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Industry Characterization: On-Road Heavy Duty Diesel Engine Rebuilders

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Industry Characterization:
On-Road Heavy Duty Diesel Engine Rebuilders

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1. Introduction

The purpose of this report is to characterize the heavy duty diesel engine (HDDE) rebuild industry. This report is prepared under the direction of EPA, as part of their rulemaking support for revisions to the emissions standards for HDDEs. For purposes of EPA's proposed regulations, HDDEs are those with gross vehicles weights (GVW) of 8,500 pounds and greater, also known as Class 2B through Class 8 (see Exhibit 1-1). However, as documented previously,[1] and as confirmed by research conducted for this report, the engines in the market segment defined by Classes 2B through 5 (light-heavy duty diesel engines or LHDDEs) are generally not rebuilt. The bodies of these trucks are not designed for long-term use (i.e., several hundred thousand miles). The body - not the engine - is generally the limiting factor in the LHD duty truck lifetime. By contrast, in the medium-heavy duty diesel engine (MHDDE - Classes 6 and 7) and the heavy-heavy duty diesel engine (HHDDE - Class 8) markets, the vehicle body is designed for long-term use. A 1987 study found that heavy duty truck engines are rebuilt an average of four times over the course of a lifetime, and may be rebuilt as many as six times.[2] Rebuilds as a percentage of population illustrated in Exhibit 1-1 show that rebuilds are significant in the MHDDE and HHDDE markets. Therefore, this industry characterization focuses only on the MHDDE and HHDDE rebuild/remanufacturing markets. Urban buses are not considered in this report.

EXHIBIT 1-1
HEAVY DUTY TRUCK CHARACTERISTICS

Class	Gross Vehicle Weight (lbs)	Heavy Duty Truck Type	Percentage of Population (1995)
2B - 5	8,500 - 19,500	Light	Low
6 - 7	19,501 - 33,000	Medium	7 %
8	33,000 and over	Heavy	14 %

Source: DataMac database, MacKay & Company, 1995.

The current population for Classes 6, 7, and 8 trucks in service is a key factor in the number of annual rebuilds that occur. As shown in Exhibit 1-2, the 1995 HDDE universe contains approximately 2.8 million vehicles, the majority of which (59 percent) are in Class 8. Over the next five years, the medium and heavy HDDE populations are projected to increase to approximately 3.1 million vehicles. While the Class 7 share of the heavy duty truck population is increasing, Class 8 will still account for roughly twice as many diesel trucks as Class 7. The Class 6 population decreased 25.8 percent during the 1990 to 1995 period.[3] The trucking industry is replacing Class 6 trucks with larger Class 7 vehicles, as evidenced by the population increase of 26.0 percent in Class 7 over the same 1990 to 1995 period.[4]

Cost is the major factor influencing an owner's decision to rebuild an engine. A new Class 8 engine costs approximately $22,000,[5] and a new Class 6 or Class 7 engine costs $12,000 to $13,000.[6] By comparison, a Class 8 engine rebuild performed out-of-frame (i.e., the engine is removed, rebuilt, and replaced) typically costs $6,500 to $8,500, while Class 6 and 7 rebuilds cost $4,000 to $5,500 depending on what components are replaced.[7] Rebuilds restore engine performance at a substantial savings over buying new equipment.

EXHIBIT 1-2
HEAVY DUTY DIESEL TRUCK POPULATION CHANGE, 1990 - 2000

Truck Class	Population, 1990	Population, 1995 (% change from 1990)	Projected Population, 2000 (% change from 1995)
6	464,993	354,370 (-23.8%)	283,630 (-20.0%)
7	685,832	793,540 (15.7%)	972,370 (22.5%)
8	1,411,409	1,650,112 (16.9%)	1,817,860 (10.2%)
Total	2,562,234	2,798,022 (9.2%)	3,073,860 (9.9%)

Source: DataMac database, MacKay & Company, 1995.

Other factors determining the number of rebuilds conducted annually are the number of vehicle miles traveled between rebuilds and the average annual vehicle mileage (see Exhibit 1-3). Mileage is the key indicator, because vehicle age does not always correlate well to the amount of wear an engine has experienced (i.e., hours of operation). Mileage to the second overhaul is generally 15 to 20 percent lower than the mileage to first overhaul.[8] This drop in mileage reflects the fact that wear rates are not linear (i.e., as an engine gets older, its parts deteriorate at an increased rate).

As with any piece of complex machinery, parts of an internal combustion engine will wear out and eventually fail after extended periods of use, even with routine maintenance as specified by the manufacturer. Although rebuilds may be performed as preventative maintenance (at a specified mileage, for example), this is rarely done for truck engines. Engine overhauling is a matter of economics, and is generally not undertaken unless physical evidence suggests rebuilding is the only alternative that will maintain engine performance. Conducting unscheduled maintenance and parts replacement is the preferred, less costly alternative. Diesel engines run at high compression ratios. When compression is reduced, engine performance and fuel economy decrease. Reduced compression is caused by irregularities in the cylinder wall that develop as the engine ages. When these factors are noticed by the operator, an

EXHIBIT 1-3
MILEAGE TO OVERHAUL (IN- OR OUT-OF- FRAME) & NUMBER OF OVERHAULS (1995)

	Average Mileage to Overhaul			Total Number of Overhauls	
	In-Frame	Out-of-Frame	Weighted (*)	In-Frame	Out-of-Frame
6	260,797	344,137	297,654	20,720	16,429
7	389,676	447,264	411,300	28,599	17,196
8	468,003	593,992	511,119	160,163	83,327
Total	NA	NA	NA	209,482	116,952

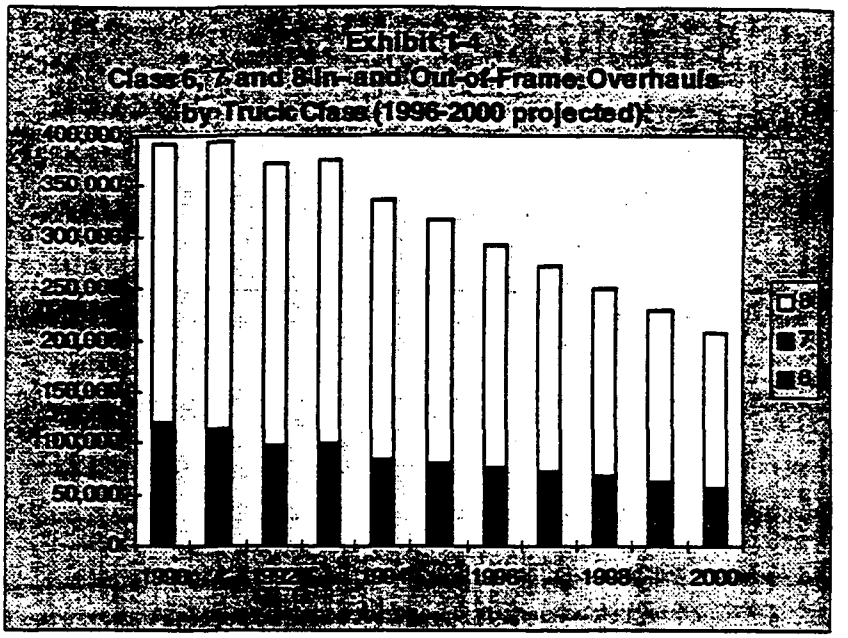
(*) Weighted average for overhauls, by number of in- and out-of -frame overhauls performed.

