of TCGM's application is available for inspection and copying in the Office of Fuels Programs Docket Room, room 3F-056 at the above address. The docket room is open between the hours of 8 a.m. and 4:30 p.m., Monday through Friday, except Federal holidays.

Issued in Washington, DC, on March 28, 1991.

Clifford P. Tomaszewski,

Acting Deputy Assistant Secretary for Fuels Programs, Office of Fossil Energy.

[FR Doc. 91-7945 Filed 4-3-91; 8:45 am]

BILLING CODE 6450-01-M

ENVIRONMENTAL PROTECTION AGENCY

FRL-3917-6]

Request for Information Concerning Heavy-Duty Engine Rebuild Study

AGENCY: Environmental Protection Agency.

ACTION: Notice, request for information.

SUMMARY: As required by the Clean Air Act Amendments of 1990, the Agency has begun a study of heavy-duty engine rebuild practices and the impact these practices have on engine emissions. This study will assist the Agency in determining whether regulations governing rebuilding practices are needed. To aid the Agency in conducting this study, EPA requests written submissions from all interested parties who wish to comment on heavy-duty engine rebuild practices, the impact of these practices on engine emissions, and any other related aspects of the heavy-duty truck market.

DATES: Comments from interested parties should be received no later than May 8, 1991.

ADDRESSES: Written comments should be sent to: Environmental Protection Agency, Manufacturers Operations Divison (EN-340F), Attn: Karl Simon, 401 M St., SW., Washington, DC 20460.

FOR FURTHER INFORMATION CONTACT: Karl Simon, at the address given above; telephone (202) 382-2510.

SUPPLEMENTAL INFORMATION:

I. Introduction

Section 202(a)(3)(D) of the Clean Air Act, as revised by the Clean Air Act Amendments of 1990, requires EPA to study the practice of heavy-duty engine rebuilding and its impact on engine emissions. On the basis of such study and any other pertinent information, the Administrator may prescribe any requirements to control rebuilding practices, including standards for emissions from rebuilt heavy-duty engines which cause or contribute to air pollution which may be reasonably anticipated to endanger public health or welfare, taking costs into account.

The EPA Office of Mobile Sources, Manufacturers Operations Division, has begun a study of heavy-duty engine rebuilding practices. For the purpose of this study, a heavy-duty engine is one used in a heavy-duty vehicle as defined at 40 CFR 86.082-2. This definition includes, in general, trucks with a gross vehicle weight rating (GVWR) greater than 8,500 pounds. The results of this study, along with any other available information on this topic, will form the basis for the determination as to whether further action by EPA, such as regulations or guidelines, to control engine rebuilding practices is needed.

Among the information sought through this request for information are data on the nature of the heavy-duty rebuilding industry, the volume of heavy-duty rebuilding occurring annually, the parties involved in rebuilding and in the manufacturing of parts used by rebuilders, the nature of rebuilding practices, and the costs associated with all aspects of this industry. EPA also plans, as part of this study, to conduct emissions testing of different heavy-duty engines in various rebuilt stages. Data generated from these tests will be used to determine the air quality impact of rebuilt engines.

Some of the questions posed in this request for information may ask for information that may be considered confidential business information by a company wishing to respond to the EPA. Submitting parties may assert a business confidentiality claim covering all or part of the information provided in response to this request. To assert a business confidentiality claim regarding any of the information, you should do so in a manner consistent with 40 CFR 2.203(b). Information covered by such a claim will be disclosed by EPA only to the extent, and by means of the procedures set forth in 40 CFR part 2, subpart B. If no claim accompanies the information when it is received by EPA, it may be made available to the public without further notice to the submitting party.

Questions:

Please indicate the questions you are responding to in your response. Whenever possible, please break down responses into the following two categories:

a. Fuel type

1. gas,
2. diesel.

b. Vehicle/engine class

1. Class IIB (8,500 < GVWR < 10,000 lbs).
2. Class III (10,000 < GVWR < 14,000 lbs).
3. Class IV (14,000 < GVWR < 16,000 lbs).
4. Class V (16,000 < GVWR < 19,500 lbs).
5. Class VI (19,500 < GVWR < 26,000 lbs).
6. Class VII (26,000 < GVWR < 33,000 lbs).
7. Class VIII (GVWR > 33,000 lbs).

Interested parties are invited to address any question of fact, law, or policy which they feel may have a [illegible] in the heavy duty engine [illegible] study and is not addressed in the questions below.

1. Please describe your organization or company and its function?

a. How many members or employees do you have?

2. If you employ or represent engine mechanics, what percentage are certified by ASE or some other association?

3. If you own or operate any heavy-duty trucks, please describe your general fleet make-up in terms of model year, fuel type, and categories.

4. How would you define:

a. A rebuilt engine?

b. A remanufactured engine?

c. An overhauled engine?

5. How can one tell if an engine has been rebuilt? For example, is it labeled in any way?

a. Are original equipment manufacturer labels removed during the rebuild process?

b. What types of warranties are available on rebuilt engines?

6. Does your organization or company perform engine rebuilds? If so, please answer the following questions:

a. In the last five years, how many complete engine, long block, and short block rebuilds did you perform?

b. What criteria are used to determine when an engine needs to be rebuilt?

c. What percentage of your rebuilding is done in-chassis and what percentage is done out-of-chassis?

d. How many diesel and gasoline fuel systems (not including those already accounted for under complete engines) have you rebuilt in the past five years?

e. For each of the past five years, please list the number of rebuilds performed for the following model years:

a. 1975 and before engines.

b. 1976–1980 engines.

c. 1981–1985 engines.

d. 1986–1990 engines.

f. What percentage of your rebuild work is performed in-house and what percentage is contracted out to independent shops? Is your rebuild work done by factory-authorized or factory-owned rebuild shops? If so, please give the approximate number of engines sent out to be rebuilt each year.

7. For the following parts list, please list the criteria that are used to determine when to replace each part during rebuilding, how often they are replaced (if at all), and whether they are replaced with original equipment, rebuilt original equipment, aftermarket, rebuilt aftermarket, or some other type of parts (please specify):

a. Piston

b. Piston rings

c. Injectors/nozzles

d. Governor

e. Carburetor

f. Injection pump

g. Crankshaft

h. Main bearings

i. Cylinder

j. Catalyst

k. Turbocharger

l. Connecting rods

m. Connecting rod bearings

n. Camshaft

o. Camshaft bushings

p. Cam follower

q. Cylinder head (components)

8. How many times is the average heavy-duty engine rebuilt in its lifetime?

a. What is the approximate total mileage and time a rebuilt engine will be run before another rebuild?

b. How many years and miles will a rebuilt engine last before it must be scrapped/replaced?

c. What criteria are used to determine when to scrap the engine?

9. What is the approximate time required (in man-hours) and the cost of a typical rebuild for:

a. A long block?

b. A short block?

c. A complete engine?

d. A gasoline fuel system?

e. A diesel fuel system?

10. If you do rebuilds for customers, do they receive the same block back or do they get a like-for-like trade? How often do customers want a different-powered engine than the one they bring in?

11. How long does it take to develop and bring into production an engine replacement part and what are the approximate associated costs? This question applies to both original equipment upgrade parts and aftermarket parts.

