CHAPTER 2: Industry Characterization

To accurately assess the potential impact of this emission control program, it is important to understand the nature of the affected industries. This chapter describes relevant background information related to each of the categories of engines subject to this proposal.

2.1 Marine

This section gives a general characterization of the segments of the marine industry that may be impacted by the proposed regulations. For this discussion, we divide the recreational marine industry into twi segments: compression-ignition (CI) diesel engine manufacturers and boat builders. This industry characterization was developed in part under contract with ICF Consulting[1] as well as independent analyses conducted by EPA through interaction with the industry and other sources.[2,3,4]

2.1.1 Marine Diesel Engine Manufacturers

2.1.1.1 Identification of Diesel Engine Manufacturers

We have determined that there are at least 16 companies that manufacture CI marine engines for recreational vessels. Nearly 75 percent of diesel engines sales for recreational vessels in 2000 can be attributed to three large companies. Six of the identified companies are considered small businesses as defined by the Small Business Administration SIC code 3519 (less than 1000 employees). Based on sales estimates for 2000, these six companies represent approximately 4 percent of recreational marine diesel engine sales. The remaining companies each comprise between two and seven percent of sales for 2000. Table 2.1-1 provides a list of the diesel engine manufacturers identified to date by EPA.

Table 2.1-1 List of CI Marine Engine Manufacturers Identified by EPA

Greater than 1000 employees	*Less than 1000 employees*
Caterpillar	Alaska Diesel/Lugger
Cummins	American Diesel
Detroit Diesel	Daytona Marine
Isotta Fraschini	Marine Power
John Deere	Peninsular Diesel
Marine Corporation of America	Westerbeke
Mercruiser	
MTU	
Volvo Penta	
Yanmar	

2.1.1.2 Use of Diesel Engines

Diesel engines are primarily available in inboard marine configurations, but may also be available in sterndrive and outboard marine configurations. Inboard diesel engines are the primary choice for many larger recreational boats.

Larger boats are powered exclusively by diesel inboard engines. These boats are generally 40 feet or greater in length. Recreational boats in ports with access to the ocean (e.g. Seattle) can be 80 to 100 feet or longer. The larger boats typically require twin inboard diesel engines with 2,000 total horsepower or more. Recreational diesel marine engines are generally produced by domestic companies that have been long-standing players in the marine diesel engine market. The three companies that tend to dominate the market are Caterpillar, Cummins, and Detroit Diesel. As mentioned above, nearly 75 percent of diesel engines sales for recreational vessels in 2000 can be attributed to these three companies.

Sterndrive diesel engines account for less than 1 or 2 percent of the market. A minority of mid-sized boat owners insist on diesel powered sterndrive engines for their boats. Diesel marine sterndrive systems generally power the same types of boats as their gasoline counterparts, which tend to be 15 to 30 feet in length. Customers that choose a diesel sterndrive marine engine are generally seeking three main advantages over gasoline sterndrive marine engines. First, diesel fumes are much less ignitable and explosive that gasoline fumes. Second, diesel powered craft have a greater range than gasoline powered craft with similar fuel capacity. Lastly, diesel engines tend to be more reliable and tend to run more hours between major overhauls than gasoline engines. This last point is particularly important to boat owners who operate their boats higher than the average.

One major disadvantage of diesel sterndrive engines is their cost relative to comparably powered gasoline sterndrive engines. For example, a 40 foot twin cabin cruiser with twin gasoline sterndrive engines costs $238,000. For twin diesel sterndrive engines, the price increases approximately $50,000. The fact that the diesel engine is more expensive, coupled with the fact that diesel fuel is often less available than gasoline in the U.S., has resulted in limited domestic demand for recreational diesel sterndrive marine engines.

2.1.1.3 Current Trends

The strong economy of the mid-1990's, the rapid growth of the stock market, and the gains in personal disposable personal income have combined to accelerate big ticket purchases, including the purchases of large boats. For example, from 1995 to 1997, inboard cruiser diesel marine sales have increased by 15 percent according to data collected by ICF. In addition to positive economic conditions, favorable financing, low fuel costs, product advancement and recent model design changes have also lead to increased sales of larger boats.