Source: DataMac database, MacKay & Company, 1995.

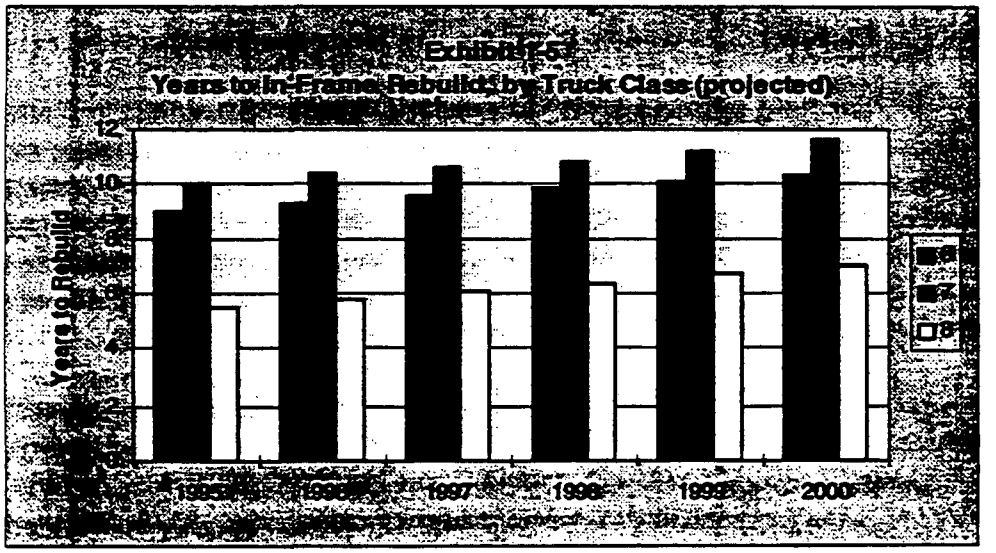
overhaul is generally performed. If the gasket and seals are failing, the operator will notice increased oil consumption. This problem is also remedied by most overhaul procedures, because engine gaskets and seals are generally replaced. An overhaul may also repair an engine that has failed completely, depending on the cause of the failure. If the break-down is due to a catastrophic failure such as a cracked engine block, a new engine (or a remanufactured engine using another block) is required.

Although many diesel engine blocks and moving parts have retained design features for decades, newer engines differ in that they are often electronically controlled. The engine computer, or 'black box,' monitors various aspects of engine operation such as compression, timing, and fuel/air mixture. These units make hundreds of adjustments to engine operating parameters each minute, depending on operating conditions. The added complexity of computer-controlled engines has narrowed the field of mechanics capable of servicing modern heavy duty trucks.[9]

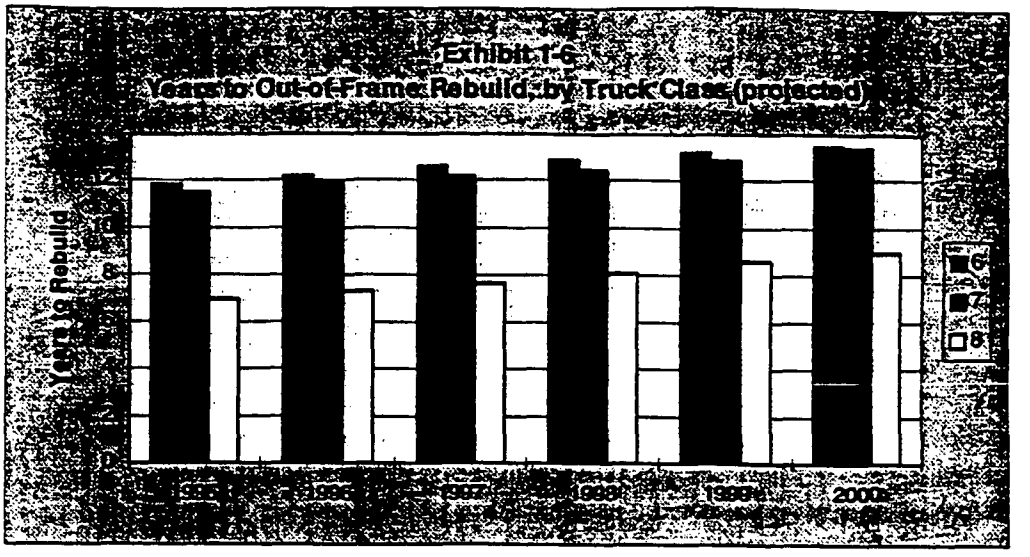
Time to engine overhauls is increasing. This increased time between engine overhauls (some engines travel 600,000 miles between overhauls, as discussed later in this report) has resulted in fleets out-sourcing more overhauls. This trend is likely to continue. Increasing engine durability has produced a downward trend in the number of rebuilds performed each year. After a peak in 1991, the number of rebuilds has decreased each year. This trend is forecast to continue past the year 2000 (see Exhibit 1-4). Exhibits 1-5 and 1-6 illustrate the projected increases in years to in-frame and out-of-frame rebuilds respectively.



Source: DataMac database, MacKay & Company, 1995.



Source: DataMac database, MacKay & Company, 1995.



Source: DataMac database, MacKay & Company, 1995.

1.1 Introduction to Terminology

The two major types of rebuild service available are in-frame and out-of-frame. In-frame rebuilds occur when the engine is still in the vehicle, while out-of-frame rebuilds occur after the engine is removed from the vehicle prior to service. In research for this report, no meaningful distinction was found between the terms "rebuild" and "overhaul." Thus, they are used interchangeably in the text of this report.

In-Frame Overhaul

The major data source used as the basis for this report, the DataMac database produced by MacKay & Company,* defines an "overhaul" occurring in-frame as replacement of the following parts: cylinder heads, pistons, piston rings, rod and main bearings, gaskets and seals, and valves and springs. The injection system is recalibrated, and the injectors and heads are disassembled and cleaned. Accessories such as the oil pump are rebuilt or replaced, and in some cases the turbocharger cartridge is replaced.[10] In engines displacing greater than 10 liters (nearly all Class 8, or HHDDEs), most cylinders contain removable liners as original equipment.[11] These engines are designed to make engine rebuilding more cost-effective. During an in-frame overhaul, the engine liners (which have become irregular and have caused performance deterioration) are removed. They are replaced with new liners that restore the cylinder bore to OEM specifications and allow normal engine compression.

* The DataMac database is a engine parts database, which predicts future demand for engine parts based on surveys of current truck owners regarding replacement frequency. Another survey element provided by truck owners is the location of parts and service purchases.

Out-of-Frame Overhaul

Out-of-frame overhauls involve the removal of the engine from the truck. Major components can be replaced where the engine is removed, or at another facility (e.g., an OEM factory). In addition to replacing the same parts as an in-frame overhaul, out-of-frame overhauls may replace the camshaft bearing, and the crankshaft may be reground. Most service items that are optional during an in-frame rebuild (e.g., turbocharger service) are performed during an out-of-frame overhaul. Out-of-frame overhauls also allow the machining of non-lined engine cylinders, a process commonly required when MHDDEs are overhauled.[12] When the cylinder bore becomes irregular on these non-lined engines, the block is machined out-of-frame by over-boring the cylinders. Sleeves which match the original specifications of the engine are then inserted into the machined cylinders, allowing normal compression.