12. Are retrofit emissions upgrade kits available now? If not, is it feasible to develop them? If so, please specify applicable model years and/or engine families.

13. What engine parts could be upgraded and included in a retrofit kit? What parts could not be upgraded?

14. Do you have any emissions test data relating to engine rebuilding? If yes, please provide.

15. Assuming that regulation of engine rebuilding practices will occur, what would you propose as the most feasible and equitable regulatory scheme?

Dated: March 28, 1991.

Michael Shapiro,

Acting Assistant Administrator for Air and Radiation.

[FR Doc. 91–7828 Filed 4–3–91; 8:45 am]

BILLING CODE [illegible]

[FRL 3919–4]

Availability of Testing Manual

AGENCY: Environmental Protection Agency.

ACTION: Notice of Availability of Document entitled "Evaluation of Dredged Material Proposed for Ocean Disposal-Testing Manual."

SUMMARY: This action announces the availability of the revised testing manual entitled "Evaluation of Dredged Material Proposed for Ocean Disposal-Testing Manual." Copies of the manual can be requested by writing to the address listed below under "**ADDRESSES**".

ADDRESSES: A copy of "Evaluation of Dredged Material Proposed for Ocean Disposal-Testing Manual" and/or the initial mixing model disks can be obtained by writing to Ms. Billie Skinner, U.S. Army Corps of Engineers, Waterways Experiment Station, EP-D, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180–6199.

FOR FURTHER INFORMATION CONTACT: David Redford, Mail Code WH-556F, Marine Permits and Monitoring Branch, U.S. Environmental Protection Agency, 401 M Street SW., Washington, DC 20460 (phone (202) 475–7179); or David Mathis, Office of Environmental Policy, CECW-PO, U.S. Army Corps of Engineers, 20 Massachusetts Ave. NW., Washington, DC 20314 (phone (202) 272-8843).

SUPPLEMENTARY INFORMATION: Proposed operations involving the dumping of dredged materials into ocean waters must be evaluated to determine the potential environmental impacts of such activities. This is done as part of the permitting process under title I of the Marine Protection, Research, and Sanctuaries Act (Pub. L. 92–532 [MPRSA]). In accordance with section 103 of the MPRSA, the Corps of Engineers (CE) is the permitting authority, with the determination to issue a permit being subject to review by the Environmental Protection Agency (EPA). The MPRSA provides that the CE use environmental criteria developed by EPA under section 102 of the Act in making permit and project decisions. The criteria developed by EPA under section 102 of the MPRSA are printed at 40 CFR parts 220–228. In order to regulate and limit adverse ecological effects of ocean dumping of dredged material, the regulations emphasize valuative techniques such as toxicity and bioaccumulation bioassays, which provide relatively direct estimates of the potential for environmental impact.

Appendix B

1. Alabama Power -- investor-owned electric utility company

2. American Trucking Associations, Inc. (ATA) -- industry association

3. Automotive Engine Rebuilders Association (AERA) - industry association

4. Automotive Parts Rebuilders Association (APRA) -- industry association

5. California Air Resources Board (CARB) -- state regulatory agency

6. Caterpillar, Inc. -- Original Equipment (OE) manufacturer

7. Council of Fleet Specialists (CFS) -- industry association

8. Cummins Engine Company, Inc. -- OE manufacturer

9. Dealers Manufacturing -- independent remanufacturer

10. Department of the Army, U.S Materiel Command -- manages equipment and vehicles for the Army

11. Detroit Diesel Corporation (DDC) -- OE manufacturer

12. Donaldson Company, Inc. -- manufacturer of aftertreatment devices

13. Engine Control Systems -- manufacturer of aftertreatment devices

14. Engine Manufacturers Association (EMA) -- industry association

15. Enginetech, Inc. -- manufacturer and distributor of engine components

16. Federal-Mogul Corporation -- manufacturer of OEM and replacement parts

17. Ford Motor Company (Ford) -- OE manufacturer

18. Fred Jones Manufacturing Company -- independent remanufacturer

19. General Motors Corporation (GM) -- OE manufacturer

20. Heavy Duty Manufacturers Association -- industry association

Appendix B

20. Heavy Duty Manufacturers Association -- industry association

21. Jasper Engine and Transmission Exchange (Jasper) -- independent remanufacturer

22. Mack Trucks, Inc. (Mack) -- OE manufacturer

23. Manufacturers of Emission Controls Association (MECA) -- industry association

24. American Truck Dealers Division of the National Automobile Dealers Association (ATD/NADA) -- industry association

25. National Engine Parts Manufacturers Association - industry association

26. National Institute for Automotive Service Excellence (ASE)-- industry association

27. Production Engine Remanufacturers Association (PERA) -- industry association

28. The Tucker Co., Inc. -- manufacturer and distributor or engine components

TABLE 5-6

SUMMARY OF REBUILD
COMPONENT SERVICING PRACTICES
IN-FRAME
FLEET SURVEY (Survey #3)
(% DISTRIBUTION)

	Not Serviced	Original Part Rebuilt	Replaced With Rebuilt Parts	Replaced With New OEM Parts	Replaced With New Aftermarket Parts	Sample Size
Piston Rings	2	0	0	93	5	42
Cylinder Liners	7	0	0	88	5	42
Pistons	7	2	2	83	5	42
Cylinder Heads	0	45	40	10	5	42
Fuel Injectors	0	43	38	14	5	42
Injection Pumps	5	50	29	12	5	42
Governors or Fuel Delay Mechanisms	9	50	24	15	3	34
Turbochargers	2	38	43	12	5	42
Aftercoolers	8	56	26	8	3	39
Roots Blowers	4	50	27	15	4	26
Rocker Arms	12	39	27	20	2	41

TABLE 5-7

SUMMARY OF REBUILD
SERVICING PRACTICES
OUT-OF-FRAME
FLEET SURVEY (Survey #3)
(% DISTRIBUTION)

	Not Serviced	Original Part Rebuilt	Replaced With Rebuilt Parts	Replaced With New OEM Parts	Replaced With New Aftermarket Parts	Sample Size
Piston Rings	0	0	0	95	5	42
Cylinder Liners	0	0	0	95	5	42
Pistons	0	0	2	93	5	42
Cylinder Heads	0	40	43	12	5	42
Fuel Injectors	0	43	45	10	2	42
Injection Pumps	2	50	36	10	2	42
Turbochargers	0	48	35	15	2	40
Aftercoolers	3	59	26	10	3	39
Roots Blowers	4	46	31	15	4	26
Rocker Arms	2	50	28	18	2	40

TABLE 5-8

SUMMARY OF REBUILD
COMPONENT SERVICING PRACTICES
IN-FRAME
REBUILD SHOP SURVEY (Survey #4)
(% DISTRIBUTION)