2.1.2 Recreational Boat Builders

2.1.2.1 Identification of Boat Builders

We have less precise information about recreational boat builders than is available about engine manufacturers. We used several sources, including trade associations and Internet sites when identifying entities that build and/or sell recreational boats. We have also worked with an independent contractor to assist in the characterization of this segment of the industry. Finally, we have obtained a list of nearly 1,700 boat builders known to the U.S. Coast Guard to produce boats using recreational gasoline and diesel engines. At least 1,200 of these companies install gasoline-fueled engines and would therefore be subject to the proposed evaporative emission standards. More that 90 percent of the companies identified so far would be considered small businesses as defined by SBA SIC code 3732.

Based on information supplied by a variety of recreational boat builders, fuel tanks for recreational boats are usually purchased from fuel tank manufacturers. However, some boat builders construct their own fuel tanks. The boat builder provides the specifications to the fuel tank manufacturer who helps match the fuel tank for a particular application. It is the boat builder's responsibility to install the fuel tank and connections into their vessel design. For vessels designed to be used with small outboard engines, the boat builder may not install a fuel tank; therefore, the end user would use a portable fuel tank with a connection to the engine.

2.1.2.2 Current Trends

Additional information provided by NMMA indicate that an estimated 72 million people participated in recreational boating in 2000, which is down slightly from 77 million in 1995. In 2000, nearly 17 million boats were in use in the United States.

2.1.2.3 Production Practices

Based on information supplied by a variety of recreational boat builders, the following discussion provides a description of the general production practices used in this sector of the marine industry.

Engines are usually purchased from factory authorized distribution centers. The boat builder provides the specifications to the distributor who helps match an engine for a particular application. It is the boat builders responsibility to fit the engine into their vessel design. The reason for this is that sales directly to boat builders are a very small part of engine manufacturers' total engine sales. These engines are not generally interchangeable from one design to the next. Each recreational boat builder has their own designs. In general, a boat builder will design one or two molds that are intended to last 5-8 years. Very few changes are tolerated in the molds because of the costs of building and retooling these molds.

Recreational vessels are designed for speed and therefore typically operate in a planing

mode. To enable the vessel to be pushed onto the surface of the water where it will subsequently operate, recreational vessels are constructed of lighter materials and use engines with high power density (power/weight). The tradeoff on the engine side is less durability, and these engines are typically warranted for fewer hours of operation. Fortunately, this limitation typically corresponds with actual recreational vessel use. With regard to design, these vessels are more likely to be serially produced. They are generally made out of light-weight fiberglass. This material, however, minimizes the ability to incorporate purchaser preferences, not only because many features are designed into the fiberglass molds, but also because these vessels are very sensitive to any changes in their vertical or horizontal centers of gravity. Consequently, optional features are generally confined to details in the living quarters, and engine choice is very limited or is not offered at all.

2.2 Large Industrial SI Equipment

Large SI engines are those spark-ignition nonroad engines that have rated power higher than 25 horsepower, that are not recreational engines or marine engines. They are typically derivatives of automotive engines, but use less advanced technology. The most common application of these engines is in forklifts. Other applications include generators, pumps, compressors, and a wide variety of other applications.

2.2.1 Manufacturers

There are seven principal manufacturers of Large SI engines. Table 2.2-1 shows that sales volumes are relatively evenly distributed among these seven manufacturers. This sales information is based on average annual volumes for the period from 1994 through 1996. Where marketing data from individual companies did not agree with the published figures, the analysis adjusts the estimated figures to improve the accuracy of historical sales volumes. The figures for "other" manufacturers presents aggregated data from four additional companies—Volkswagen, Westerbeke, Hercules, and Chrysler. While these and other numbers in this chapter may be changing somewhat over the recent and coming years, they provide a good indication of the nature of this industry segment.