The ratio of in-frame to out-of-frame overhauls was approximately 2:1 in 1995, compared to a 4:1 ratio in 1975. Because engines are traveling much farther between overhauls, operators can afford the additional time and expense associated with an out-of-frame overhaul (see Exhibit 1-7). The first rebuild tends to be an in-frame rebuild, which does not allow for a full inspection of all engine components (e.g., camshaft bearings are not accessible). This lack of inspection may also lead to an operator being cautious, contributing to shorter mileage periods between first and second rebuilds.[13] The longer distances traveled require that the camshaft bearing be serviced, in addition to other engine parts commonly replaced during an in-frame overhaul. The out-of-frame procedure allows for a more complete disassembly of the engine, and is therefore more likely to identify and replace worn parts than an in-frame rebuild. Out-of-frame overhauls also offer the possibility of decreased down-time, by allowing installation of an engine that was previously rebuilt or remanufactured,† which requires removal and replacement service time only.

EXHIBIT 1-7
AVERAGE HOURS TO COMPLETE OVERHAUL

In-Frame	59	66	62
Removal and Replacement	20	23	24
Out-of-Frame	74	91	78

Source: Plaxton, Bruce, MacKay & Company, fax August 7, 1996.

A complete overhaul also involves inspecting and replacing (as necessary) fuel system components and the turbocharger. Not performing this service will save the

† A 'remanufactured' engine is reassembled from new or rebuilt parts, to original equipment manufacturer (OEM) specifications. 'Remanufacturing' usually is performed in an assembly-line type operation, where all components are removed until only the block remains. The new/remanufactured parts are then installed to yield the remanufactured engine.

customer roughly $2,000. However, ignoring these parts of the power train during a rebuild may result in lost performance. Approximately 90 percent of out-of-frame rebuilds, and 50 percent of in-frame rebuilds replace the fuel and turbo systems.[14] Out of frame overhauls lead to the replacement of more engine parts than in-frame overhauls. This is particularly true in the case of a factory remanufactured engine, when all engine components are removed from the block and replaced by new or remanufactured parts[15].

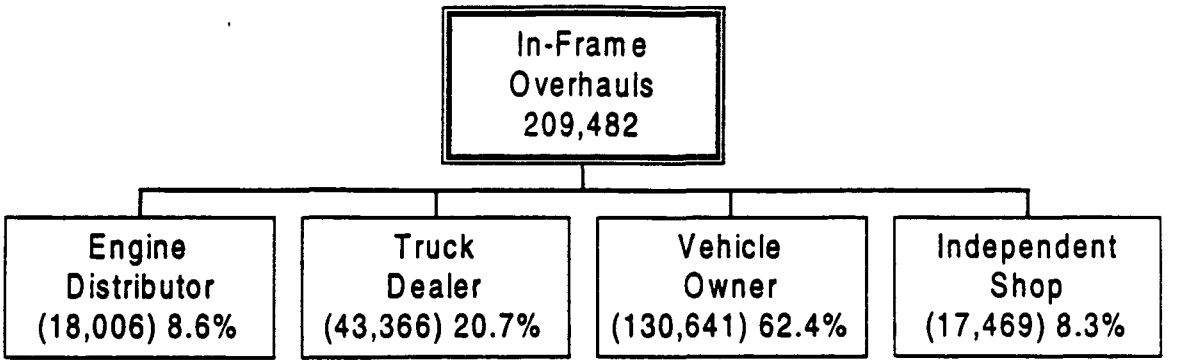
1.2 Introduction to Market Players

The DataMac database is organized around the point of contact for the end user by five industry segments: vehicle owner, truck dealership, engine distributor, independent garage, and OEM-factory rebuilder. Vehicle owner includes individuals and fleets; further discussion of fleet composition and practices is included in Section 2. Engine distributors are primarily players in the HHDDE segment, and include franchises of Cummins, Detroit Diesel, and Caterpillar that are licensed to sell and service on-highway diesel engines. Truck dealerships include locations for Mack, Kenworth, Peterbuilt, Ford, International, GM, Navistar, Volvo, and other smaller players. They are locations where the truck, as well as the engine, can be purchased. Class 6, 7, and 8 dealers are all represented in the truck dealership category. Most independent shops are small garages, though a few larger independent remanufacturers (e.g., Jasper, Springfield) have been identified.[‡] OEM-factory rebuild centers perform out-of-frame overhauls only. Discussions of truck dealership, engine distributor, independent garage, and OEM-factory remanufacturers are found in Section 3 of this report.

For in-frame rebuilds, the owner (or fleet) brings the truck to the location where the rebuild is performed. There are four defined market segments for in-frame rebuilds: fleet locations (i.e., work performed by vehicle owner), engine distributors, truck dealerships, and independent rebuilders. Exhibit 1-8 indicates the total number and percent market share of Class 6, 7, and 8 in-frame rebuilds performed by each of these segments. Vehicle owners perform the majority, 62.4 percent, of in-frame rebuilds. The largest external suppliers of in-frame rebuilds are truck dealerships, who perform 20.7 percent of the total number of rebuilds (55.0 percent of the externally supplied rebuilds, i.e., those not performed by the owners). The remaining market share is split about evenly between independent shops (8.3 percent of total and 22.1 percent of externally supplied rebuilds) and engine distributors (8.6 percent of total and 22.8 percent of externally supplied rebuilds).

[‡] While these production-style independents perform services similar to OEM remanufacturing programs, their remanufacturing activities are discussed in section 3.3, "Independent Garages".

Exhibit 1-8
Class 6, 7 & 8 In-Frame Overhauls

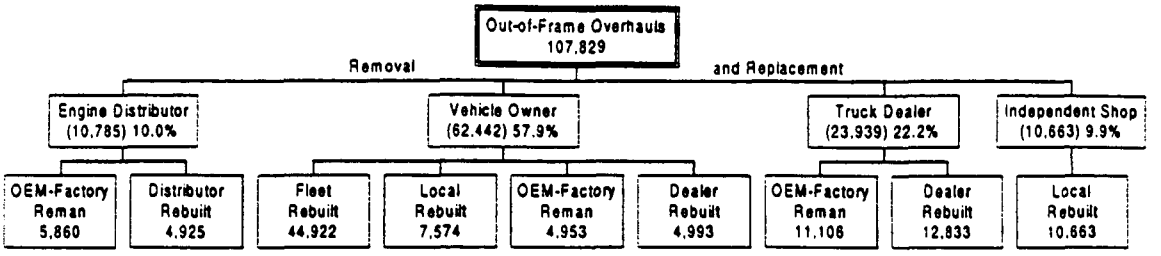


Source: DataMac database, MacKay & Company, 1995.