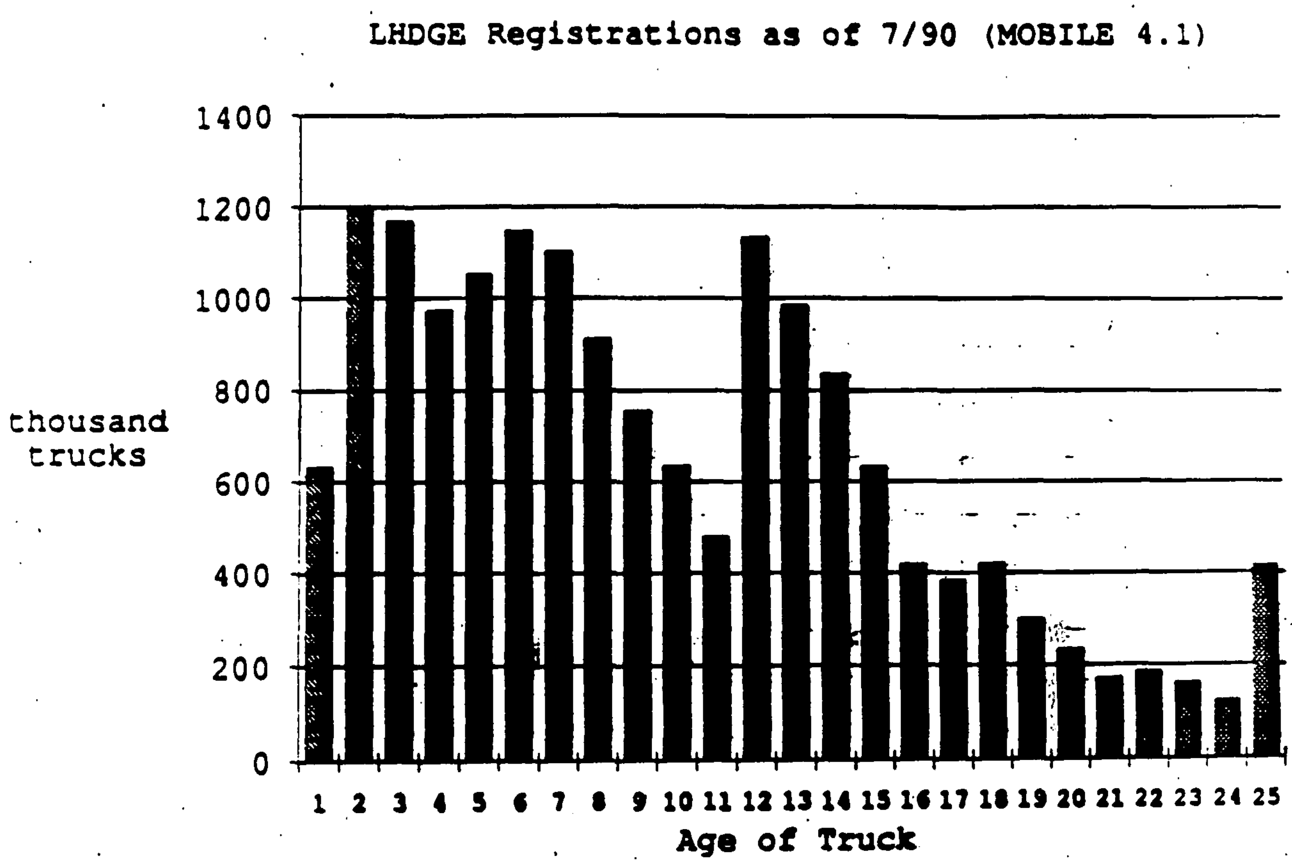
	Not Serviced	Original Part Rebuilt	Replaced With Rebuilt Parts	Replaced With New OEM Parts	Replaced With New Aftermarket Parts	Sample Size
Piston Rings	0	0	0	100	0	47
Cylinder Liners	0	0	2	98	0	47
Pistons	0	0	2	98	0	47
Cylinder Heads	0	17	68	15	0	47
Fuel Injectors	0	11	72	17	0	47
Injection Pumps	18	24	53	4	0	45
Governors or Fuel Delay Mechanisms	9	46	30	15	0	46
Turbochargers	2	13	78	7	0	45
Aftercoolers	18	33	27	22	0	45
Roots Blowers	2	35	38	7	0	40
Rocker Arms	13	22	41	24	0	46

TABLE 5-9

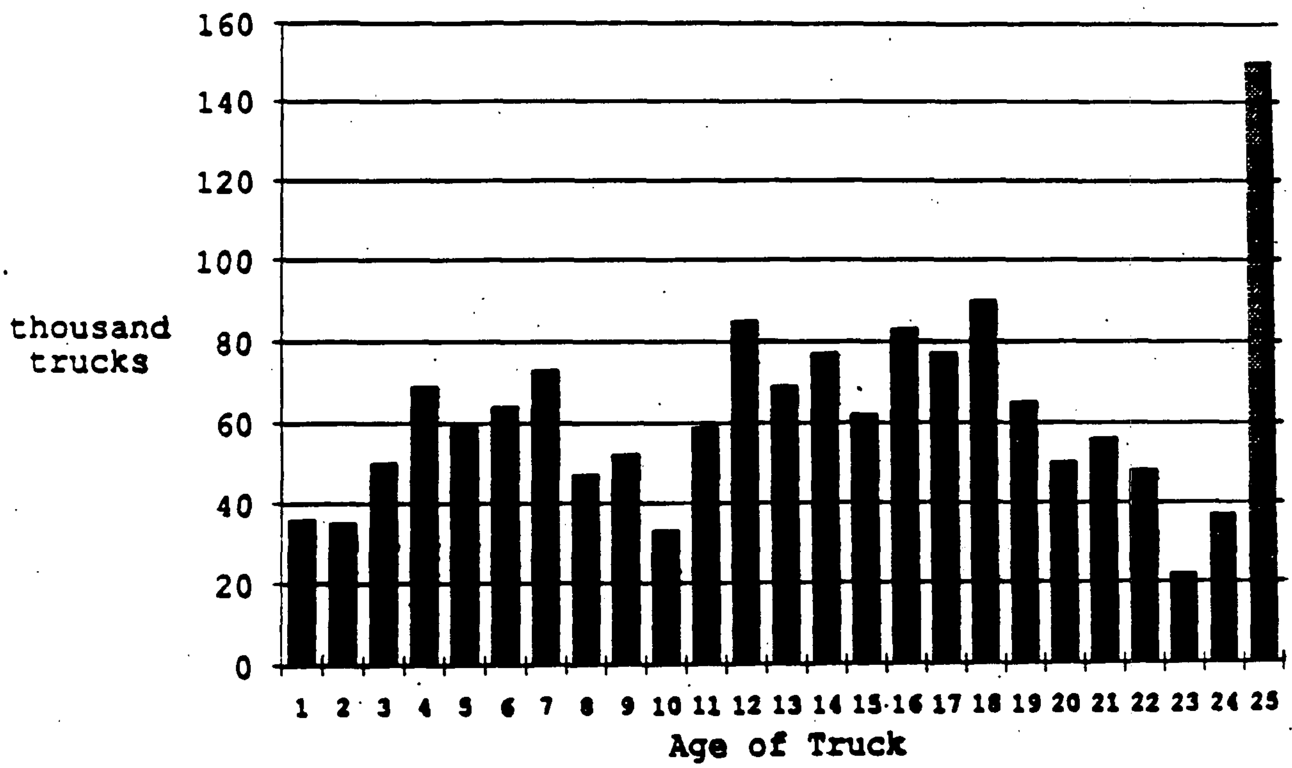
SUMMARY OF REBUILD BEHAVIOR
COMPONENT SERVICING
OUT-OF-FRAME
REBUILD SHOP SURVEY (Survey #4)
(% DISTRIBUTION)