The degree to which engine manufacturers offer integrated engine and equipment models is an important factor in determining how companies address the need to redesign their products. Companies that use their own engine models to produce equipment have the advantage of coordinating the engine design changes with the appropriate changes in their equipment models. The principal integrated manufacturers (Nissan, Mitsubishi, and Toyota) all produce forklifts. About 30 percent of Large SI equipment sales are from integrated manufacturers.

Other forklift manufacturers have also been responsible for varying degrees of engine design. Engine design expertise among these companies is so prevalent that some forklift manufacturers may assume responsibility for certifying their engines, even though they buy the engines mostly assembled from other manufacturers.

Table 2.2.-1
Engine Sales by Manufacturer

Manufacturer	Average Annual Sales	Distribution
General Motors	19,500	19%
Mitsubishi Motors	15,600	15%
Ford Power Products	14,000	14%
Nissan Industrial Engines	13,800	13%
Wis-Con Total Power	12,100	12%
Toyota	11,800	12%
Mazda	8,200	8%
Other	7,200	6%
Total	102,300	100%

2.2.2 Applications

We have also estimated populations of engine and equipment models using historical sales information adjusted according to survival and scrappage rates. Table 2-2 presents the estimated U.S. population of the various Large SI equipment applications. A recent, commercial study of the forklift market showed the need to adjust forklift population estimates.[5] That study identified a 1996 population of 491,321 engine-powered forklifts (Classes 4, 5, and 6), estimating that 80 percent of all forklifts operate on liquefied petroleum gas (LPG), with the rest running on either gasoline or diesel fuel.[a] With an estimated even split between gasoline and diesel for these remaining forklifts, we estimate a total population of spark-ignition forklifts of 442,000. This spark-ignition population includes all units operating on gasoline and LPG; a small number of spark-ignition forklifts are fueled by natural gas.

For other applications, the split between LPG and gasoline also warrants further attention. Large SI engines today are typically sold without fuel systems, which makes it difficult to assess the distribution of engine sales by fuel type. Also, engines are often retrofitted for a different fuel after the initial sale, making it still more difficult to estimate the prevalence of the different fuels. The high percentage of propane systems for forklifts can be largely attributed to expenses related to maintaining fuel supplies. LPG cylinders can be readily exchanged with minimal infrastructure cost. Installing and maintaining underground tanks for storing gasoline has always been a significant expense, which has become increasingly costly due to the new requirements for replacing underground tanks.

[a]Molecular propane (C_3H_8) is the most common constituent in LPG. LPG is therefore commonly referred to as propane.

Natural gas is a third fuel option. While natural gas and LPG fuel systems are very similar, natural gas installations are much less common in Large SI engines. Natural gas supply systems typically offer the advantage of pipeline service, but the cost of installing high-pressure refueling equipment is an obstacle to increased use of natural gas.

Some applications of nonroad SI equipment face much different refueling situations. Lawn and garden equipment is usually not centrally fueled and therefore operates almost exclusively on gasoline, which is more readily available. Agriculture equipment is predominantly powered by diesel engines. Most agriculture operators have storage tanks for diesel fuel. Those who use spark-ignition engines in addition to, or instead of, the diesel models, would likely invest in gasoline storage tanks as well, resulting in little or no use of LPG or natural gas for those applications. For construction, general industrial, and other nonroad equipment, there may be a mix of central and noncentral fueling, and motive and portable equipment; we therefore believe that estimating an even mix of LPG and gasoline for these engines is most appropriate. The estimated distribution of fuel types for the individual applications are listed in Table 2-2.

An additional issue related to population figures is the level of growth factored into emission estimates for the future. EPA's Nonroad Emission Model incorporates application-specific growth figures. The projected growth is reflected in the population estimates included in Table 2.2-2.