When owners choose to perform out-of-frame rebuilds, the interactions get more complicated in several ways (see Exhibit 1-9). Two separate activities take place: removal and replacement of the engine, and mechanical rebuilding/remanufacturing of the engine. It is important to note that the engine installed (replaced) in the truck is not necessarily the same engine removed from the truck. This feature of external rebuilds allows for additional locations: OEM-factory remanufacturers, and production-style independent remanufacturers. Remanufacturing operations are performed on an assembly line, replacing identical parts on all engines regardless of wear. In Exhibit 1-9, these remanufacturing operations are included in "OEM-Factory Reman" (OE remanufacturing programs), and in "Local Rebuilt" (larger independent operations such as Springfield Remanufacturing). Note that not all "Local Rebuilt" engines are remanufactured by these larger assembly-line type operations. The "Local Rebuilt" category also includes out-of-frame overhauls performed by smaller independents, which may not replace as many engine parts as the OEM and larger production-style facilities. Generally, when purchasing a factory/independent remanufactured engine, the owner trades in the existing engine, thereby ensuring a supply of engine blocks for the factory. Finally, when an out-of-frame overhaul takes place, some portion of owners elect to install a different engine type (new or used). EPA requires that in this switching process, any rebuilt or remanufactured engine must be at least of the same emissions era as the engine being removed.

The two levels of the chart in Exhibit 1-9 show the market share for each step of the out-of-frame overhaul. The line labeled "Removal and Replacement," breaks down the number of older engines physically removed and replaced with rebuilt engines at a given location type, regardless of where the actual rebuild took place. Vehicle owners removed and replaced approximately 58 percent of engines that were overhauled. While some of these overhauls were performed outside the owners' maintenance shops, approximately two-thirds of the engines removed by the owner were overhauled on-site. Relative to in-frame overhauls, the market share for independent shops is slightly lower.

Exhibit 1-9
Class 6, 7 & 8 Out-of-Frame Overhauls



Source: DataMac database, MacKay & Company, 1995

The overlap between participants becomes clear when examining the third level in the exhibit. For instance, the removed engine can be replaced by an engine overhauled at the factory/production style independent remanufacturer, at the truck dealership, or at the facility where the engine is removed and replaced.

The 1995 EPA report, "Heavy-Duty Engine Rebuilding Practices," broke down rebuilding practices of fleets, original equipment manufacturers (OEMs), and independents. Within the independent rebuilder market segment, practices were discussed separately by the non-production style and production style independents. In this report, fleets continue to be discussed as a location where rebuilds are performed. The OEMs, as described by EPA, are included in the OEM-factory rebuilders category. The other OEM-related categories in this report, truck dealerships and engine distributors, were not explicitly discussed in the EPA report. Finally, both non-production style and production style independents are included in this report's category of independent garages. There are four confirmed large independent rebuilders that constitute the production style independents.[§]

[§] The four confirmed production-style independents are: Springfield Manufacturing, Franklin Power, Dealers Manufacturing, and Jasper Engine. Each maintains an assembly-line type operation for on-road diesel engine rebuilding and generates at least $25 million in annual revenues.

2. Internal Sources of Rebuilds: Fleets and Vehicle Owners

Fleets, as defined by MacKay & Company, are groups of one or more trucks owned by a single entity that are used in a variety of applications including lease/rental, for-hire carriers, manufacturing, mining/construction/refuse, and agriculture. As illustrated in Exhibit 2-1, there are approximately 41,400 fleets with 10 or more trucks, representing 1,752,900 vehicles in the United States. Fleet locations are facilities where trucks can be stored and/or serviced. Larger fleets often operate more than one location and may also have centralized maintenance facilities. According to Commercial Carrier Journal there are approximately 83,000 fleet locations for fleets with 10 or more trucks.[16] Although fleets are a very important part of the rebuild market, a combination of fewer rebuilds being performed (because of increased engine reliability) and increased skill needed to service more complex engines will result in fleets performing fewer rebuilds in the future.

EXHIBIT 2-1
DISTRIBUTION OF CLASS 6, 7 & 8 TRUCKS BY FLEET SIZE

1-9	366,375	661,964
10-24	25,051	383,486
25-99	12,547	350,657
100-499	2,947	313,473
500+	855	1,088,770
Total	407,775	2,798,350

Source: DataMac database, MacKay & Company, 1995.

As can be seen in Exhibit 2-1, the vehicle population within fleets is bimodal, with a large percentage of trucks in small and large fleets. Thirty nine percent of heavy duty trucks are in fleets with 500 or more vehicles.

Fleets with more than ten trucks have found it practical to own garage facilities where both preventative maintenance and more complex repairs such as in-frame and out-of-frame rebuilds can be performed. Very large fleets (over 1,000 trucks) often use sophisticated databases to track the performance of their vehicles.[17] These systems can track the details such as: personnel, maintenance procedures, parts, and engines. Unlike other players in the rebuild market, however, overhauls are an expense for fleets, rather than a source of revenue. Performing engine service work at fleet locations requires hiring skilled mechanics. Nonetheless, it has been cheaper historically for fleets with ten or more trucks to perform their own engine service work than to have them serviced at independent garages, truck dealerships, engine distributors, or OEM-factory remanufacturing facilities. On the other hand, smaller fleets with 1 to 9 trucks typically do not benefit from the economies of scale and therefore likely out-source engine work to independent garages, truck dealerships, engine distributors, or OEM-factory remanufacturing facilities.[18]

Currently, fleet owners perform far more rebuilds than any other market segment. Exhibit 2-2 presents fleet rebuilding frequency relative to all other service locations in the United States. Fleets perform 62 percent (130,641 rebuilds) of all in-frame rebuilds. Given that this service requires fewer mechanic hours and less machine work than out-of-frame rebuilding, it is not surprising that fleets with service locations frequently opt to perform in-frame rebuilds themselves.

EXHIBIT 2-2
CLASS 6, 7 & 8 OVERHAUL LOCATION

Overhaul Location	In-Frame Overhauls	Out-of-Frame Overhauls
Fleet Garage	130,641 (62%)	44,922 (42%)
All Other Locations	78,841 (38%)	62,907 (58%)
Total	209,482	107,829

Source: DataMac database, MacKay & Company, 1995.

Fleets also perform 42 percent (44,922 rebuilds) of all out-of-frame rebuilds. As previously illustrated in Exhibit 1-9, fleets are the location for the removal and replacement of 62,442 engines. While 44,922 of the engines removed are rebuilt at the fleet service locations, 17,520 engines are serviced by independent garages, dealerships, distributors, and OEM-factory remanufacturing facilities. In these instances, fleets out-source the rebuild to other players in the rebuild market.

When fleets out-source truck work they use certain criteria to determine where work should be done. Based on MacKay & Company surveys, fleets established the following priority for service determinants: quality of work; turn-around time; warranty; uniformity of service; good value; convenience of location; and low price.[19]

Companies that own private fleets which transport raw material or finished goods are increasing concentration on their primary businesses.[20] As a result, these companies are contracting out more of their shipping needs. In addition, for-hire carriers and lease/rental fleets are out-sourcing their more complex engine service work for a variety of reasons. One reason is engine durability; engines are becoming more reliable, and may go as far as 600,000 miles between rebuilds. Twice as many heavy duty engines were expected to run 500,000 miles or longer before their first overhaul in 1993 compared to 1991.[21] By the year 2000, heavy duty diesel engines are predicted to average 639,000 miles before their first overhaul[22] which represents a 48 percent increase over the mileage to first overhaul reported in 1987.[23]

Truck fleets are composed of newer vehicles: 23 percent of trucks were 1 to 2 years old in 1995, as compared to 19 percent in 1991.[24] As a result of this increased durability, many fleets are choosing to out-source overhaul work. In addition, large fleets such as Schneider and J.B. Hunt typically trade in their trucks before an overhaul is required.[25] The cost of the specialists who perform overhauls is another reason fleets are turning to external sources. Specialists are more expensive than less-skilled mechanics

who perform routine maintenance such as oil changes. Since 1989, electronic engines have become more common in the heavy duty market. These engines are more difficult for fleets to service. In a survey of fleet owners, 88 percent felt that truck dealers have acceptable service capabilities for electronic engines, while only 61 percent of fleet owners rated their fleet shop as acceptable.[26] More durable and more complex engines require fleets to either hire skilled mechanics for increasingly infrequent rebuild jobs, or to out-source this work.