	Not Serviced	Original Part Rebuilt	Replaced With Rebuilt Parts	Replaced With New OEM Parts	Replaced With New Aftermarket Parts	Sample Size
Piston Rings	0	0	0	100	0	47
Cylinder Liners	0	0	2	98	0	47
Pistons	0	0	2	98	0	47
Cylinder Heads	0	19	64	17	0	47
Fuel Injectors	0	9	77	15	0	47
Injection Pumps	0	23	66	11	0	47
Turbochargers	0	11	81	9	0	47
Aftercoolers	0	39	39	20	2	44
Roots Blowers	0	38	51	10	0	39
Rocker Arms	0	20	50	30	0	46

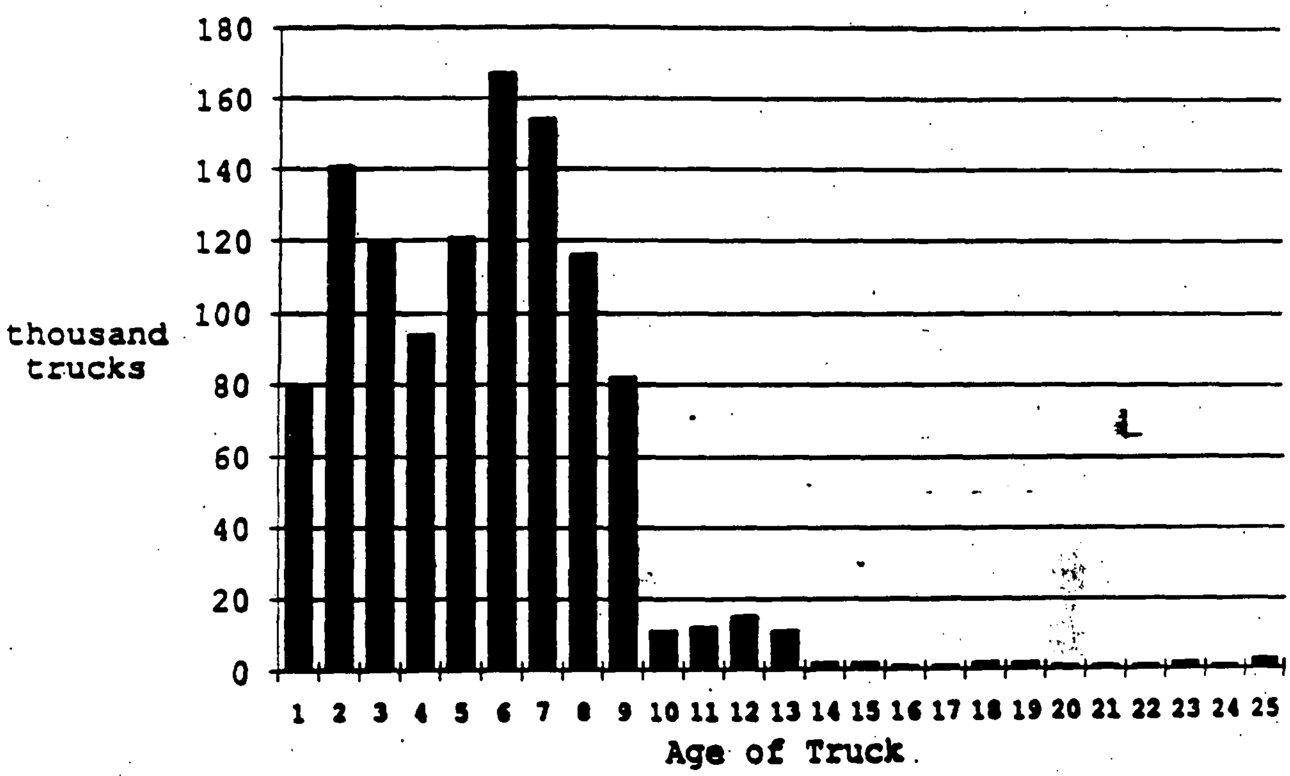
Sleeves	New
Pistons, Pins & Lock Rings	New
Piston Rings	New
Rod Bushings	New
Connecting Rods	Remfg.
Rod Bolts & Nuts	New
Connecting Rod Bearings	New
Camshaft	Remfg.
Camshaft Bearings	New
Cam Followers, Rollers, Bushings & Pins	New
Cam Thrust Washers	New
Crankshaft	Remfg.
Main Bearings	New
Crankshaft Thrust Washers	New
Valves, Springs, Seats & Guides	New
Rocker Arm Shafts	New
Blower	Remfg.
Turbocharger	Remfg.
Governor	Remfg.
Air Compressor*	Remfg.
Injector Tubes	New
Fuel Supply Pump	Remfg.
Fuel Injector Pump	Remfg.
Fuel Injectors	Remfg.
Fuel Lines	New
Accessory Drives	Remfg.
Hoses & Fittings	New
Lines & Belts	New
Water, Oil & Fuel Filters	New
Oil Pump	Remfg.
Water Pump	Remfg.
Flywheel	Remfg.
Gaskets & Seals	New
Starter Ring Gear	New
Vibration Damper	New or Remfg.
Thermostats	New
Idler Gear Bearings	New