Table 2.2-2
Operating Parameters and Population Estimates for Various Applications of Engines Rated above 19 kW

Application*	Load Factor	Usage Rate (hours/yr)	1996 Population	Projected 2010 Population	Percent LPG/CNG
Forklift	0.30	1500	442,000	547,063	95
Generator	0.68	115	205,990	202,177	50
Welder	0.51	208	55,495	67,872	50
Commercial turf	0.60	733	41,440	55,074	0
Pump	0.69	221	41,104	44,830	50
Air compressor	0.56	484	24,182	28,633	50
Baler	0.62	68	21,937	27,597	0
Irrigation set	0.60	716	17,800	9,724	50
Aerial lift	0.46	361	15,734	15,555	50
Scrubber/sweeper	0.71	516	14,154	13,955	50
Chipper/grinder	0.78	488	12,218	16,262	50
Leaf blower/vacuum	0.75	56	10,823	14,384	0

Application*	Load Factor	Usage Rate (hours/yr)	1996 Population	Projected 2010 Population	Percent LPG/CNG
Oil field equipment	0.90	1104	8,792	8,924	100
Sprayer	0.65	80	8,635	10,863	0
Trencher	0.66	402	8,168	9,604	50
Specialty vehicle/cart	0.58	65	7,833	8,726	50
Skid/steer loader	0.58	310	7,795	9,164	50
Other general industrial	0.54	713	3,987	3,942	50
Rubber-tired loader	0.71	512	3,476	4,088	50
Gas compressor	0.60	8500	3,023	1,620	100
Paving equipment	0.59	175	2,996	3,524	50
Terminal tractor	0.78	827	2,905	2,872	50
Bore/drill rig	0.79	107	2,618	3,080	50
Ag. tractor	0.62	550	2,152	2,707	0
Concrete/industrial saw	0.78	610	2,133	2,509	50
Rough terrain forklift	0.63	413	1,933	2,273	50
Roller	0.62	621	1,596	1,878	50
Crane	0.47	415	1,584	1,864	50
Other material handling	0.53	386	1,535	1,518	50
Paver	0.66	392	1,337	1,573	50
Other agriculture equipment	0.55	124	1,234	1,552	0
Other construction	0.48	371	1,222	1,436	50
Pressure washer	0.85	115	1,207	2,271	50
Aircraft support	0.56	681	840	1,238	50
Crushing/processing equip	0.85	241	532	628	50
Surfacing equipment	0.49	488	481	567	50
Tractor/loader/backhoe	0.48	870	416	489	50
Hydraulic power unit	0.56	450	339	384	50
Other lawn & garden	0.58	61	333	443	0
Refrigeration/AC	0.46	605	163	226	100

*The list of applications and the associated load factors and usage rates are from PSR. The population figures and the distribution of fuel types are from the EPA's Nonroad Model.

2.2.3 Engine Design and Operation

Most engines operate at a wide variety of speeds and loads, such that operation at rated power (full-speed and full-load) is rare. To take into account the effect of operating at idle and partial load conditions, a load factor indicates the degree to which average engine operation is scaled back from full power. For example, at a 0.3 (or 30 percent) load factor, an engine rated at 100 hp would be producing an average of 30 hp over the course of normal operation. For many nonroad applications, this can vary widely (and quickly) between 0 and 100 percent of full power. Table 2-2 shows the load factors that apply to each nonroad equipment application.

Table 2-2 also shows annual operating hours that apply to the various applications. These figures represent the operating levels that apply through the median lifetime of equipment.

2.2.3.1 Automotive-Derived Engines

The majority of Large SI engines are industrial versions of automotive engines. Tables 2.2-3 and 2.2-4 show that four-cylinder engines rated under 100 horsepower dominate the market. There are also substantial niche markets available for smaller and larger engines. In the absence of emission standards, there has been limited transfer of emission-control technology from automotive to industrial engines.

Producing an industrial version of an automotive engine typically involves fitting a common engine block with less expensive systems and components appropriate for nonroad use. Manufacturers remove most of the sophisticated systems in place for the high-performance, low-emission automotive engines to be able to produce the industrial engine at a lower cost. For example, while cars have used electronic fuel systems for many years, almost all industrial engines still rely on mechanical fuel systems. Chapter 3 describes the baseline and projected engine technologies in greater detail.