3. External Sources of Rebuilds

In this section, the characteristics of truck dealerships, engine manufacturers, independent garages (including production-style independents), and OEM-factory rebuilders are examined. The typical revenue sources, profit sources, and number of employees for businesses in each category are presented, to the extent data are available.

3.1 Truck Dealerships

Truck dealerships sell new trucks and parts. These locations also service trucks through franchise agreements with truck and engine manufacturers. Truck dealerships sell trucks that can be equipped with one of several types of engines from several engine manufacturers. The major truck dealership networks include Mack, Peterbuilt, Kenworth, General Motors, Volvo, and Navistar. These truck dealerships have a total of 1,800 truck franchise locations. These 1,800 franchise locations are controlled by 1,200 truck franchises, which are in turn owned by roughly 1,000 companies and/or individuals. Generalizing about these 1,000 companies is difficult because the dealership market is highly concentrated: approximately 150 to 200 companies have greater than $50 million in revenues, maintain multiple locations, and frequently own multiple franchise agreements, with multiple truck companies.[27] Truck dealerships with greater than $25 million in revenues perform 37 percent of the in-frame and 27 percent of the out-of-frame truck dealership rebuilds.[28] In addition, 25 to 30 of the 1,800 dealer locations account for approximately 25 percent of all truck sales.[29]

Overall, for Classes 6, 7, and 8, truck dealerships performed 22 percent of the overhauls in 1995. Dealerships completed 43,366 in-frame and 17,826 out-of-frame rebuilds at the approximately 1,800 truck franchise locations in the United States.[30] The number of parts in the engine replaced or remanufactured during these in-frame and out-of-frame overhauls performed at truck dealerships can vary. One option offered by some truck dealerships is a service program that is backed by OEM warranties.[31] By following manufacturer guidelines on which parts to replace, the brand of replacement parts to use, and overhaul procedures to follow, rebuilds performed at truck dealerships can be authorized and warrantied by the manufacturer. Examples of well-established programs include the Cummins National Overhaul Warranty (NOW) and Caterpillar's Overhaul Protection for Trucks (OPT). Warrantied engines can be dynamometer tested by the truck dealerships to ensure power performance, but are not tested for emissions integrity.[32] Roughly 59 percent of the 17,826 out-of-frame rebuilds performed by truck dealerships are extensive enough to be warrantied under such OEM-sponsored programs.

Alternatively, at the request of the vehicle owner, truck dealerships may provide in-frame or out-of-frame overhaul service that is not manufacturer warrantied. Because few dealerships have machining equipment,[33] they frequently contract out specific jobs associated with rebuilding. This is particularly true for cylinder block machining work

performed during out-of-frame rebuilding, which can be outsourced to local, independent machine shops.[34] Parts (e.g. engine block, crankshaft) that have been machined outside the dealership are re-installed by the dealer.

Another service occurring frequently at truck dealerships is the removal and replacement of engines. As illustrated in Exhibit 3-1, approximately 24,000 engines were removed and replaced at truck dealerships. As the number of trucks that receive only removal and replacement service from the dealer (11,106 trucks) suggests, dealerships actually perform out-of-frame rebuilding on just over half the number of trucks that have engines removed at their location.

EXHIBIT 3-1
CLASS 6, 7 & 8 OUT-OF-FRAME OVERHAULS PERFORMED ON ENGINES REMOVED AT TRUCK DEALERSHIPS

Factory Remanufactured	11,106 (46.3%)
Dealer Rebuilt	12,833 (53.6%)
Total	23,939

Source: DataMac database, MacKay & Company, 1995.

Truck dealerships are frequently the place where new and factory remanufactured engines are installed. In these situations, the vehicle owner trades in the old engine for either a new or factory remanufactured engine. The vehicle owner may also choose to remove the old engine, ship it to the factory for rebuild, and re-install it. Because this option is more time-consuming, it is done less frequently, usually by owners of engine makes and models that are not readily available.

According to MacKay & Company, one consistent characteristic of dealerships is their sources of revenue and profit illustrated in Exhibits 3-2 and 3-3. Heavy-duty truck dealerships have historically priced new trucks competitively with low profit margins. While new truck sales make up roughly 65 percent of truck dealership revenue, they comprise only 28 percent of total profits. Conversely, sales of service and parts are only 22 percent of revenues, but 63 percent of total profit contribution.

On average 32 percent of the parts and service revenue and profit is related to engine overhauling. Engine overhauling, therefore, contributes roughly 7 percent to total revenue and 20 percent to total dealer profits. Given that some dealerships may perform significantly more engine servicing than others, these percentages will vary.

EXHIBIT 3-2
REVENUE CONTRIBUTION

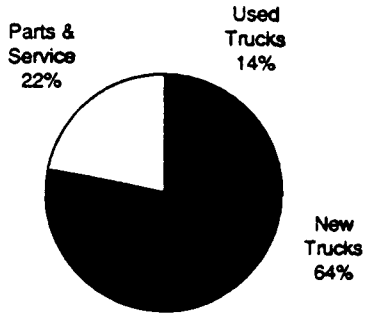
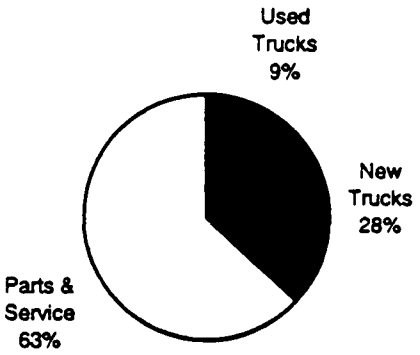


EXHIBIT 3-3
PROFIT CONTRIBUTION



Source: "Understanding the Independent Service Aftermarket," MacKay & Company, 1995.