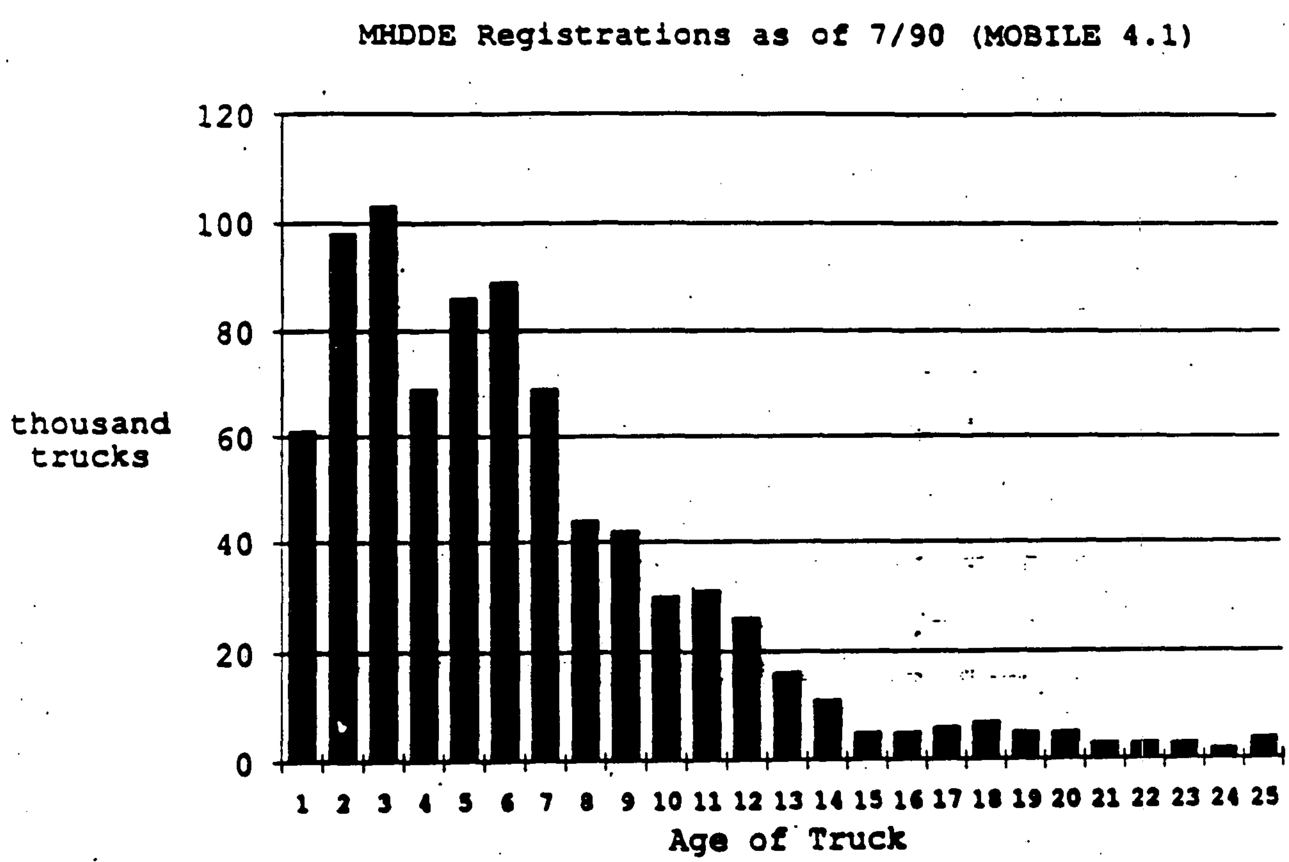

LHDGE Registrations as of 7/90 (MOBILE 4.1)
1400
1200
1000
800
600
400
200
0
thousand trucks
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Age of Truck

HHDGE Registrations as of 7/90 (MOBILE 4.1)

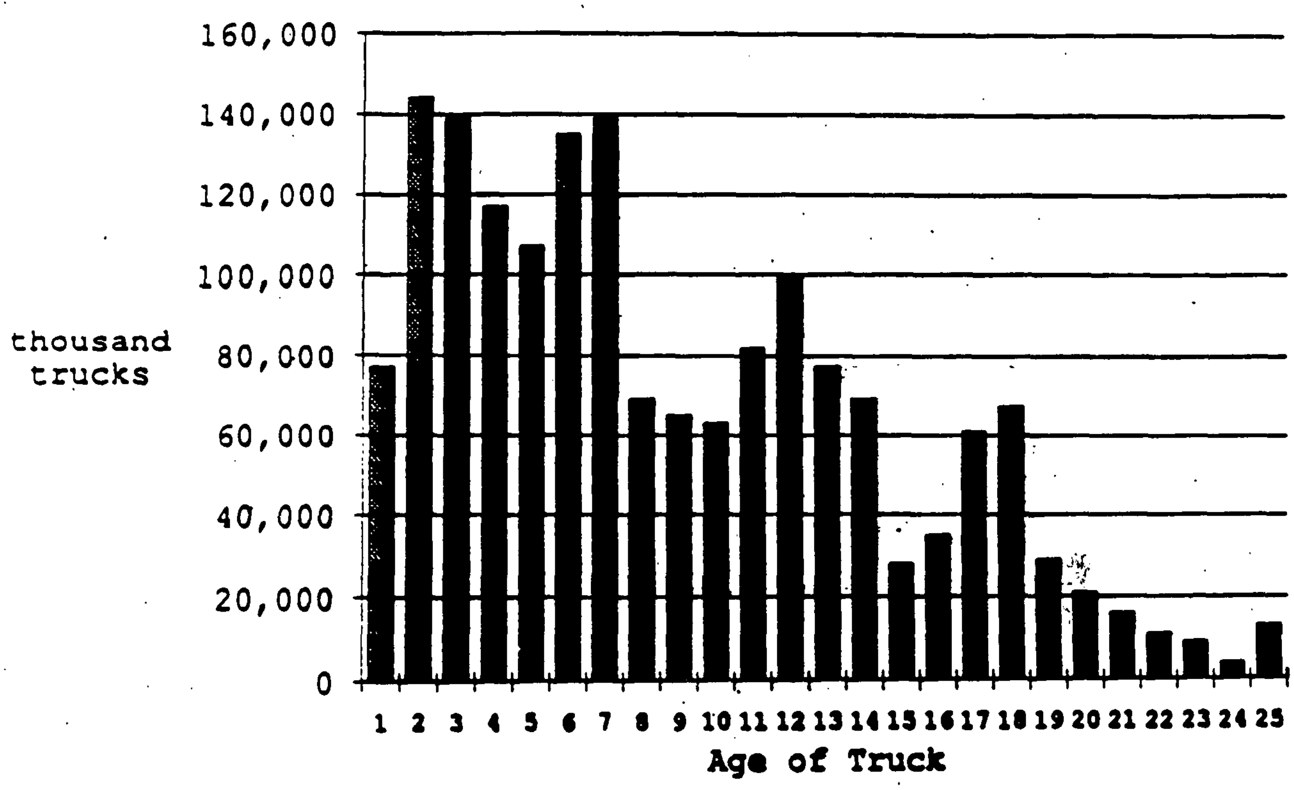


LHDDE Registrations as of 7/90 (MOBILE 4.1)