Table 2.2-3
Power Distribution

Power Rating	Average Annual Sales	Distribution
25 < HP < 49	34,400	34%
50 < HP < 99	47,300	46%
100 < HP < 174	19,000	19%
HP > 174	1,600	2%
Total	102,300	100%

Table 2.2-4
Engine Sizes

Number of Cylinders	Average Annual Sales	Distribution
1	100	0.1%
2	500	0.4%
3	7,000	7%
4	78,100	76%
6	10,700	11%
8	6,000	6%
Total	102,300	100%

2.2.3.2 Air-Cooled Engines

Some manufacturers produce engines exclusively for industrial use, most of which are air-cooled models. Air-cooled engines with less than one liter total displacement are typically very similar to the engines used in lawn and garden applications. Total sales of air-cooled engines over one liter are about 9,200 per year, 85 percent of which are rated under 50 hp. While these engines can use the same emission-control technologies as water-cooled engines, they have unique constraints on how well they control emissions. Air-cooling doesn't cool the engine block as uniformly as water-cooling. This uneven heating can lead to cylinder-to-cylinder variations that make it difficult to optimize fuel and air intake variables consistently. Uneven heating can also distort cylinders to the point that piston rings don't consistently seal the combustion chamber. Finally, the limited cooling capacity requires that air-cooled engines stay at fuel-rich conditions when operating near full power.

While air-cooled engines account for about 9 percent of Large SI engine sales, their use is concentrated in a few specialized applications. Almost all of these are portable (non-motive) applications with engine operation at constant speeds (the speed setting may be adjustable, but operation at any given time is at a single speed). Many applications, such as concrete saws and chippers, expose the engine to high concentrations of ambient particles that may reduce an engine's lifetime. These particles would also form deposits on radiators, making water-cooling less effective. Because lower-emitting water-cooled engines may not be suitable alternatives in these severe-duty applications, the proposed emission standards take into account the technology constraints of air-cooled engines.

2.2.4 Customer Concerns

Most Large SI engines are used in industrial applications. These industrial customers have historically been most concerned about the cost of the engine and equipment, and about reliability. In many cases, the customer values consistent and familiar technology as a means of

simplifying engine maintenance. As described in Chapter 5, equipment users have largely ignored the potential for improving fuel economy in making purchasing decisions. As a result most Large SI engines being sold today have relatively simple carburetor technology that is similar to automotive technology of the early 1980s.

There is a large subset of these engines that are operated indoors or in other areas with restricted airflow much of the time. For these indoor engines, customers have generally wanted engines with lower CO emissions. Thus most indoor engines are fueled with LPG or CNG. In some cases, where the customer wants even lower emissions, they will purchase engines equipped with exhaust catalysts.

2.3 Snowmobiles

Snowmobiles are normally one or two passenger vehicles that are used to traverse over snow-covered terrain. They have a track in the rear similar to that of a bulldozer, and runners (similar to skis) in the front for steering. Snowmobiles are used primarily for recreational purposes. However, a small number of them are produced and used for utility purposes, such as search and rescue operations. Annual snowmobile sales in the U.S. have varied dramatically over the years, but sales between 1996 and 2000 have averaged about 157,000 units per year.

2.3.1 Manufacturers

Manufacturers of snowmobiles are classified under the North American Industrial Classification Code System (NAICS) as code 336999, Other Transportation Equipment Manufacturing. These codes are used by the Small Business Administration (SBA) in classifying businesses as large or small, depending on the number of employees. Snowmobile manufacturers have the NAICS subclassification 3369993414, and must have fewer than 500 employees to be considered a small business.

There are four major manufacturers of snowmobiles which account for almost the entire U.S. snowmobile market. These manufacturers are Arctic Cat, Bombardier (Ski-Doo), Polaris and Yamaha. Polaris is the largest snowmobile manufacturer, by sales volume, followed by Arctic Cat, Bombardier and Yamaha. There are less than five small snowmobile manufacturers that combined make up significantly less than one percent of the U.S. snowmobile market. These small manufacturers specialize in high performance snowmobiles and other unique designs (such as stand-up snowmobiles).