3.2 Engine Distributors

Engine distributors are locations licensed by each OEM to sell new engines from the factory, remanufactured engines from the factory, and parts that meet OEM specifications. Some of these locations also have service bays and perform in-frame and out-of-frame overhauls on-site. The major distributor brand names are Caterpillar, Cummins, and Detroit Diesel. The engine is the only part of a truck that can be sourced separately through a distributor.[35] Distributors typically deal in large-volume engine orders. Large truck orders through distributors often are given manufacturer's incentives to encourage fleets shopping for new vehicles to select that distributor's engine brand. As with truck dealerships, profits from engine sales are small. Distributors anticipate profits from future parts and service sales over the lifetime of trucks.[36]

As diesel trucks became popular for long-haul transportation over the past decades, manufacturers, specifically Cummins, established distributors to sell and service diesel engines. Over time, truck dealers, and independent shops have developed the ability to supply and service parts for diesel trucks. Distributors are more integral to the Class 8 truck service market for historical reasons. Class 8 trucks historically have had the ability to accept engines made by several manufacturers. This fact has perpetuated the existence of engine distributors that primarily solicit large volume orders for engine manufacturers. As the distributor is frequently the point of final sale for the engines, the distributor has also provided the more lucrative engine repair services. Class 6 and 7 trucks generally are engineered to accept engines from only one specific manufacturer, and are more frequently serviced at the dealer. In addition, Navistar has a substantial share of the Class 6 and 7 market, and does not have engine distributors. These facts explain why the overhaul market share of Class 6 and 7 distributors is smaller than that of Class 8.[37]

Each of the major OEMs have approximately 25 to 40 distributorships nationwide. Caterpillar has 29 distributorships,[38] while Detroit Diesel has 28.[39] Distributors usually have three to seven locations within their sales region.[40] Caterpillar distributors typically generate over $100 million in annual revenue, while a few locations have revenue in the range of $40 to 50 million. One location in Texas has revenue in excess of $300 million per year.[41]

For Classes 6, 7, and 8, engine distributors performed 7 percent of the overhauls in 1995. Distributors completed 8.6 percent of in-frame overhauls, and removed and replaced 10.0 percent of engines which were overhauled out-of-frame.[42] Engine distributors performing in-frame overhauls are certified by the OEM to perform maintenance. These repairs are warrantied through the OEM.

EXHIBIT 3-4
CLASS 6, 7 & 8 OUT-OF-FRAME OVERHAULS PERFORMED ON ENGINES REMOVED AT ENGINE DISTRIBUTOR

Factory Remanufactured	5,860
Distributor Remanufactured	4,925
Total	10,785

Source: DataMac database, MacKay & Company, 1995.

Approximately 11,000 engines were removed and replaced at the distributor for out-of-frame overhauls in 1995 (see Exhibit 3-4). Of these engines, approximately 5,900 were removed from the vehicle at the distributor's garage and replaced with an engine from a OEM-factory remanufacturer. Only 4,900 of the engines removed at the distributor were rebuilt in the distributor's garage.

3.3 Independent Garages

Independent garages are shops that are not affiliated with engine or truck manufacturers through franchise agreements and are not authorized by manufacturers to perform service. This market segment performed roughly 17,500 in-frame and 18,200 out-of-frame rebuilds in 1995. Several thousand shops fall into the independent garage category, ranging from very large production-style independents such as Jasper Engines, to the very small one- to three-person shop. Smaller shops make up the vast majority of independent garages.

There are four large, production-style independent shops; each has revenues of greater than $25 million and each is involved in other services in addition to HDDE rebuilding. These shops are production-style facilities that work on hundreds of engines annually. They are factory-type assembly line operations with remanufacturing processes similar to those of an OEM (discussed in Section 3.4). The production-style

independents remanufacture engines to OE specifications. Although their rebuilt engines are not warrantied by the OEM, the production-style independent generally offers a similar warrantee. As seen in Exhibit 3-5, large independent garages perform out-of-frame rebuilds only. Out of the 18,237 out-of-frame rebuilds performed at independent garages, about 14 percent were done by these large garages in 1995. Vehicle owners receive out-of-frame rebuilding services from large independent shops by removing their old engines and either trading them in for remanufactured engines, or shipping them to the independent shop for rebuilding. Removal and replacement does not take place at the independent facility; engines must be shipped to the facility from another removal and replacement location.

EXHIBIT 3-5
SIZE BREAKDOWN OF INDEPENDENT GARAGES

Type and Location	In-Frame	Out-of-Frame
Large Independent Garages	–	2,618
Small Independent Garages	17,469	15,619
Total	17,469	18,237

Source: DataMac database, MacKay & Company, 1995.

A large number of small independent garages perform both in-frame and out-of-frame rebuilding. As illustrated in Exhibit 3-5, these small independent garages performed approximately 17,000 in-frame and 15,600 out-of-frame rebuilds in 1995. These rebuilds are not warrantied by the manufacturer, but are often warrantied for short periods of time (e.g., 30 days) by the independent garage performing the service. The out-of-frame rebuilds performed at small independent garages will generally involve removal and replacement of, or rebuilding of more engine parts than in-frame rebuilds performed at similar facilities. Independent garages of any size may have the ability to completely remanufacture engines, replacing all important parts regardless of wear, and may test the rebuilt engine on a dynamometer, although most locations do not have all of these capabilities. Even if an independent garage has technically advanced service capabilities and is performing out-of-frame rebuilds, its service practices are likely significantly different from those of a production-style facility. Generally, each engine part is judged independently, and replaced on an as-needed basis. For instance, rather than remove and replace fuel system and turbo components as a standard practice, an independent garage will often elect to keep existing components on a rebuilt engine, as long as they remain within OE specifications.

Some independent shops do not use OEM parts to rebuild HDDEs. Because OEM part suppliers are sometimes required by contract to supply parts only to the OEM, and not to other non-affiliated outlets, there is a market for non-OEM parts. A 1987 study estimated that non-OEM aftermarket parts accounted for 10 to 15 percent of the parts market.43 The vast majority of these non-OEM parts are well manufactured, and meet OEM specifications. The part may even be improved and customized, increasing

part durability over the life of the engine. Indeed, some manufacturers of aftermarket parts also supply OEMs. These parts obviously meet OEM specifications, since identical components are delivered to the OEM and to the engine rebuilder. Because of the high quality of these parts, rebuilt heavy duty truck engines can be assumed to meet or exceed OEM specifications when they re-enter service.44 OEMs have acknowledged this generally high level of aftermarket parts quality, and monitor the aftermarket manufacturers as competitors in the parts market.45 OEMs have expressed concern that, in the interest of increasing profit margins, independent rebuilders may be using cheaper non-OEM parts during rebuilds. However, aftermarket replacement parts often have no price advantage over OEM parts, and are in some cases more expensive than OEM parts.46

There are several estimates for the number of independent garages and employees at these garages:

(1) James Moss, publisher of Truck Parts & Service, estimates 8,200 truck repair garages with a total of 75,000 employees;

(2) Michael Duebner, Executive Vice President of Automotive Engine Rebuilders Association, estimates 9,600 to 12,000 garages; and

(3) MacKay & Company estimates 2,800 to 3,000 independent garages.

These industry experts attribute this variation to the fact that a significant number of shops only occasionally service heavy-duty diesel trucks, and primarily service other types of engines, such as passenger cars, off-road heavy duty diesel equipment, or marine equipment.** The higher estimates listed in (1) and (2) above may also include engine *parts* remanufacturers (e.g., a shop that turns crankshafts, but does assemble/disassemble engines), in addition to actual engine remanufacturers considered in this report.