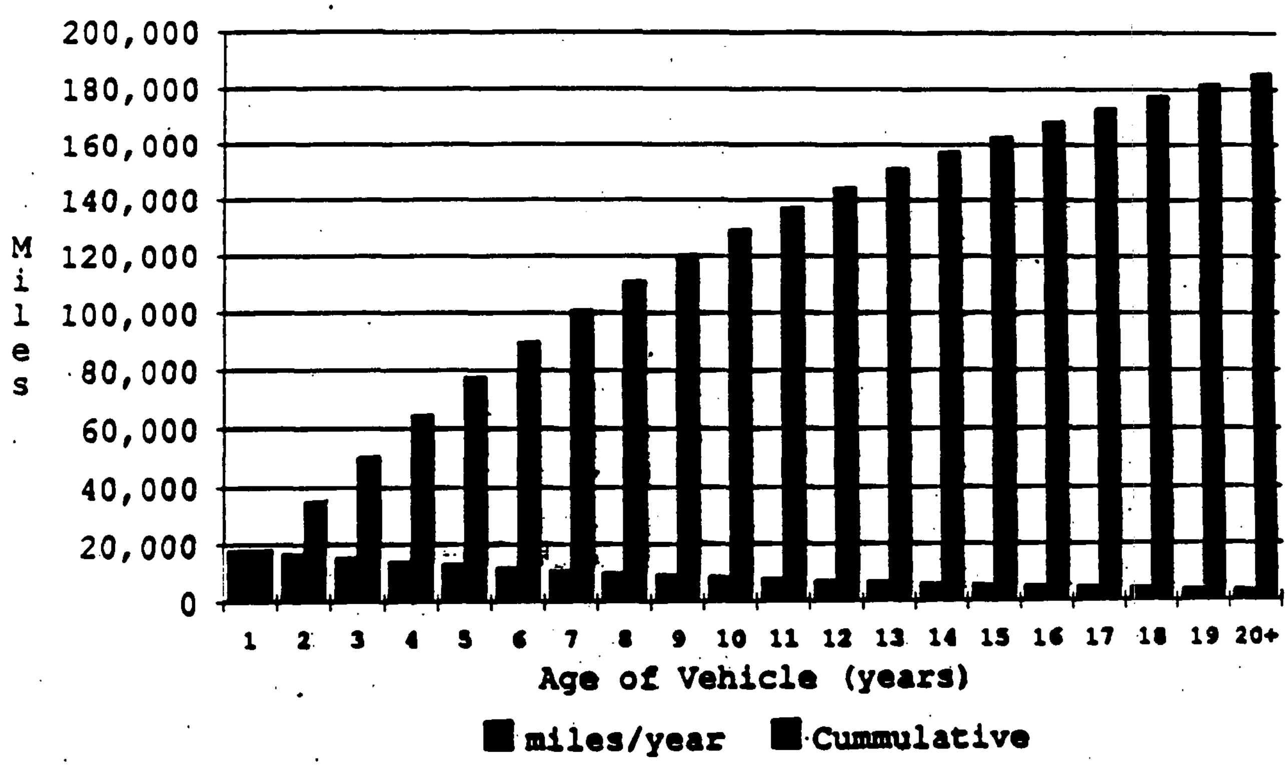


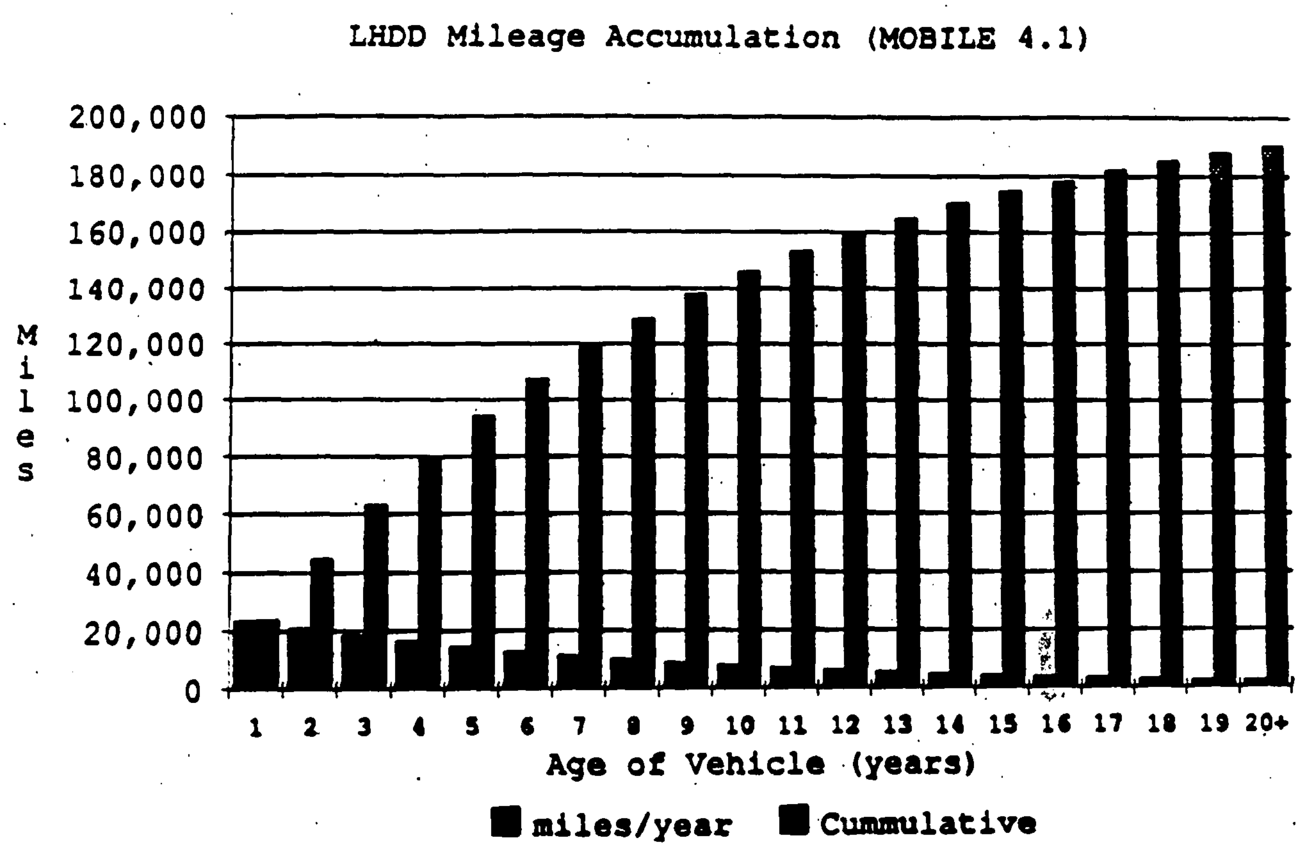

MHDDE Registrations as of 7/90 (MOBILE 4.1)
thousand trucks
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Age of Truck

HHDDE Registrations as of 7/90 (MOBILE 4.1)