MacKay & Company bases its estimates on distribution surveys to vehicle owners and service providers. The surveys reveal that, on average, the estimated 2,800 shops have 12 employees and average revenues of $1.25 million. Eight of the twelve employees are generally engaged in service work. Nearly two-thirds of the independent garages have revenues below the market segment average (less than $1 million).[47] The surveys indicate, not surprisingly, that a strong correlation exists between revenue and employee data: shops with less than $500,000 in parts and service revenue have greater than 10 employees, while the 1 percent of shops with parts and service revenues greater than $10 million have more than 30 employees.[48]

** The Automotive Engine Rebuilders Association membership list provided another source for estimating the number of Independent Garages. In a recent survey, 1,621 active members indicated that they have the ability to perform diesel heavy-duty and industrial engine rebuilding. However, only 67 listed this as their only line of business; most indicated several lines of business primarily dealing with passenger car engines.

The extent to which small independent garages rely on revenue from engine rebuilding depends on how many rebuilds they perform. According to MacKay & Company, roughly 400 to 500 companies focus mainly on HDD trucks and likely perform 40 to 50 rebuilds annually. The remaining 2,400 shops perform rebuilds infrequently, averaging 6 per year.

The customer base of the independent garage is much the same as for the other market segments. For-hire carriers represent 27 percent of the demand for overhaul parts from independent garages, while construction/ mining/refuse fleets constitute 20 percent of the demand.[49] Independent garages have increased their overhaul parts and service market share in the last five years by shifting focus from gasoline to diesel engines.[50] In addition, because fleets are looking for service alternatives as truck durability increases and regulations proliferate, independent garages will likely see an expanding customer base of cost-conscious, smaller fleets. Small independent garages generally charge 20 percent less for service labor than the industry average, are conveniently located, and are open 66 hours a week.[51] Mitigating this expected increase in market share are environmental statutes governing the disposal of hazardous waste, at the federal, state and local levels.[52] This "checkerboard" of regulations makes compliance difficult for the smaller garages. Many of the waste products of engine rebuilding are considered hazardous by EPA, adding substantially to the costs of garages wishing to perform rebuilds.[53] All engine rebuilds involve removing and cleaning the oil pan. The residue in the oil pan contains heavy metals such as chromium (used as a coating for piston rings and engine bearings), which are regulated under the Resource Conservation and Recovery Act (RCRA). States such as Florida, California and Illinois require that used oil filters be crushed before disposal and waste disposal companies are unlikely to haul or dispose of uncrushed oil filters in other states. As with oil pan residue, the oil crushed from the filters is contaminated with heavy metals. Garages must incur the costs of hiring a waste disposal company to haul and dispose of hazardous waste. In addition to waste disposal regulations, when cleaning the engine block, small independent garages may use highly caustic chemicals with reporting requirements under the Toxic Chemical Release Inventory

3.4 OEM-Factory Remanufacturers

OEM-factory remanufacturers represent assembly-line rebuilding facilities that perform OEM-authorized overhauls. Production-style independent remanufacturers use the same processes as these OEM facilities. These facilities include OEM remanufacturing programs and some production-style independent rebuilders (in the DataMac database, these are a subset of the independents performing out-of-frame rebuilds) that maintain preferred business relationships with OEMs. This market segment performs out-of-frame rebuilds only, and is not involved in engine removal and replacement. In 1995, OEM-factory remanufacturers performed approximately 21,900 out-of-frame rebuilds on Classes 6, 7, and 8 on-highway trucks, 20 percent of the total out-of-frame rebuilds. The largest percentage (roughly 50 percent) of these rebuilt

engines were sold through truck dealers; 23 percent were sold directly to vehicle owners; and 22 percent were sold through engine distributors.

All four of the major Class 8 HDDE engine manufacturers (Caterpillar, Cummins, Mack, and Detroit Diesel) operate remanufacturing programs. In addition, Navistar International has established preferred-supplier relationships with Springfield Remanufacturing Corporation and Franklin Power Products to perform OEM-authorized rebuilds. These six companies account for the vast majority of OEM-factory rebuilds. Ford and GM, producers of light HDDE, have confirmed that there is no real demand for light diesel rebuilds.[††] GM has no rebuild facility for diesel engines, and has not authorized any facility to perform this service.[54] Although GM has authorized remanufacturers for their trucks, these facilities are assumed to contribute little to the overall production attributed to OEM-factory remanufacturers.

All OEM-factory remanufacturers have revenues exceeding $25 million. For the OEMs, remanufacturing represents a small fraction of overall revenues. In addition to maintaining other, more significant lines of business, these OEM remanufacturing facilities are generally not limited to on-highway HDDEs. For example, Detroit Diesel Corporation has a high horsepower and industrial engine remanufacturing center. The preferred suppliers for Navistar, Springfield Remanufacturing and Franklin Power, attribute 50 percent and 20 percent of their revenues to HDDE rebuilding respectively. OEM-factory remanufacturing companies typically have 300 or more employees working in one or more locations on rebuilding. Some companies, such as Cummins, have separate locations for rebuilding cores, components, and fuel injectors. Springfield Remanufacturing, on the other hand, has only one on-highway rebuilding facility. The number of rebuilds per company ranges from roughly 1,000 to 9,000 rebuilds annually.

OEM-factory remanufacturers rebuild engines to the latest OEM specifications using new and remanufactured OEM parts. The complete replacement of all engine parts is the defining characteristic of the OEM-factory remanufacturer out-of-frame rebuild. Each engine component is tested prior to assembly and the completed engine is also tested on a dynamometer. In addition, remanufactured engine emission integrity is confirmed to the engine model year specifications. Remanufactured engines come with a factory warranty. Manufacturers recommend replacing several additional parts when installing a remanufactured engine. These parts include valve filters, oil pump, oil pump screen, water pump, fuel system components (when applicable), and remanufactured turbocharger (when applicable).[55]

[††] This fact has been reiterated by numerous industry experts. Rebuild work on light HDDEs typically is performed in response to catastrophic engine failure. The useful life of light-duty trucks is primarily limited by body deterioration.

OEM-factory remanufacturers receive engine cores used in this rebuild process from dealers, distributors and directly from vehicle owners (fleets) as part of the core trade-in industry practice. Remanufactured engines are typically priced at 50 to 60 percent of the cost of new engine, if the replaced engine core is traded in.[56, 57] Credit is given for those reusable or rebuildable parts of the engine returned by the truck owner. In exchange, customers receive a remanufactured engine that can be installed quickly. Purchasing a remanufactured engine through OEM-factory remanufacturers can eliminate much of the time needed to perform an out-of-frame overhaul at a fleet facility, distributor, dealership, or independent garage. For example, Mack remanufactured engines are kept in stock at the company's distribution centers and, in many cases can be delivered the next working day. Removal and replacement is the only down-time required if a factory remanufactured engine is installed.

4. Conclusion

Data for the number of rebuilds performed by business type and size are summarized in Exhibit 4-1. In this exhibit, in-frame and out-of-frame rebuilds are summed. Small companies have less than $25 million in annual revenue, and large companies have greater than $25 million.

EXHIBIT 4-1
NUMBER OF REBUILDS PERFORMED BY BUSINESS TYPE AND SIZE

Business Type	Small	Large	Total
Truck Dealer			
# companies	1,625	175	1,800
# rebuilds	39,169	22,023	61,192
rebuilds/company	24	126	34
Engine Distributor			
# companies	--	180	180
# rebuilds		22,931	22,931
rebuilds/company		127	127
Independent Shops			
# companies	2,796	4	2,800
# rebuilds	33088	2618	35,706
rebuilds/company	11.8	654	12.8
OEM-Factory Remanufacturers			
# companies	--	5 to 7	5 to 7
# rebuilds		21,919	21,919
rebuilds/company		3,653	3,653

Source: DataMac and Bruce Plaxton

Definitions: Large businesses have revenue of more than $25 million; small businesses have revenue of less than $25 million.

Only truck dealerships and independent shop universes are comprised of both small and large companies. The median number of rebuilds for large truck dealerships is 126, approximately five times the median number of rebuilds for small truck dealerships. The median number of rebuilds for large independent shops is more than 50 times higher than the median for small shops. This reflects the fact that small independent shops perform labor-intensive rebuilds, while large independent shops perform exclusively out-of-frame rebuilds using an assembly line process. Smaller independent shops are less specialized than the larger independent rebuild shops. Smaller independents offer a full range of truck maintenance services, such as oil changes and belt replacement. Engine rebuilding makes up a small part of their revenue. Similarly, small truck dealerships lack the large volume of rebuilding business required to justify investing in specialized rebuilding equipment. Smaller dealers focus on preventative maintenance, leaving larger dealers to perform the majority of dealer-based rebuilds.

When comparing business types within the "small" categories, the small independents perform fewer rebuilds, on average, than the small truck dealerships. However, as detailed in section 3.3, the small independents are likely comprised of 400 to 500 garages that perform 40 to 50 rebuilds per year, with the remaining 2,300 to 2,400 garages performing three to seven rebuilds per year. Thus, the small independent garage that focuses on HDDE rebuilding performs more rebuilds annually than the average truck dealership.

The "large" businesses fall into two categories. Engine distributors and truck dealerships perform labor-intensive out-of-frame and in-frame rebuilds. The average number of rebuilds performed by these businesses, approximately 125, is quite similar. The production-style rebuilders, represented by the large independents and the OEM-factory rebuilders, perform an average of 650 and 3,650 rebuilds per year, respectively.

In Exhibit 4-2, a similar profile is presented for fleets. Because rebuilding is an expense for fleets, revenue is not an appropriate indicator of fleet size. In this exhibit, small fleets are those with 24 or fewer trucks and large fleets have 25 or more trucks.

EXHIBIT 4-2
NUMBER OF REBUILDS PERFORMED BY SMALL AND LARGE FLEETS

	Small (1 to 24 trucks)	Large (25 or more trucks)	Total
# fleets	391,426	16,349	407,775
# rebuilds	72,627	102,936	175,563
rebuilds/company	0.2	6.3	0.4

Source: DataMac. MacKay & Company, December 1995.

The overall trends in the HDDE rebuilding business are primarily determined by large fleets that make the decisions of whether, when, and how to replace or rebuild engines. It is anticipated that fleets which newly out-source rebuilds will select independents approximately 50 percent of the time, and select other sources (i.e., truck dealerships, engine distributors, and OEM-factory rebuilders) approximately 50 percent of the time. Due to cost advantages, the overall market share for the independent garages is predicted to increase to 10 percent by the year 2000.[58] Within the other distribution channels, OEM-factory remanufacturers and large independents are well-positioned by offering quick-turn-around service and "like-new" engines. Truck dealerships and engine distributors seek to match this competitive advantage by carrying an inventory of rebuilt engines, and offering warranties as well.

Endnotes

[1] U. S. Environmental Protection Agency, Manufacturers Operations Division, "Heavy Duty Engine Rebuilding Practices, Final Report," March 21, 1995.

[2] "Survey of Heavy-Duty Diesel Engine Rebuilding, Reconditioning, and Remanufacturing Practices," Sierra Research, August, 1987.

[3] "1995 Heavy Duty Parts Aftermarket Market Monitor and Forecast Service," MacKay & Company, 1995.

[4] ibid.

[5] Conversation with Detroit Diesel, June 1996.

[6] Conversation with Cummins, June 1996.

[7] Plaxton, Bruce, Senior Vice President, MacKay & Company. Conversation August 1, 1996.

[8] "Survey of Heavy-Duty Diesel Engine Rebuilding, Reconditioning, and Remanufacturing Practices," Sierra Research, August, 1987.

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[13] ibid.

[14] Plaxton, Bruce, Senior Vice President, MacKay & Company. Conversation October 14, 1996.

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[17] "Survey of Heavy-Duty Diesel Engine Rebuilding, Reconditioning, and Remanufacturing Practices," Sierra Research, August, 1987.

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[19] "Understanding the Independent Service Aftermarket," Truck Parts & Service, February, 1996.

[20] ibid.

[21] Deierlein, Bob, "Engines," *Fleet Feedback*, April, 1993

[22] McCullough, Patricia, "Aftermarket Outlook: Who'll Buy the Parts", Newport Communications White Paper, April, 1996.

[23] "Survey of Heavy-Duty Diesel Engine Rebuilding, Reconditioning, and Remanufacturing Practices," Sierra Research, August, 1987.

[24] ibid.

[25] McCullough, Patricia, "Aftermarket Outlook: Who'll Buy the Parts", Newport Communications White Paper, April, 1996.

[26] Deierlein, Bob, "Engines", *Fleet Feedback*, April, 1993.

[27] Plaxton, Bruce, Senior Vice President, MacKay & Company. Interview on August 1, 1996.

[28] DataMac, MacKay & Company December 1995.

[29] ibid.

[30] DataMac, MacKay & Company December 1995.

[31] U.S. Environmental Protection Agency, Manufacturers Operations Division, "Heavy Duty Engine Rebuilding Practices, Final Report," March 21, 1995. Confirmed by conversation with Bruce Plaxton.

[32] Plaxton, Bruce, Senior Vice President, MacKay & Company. Interview on August 1, 1996.

[33] Duebner, Michael, Executive Vice President, Automotive Engine Rebuilders Association.

[34] Polich, Joe, Executive Vice President, Production Engine Remanufacturers Association. Interview on May 10, 1996.

[35] Plaxton, Bruce, Senior Vice President, MacKay & Company. Interview on August 1, 1996.

[36] ibid.

[37] ibid.

[38] ibid.

[39] Detroit Diesel Distributor/Dealer Directory, 1995.

[40] Plaxton, Bruce, Senior Vice President, MacKay & Company. Interview on August 1, 1996.

[41] ibid.

[42] DataMac, MacKay & Company, December 1995.

[43] "Survey of Heavy-Duty Diesel Engine Rebuilding, Reconditioning, and Remanufacturing Practices," Sierra Research, August, 1987.

[44] Testimony of Michael Duebner, President, Automotive Engine Remanufacturers Association, Hearing on Notice of Proposed Rulemaking, August 12, 1996.

[45] ibid.

[46] ibid.

[47] Plaxton, Bruce. Senior Vice President, MacKay & Company. Memorandum dated August 7, 1996.

[48] ibid.

[49] DataMac supplemental materials.

[50] DataMac supplemental materials, page 66.

[51] MacKay & Company, distribution survey results.

[52] Plaxton, Bruce, Senior Vice President, MacKay & Company. Interview on August 1, 1996.

[53] ibid.

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

[55] Birkland, Carol. "Engines All But New," Fleet Equipment Journal. March 1996.

[56] Rorke, Dan. Vice President and General Manager of Heavy Duty Division, Springfield Remanufacturing. Interview on May 21, 1996.

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