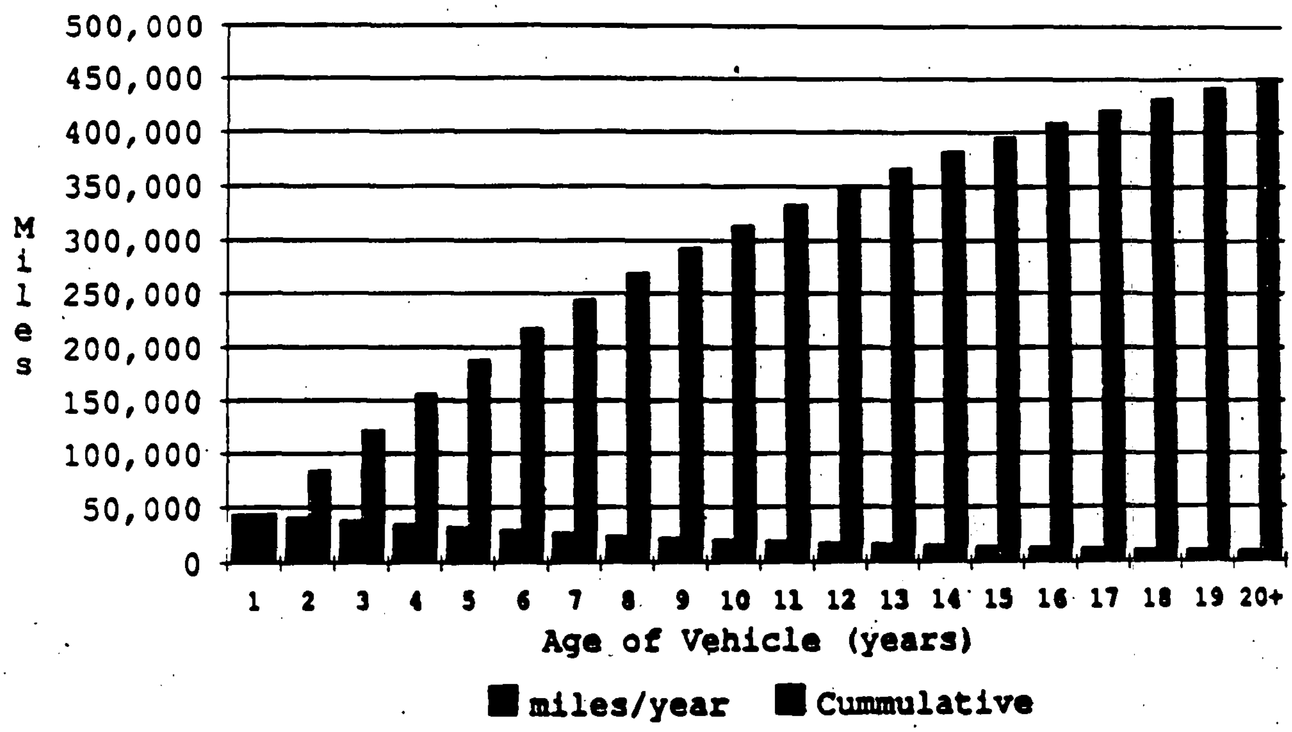


HDG Mileage Accumulation (MOBILE 4.1)

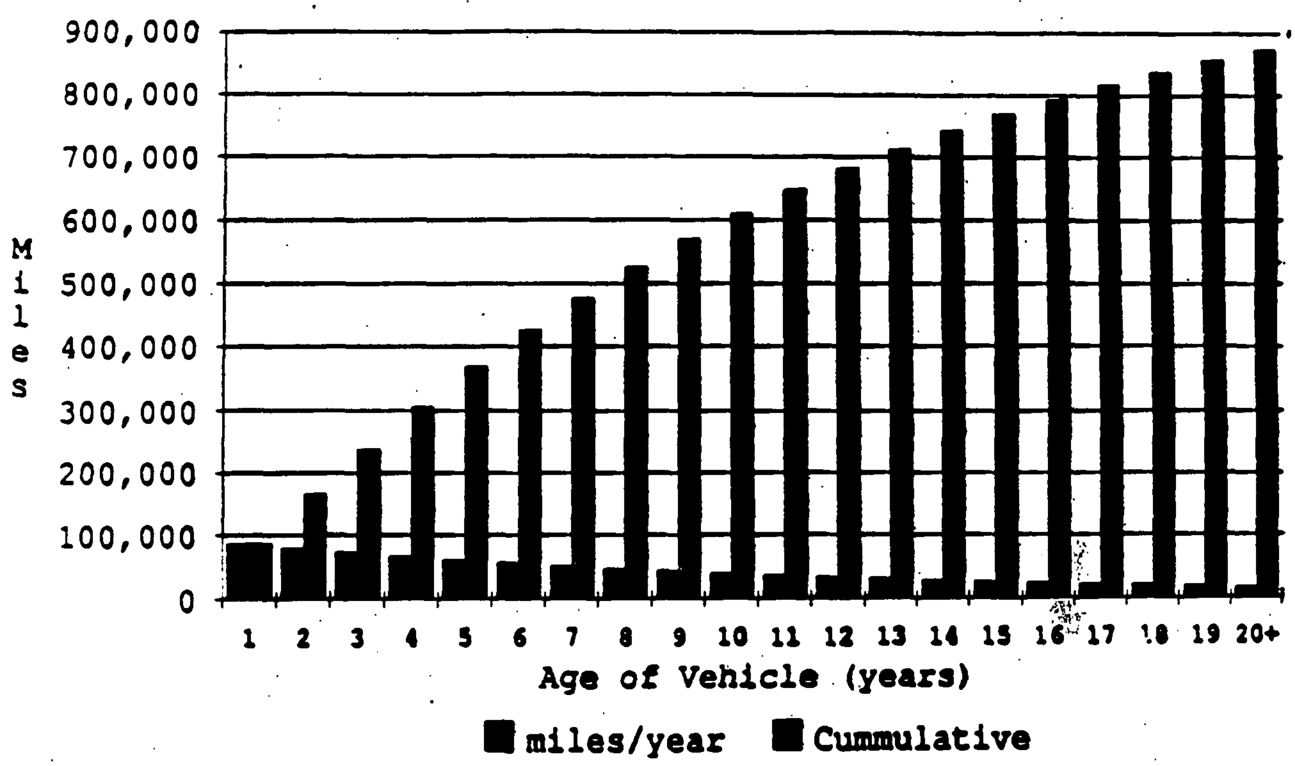


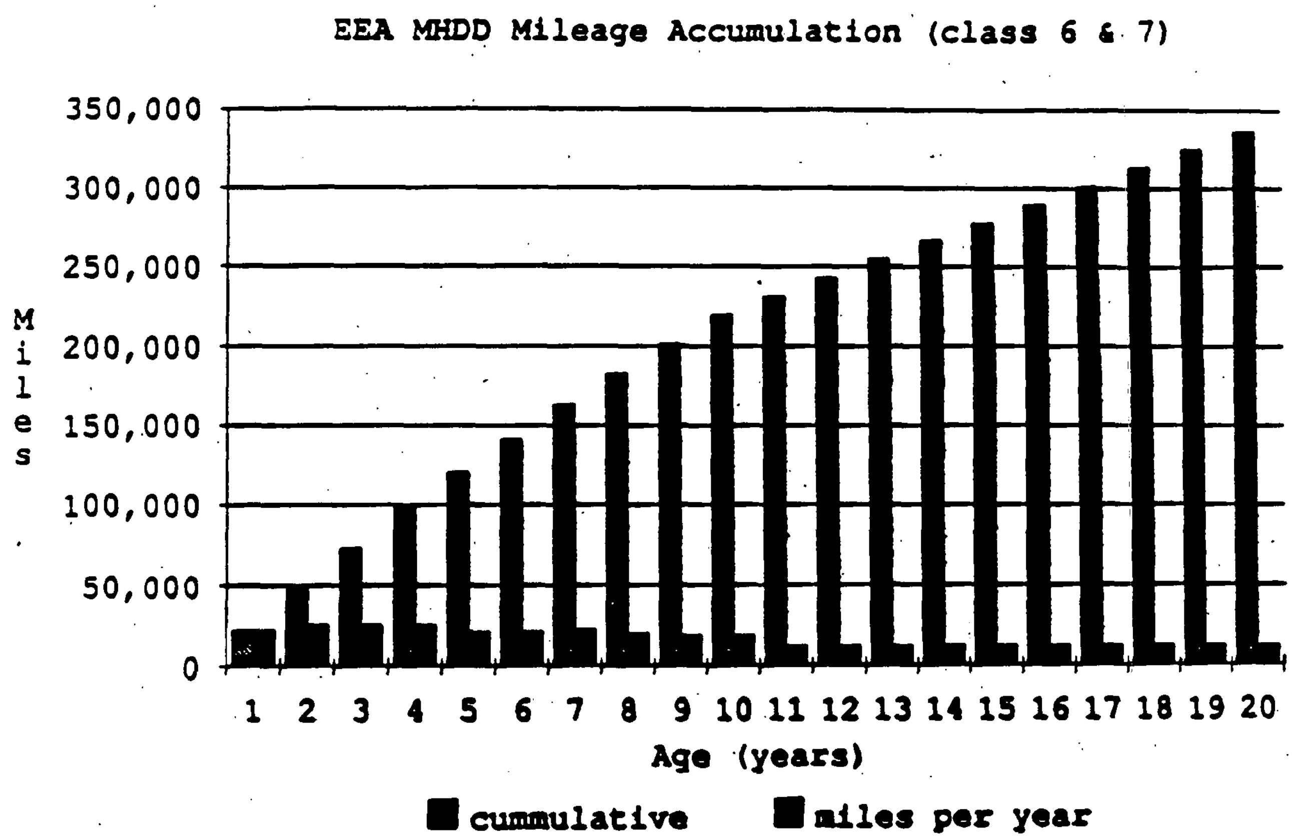

LHDD Mileage Accumulation (MOBILE 4.1)
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Miles
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20+
Age of Vehicle (years)
miles/year
Cummulative

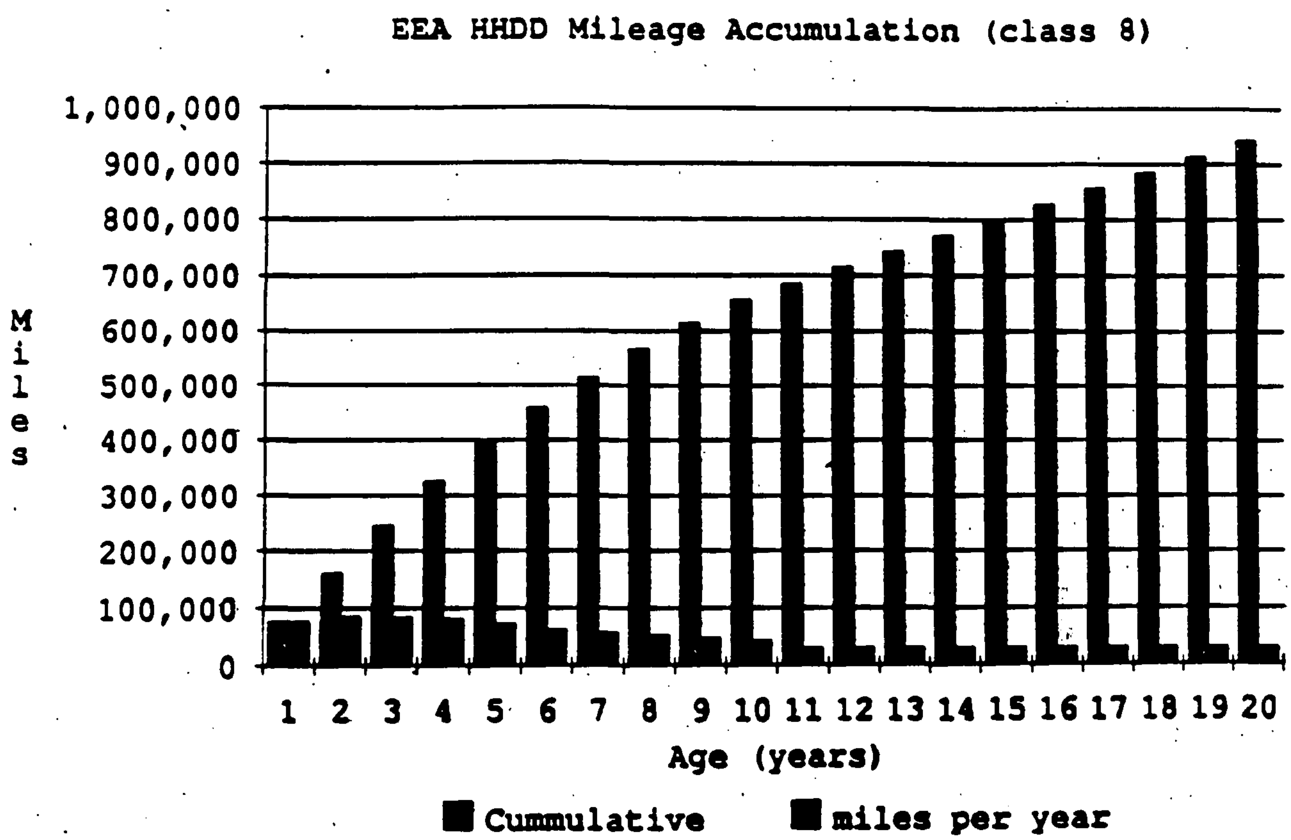
MHDD Mileage Accumulation (MOBILE 4.1, class 6, 7 & 8a)



HHDD Mileage Accumulation (MOBILE 4.1, class 8b)




EEA MHDD Mileage Accumulation (class 6 & 7)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Miles
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Age (years)
cummulative
miles per year



EEA HHDD Mileage Accumulation (class 8)
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Miles
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Age (years)
Cummulative
miles per year

Travel Fraction (VMT) as of Jan. 1, 1990
(contribution of a given MY within each weight class)

Model Year	2HDV	LHDV	MHDV	HHDV	HDGV
90	0.00%	0.00%	0.00%	0.00%	0.00%
89	17.10%	19.80%	17.10%	17.20%	11.90%
88	15.20%	16.90%	15.20%	15.20%	11.20%
87	10.20%	10.90%	10.20%	10.20%	9.10%
86	10.00%	10.30%	10.00%	10.00%	8.70%
85	11.20%	11.10%	11.20%	11.20%	8.70%
84	9.40%	9.00%	9.40%	9.40%	7.90%
83	5.10%	4.70%	5.10%	5.10%	5.80%
82	4.10%	3.70%	4.10%	4.10%	4.50%
81	2.90%	2.50%	2.90%	2.90%	3.50%
80	3.20%	2.60%	3.20%	3.20%	2.80%
79	3.30%	2.60%	3.30%	3.30%	5.50%
78	2.20%	1.70%	2.20%	2.20%	4.30%
77	1.70%	1.20%	1.70%	1.70%	3.60%
76	0.70%	0.50%	0.70%	0.70%	2.60%
75	0.70%	0.50%	0.70%	0.70%	1.90%
74	0.80%	0.50%	0.80%	0.80%	1.60%
73	0.80%	0.50%	0.80%	0.80%	1.70%
72	0.50%	0.30%	0.50%	0.50%	1.10%
71	0.30%	0.20%	0.30%	0.30%	0.80%
70	0.20%	0.10%	0.20%	0.20%	0.60%
69	0.20%	0.10%	0.20%	0.20%	0.60%
68	0.10%	0.10%	0.10%	0.10%	0.40%
67	0.10%	0.00%	0.10%	0.10%	0.30%
66-	0.20%	0.10%	0.20%	0.20%	0.70%

where:
HDGV = heavy duty gas vehicle (all classes)
2HDV = class 2B HDDV
LHDV = class 3 - 5 HDDV
MHDV = class 6 - 8a HDDV
HHDV = class 8a and above