2.3.2 Sales and Fleet Size

Snowmobile sales tend to vary both with the state of the U.S. economy (being a discretionary recreational purchase) and snowfall. Thus, annual sales have varied, sometimes dramatically, over the years. Table 2.3.-1 shows annual U.S. snowmobile sales from 1992 through 2000, as reported by the International Snowmobile Manufacturers Association. The current snowmobile fleet in the U.S. is roughly 1.5 million units.

Table 2.3.-1
U.S. Snowmobile Sales

Year	Unit Sales
2000	136,601
1999	147,867
1998	162,826
1997	170,325
1996	168,509
1995	148,207
1994	114,057
1993	87,809
1992	81,946

2.3.3 Usage

There are a variety of snowmobile types currently produced and tailored to a variety of riding styles. The majority of the snowmobile market is made up of high performance machines. These snowmobiles have fairly high powered engines and are very light, giving them good acceleration, speed and handling. The performance sleds come in several styles. Cross country sleds are designed for aggressive trail and cross country riding. Mountain sleds have longer tracks and a wider runner stance for optimum performance in mountainous terrain. Finally, muscle sleds are designed for high top speeds (in excess of 120 miles per hour) over flat terrain such as frozen lakes. Performance snowmobiles are generally designed for a single rider.

The second major style of snowmobile is designed for casual riding over groomed trails. These touring sleds are designed for one or two riders, and tend to have lower powered engines than performance snowmobiles. The emphasis in this market segment is more on comfort and convenience. As such, these sleds feature a more comfortable ride than the performance machines and tend to have features such as electric start, reverse, and electric warming hand grips.

The last, and smallest, segment of the snowmobile market is the utility sled segment. Utility snowmobiles are designed for pulling loads and for use in heavy snow. Thus, the engines are designed more for producing torque at low engine speeds, which typically corresponds to a reduced maximum speed of the snowmobile. Utility snowmobiles are common in search and rescue operations.

A typical snowmobile lasts seven to nine years and travels over 5,000 miles during its lifetime, with annual mileage dropping with age. The average snowmobile is used 57 hours per year.

2.3.4 Customer Concerns

2.3.4.1 Performance

Good snowmobile performance is very important to snowmobilers. This is especially true for the performance segment of the market, where high power and low weight are crucial for the enjoyment of the performance snowmobile enthusiast. The performance snowmobile segment is driven by a constant demand for more power and lower weight. In the touring segment of the market performance in terms of power and weight is somewhat less important, but still significant. In this segment comfort features and fuel economy play a bigger role in customer satisfaction than in the performance segment. In all snowmobile market segments durability and reliability are very important to the customer.

2.3.4.2 Cost

The price of snowmobiles produced by the four major manufacturers currently ranges from about $3,700 for some entry level models to around $12,000 for some high performance and luxury touring machines. The average cost of snowmobiles sold in the U.S. is in the $6,000 to $7,000 range. Some of the high performance snowmobiles produced by the small manufacturers can approach $20,000, but this is an extremely small niche market.

Snowmobiles are for the most part a recreational product and are thus a discretionary purchase. Cost is an important factor for snowmobilers, and significant cost increases could cause people to spend their discretionary income on other recreational opportunities. This is especially significant in the low cost, entry level snowmobile segment (the point of entry into the sport of snowmobiling) where significant cost increases could discourage people from taking up snowmobiling.

2.4 All-Terrain Vehicles

All Terrain Vehicles (ATVs) are normally one-passenger open vehicles that are used for recreational and other purposes requiring the ability to traverse over most types of terrain. Most modern ATVs have four-wheels, and have evolved from three-wheeled designs that were first introduced in the 1970s. According to data provided by an EPA contractor, production for ATVs sold in the U.S. has averaged about 390,000 units between 1996 and 2000. However, ATV sales have increased during that time to more than 550,000 units in 2000. Thus, ATVs constitute the largest single category of non-highway recreational vehicles, although it is difficult to calculate the total vehicle population at any given point in time because of the fact that many states do not require registration of ATVs.

2.4.1 Manufacturers

Manufacturers of ATVs are classified under the North American Industrial Classification System (NAICS) as code 336999, Other Transportation Equipment Manufacturing. These codes are used by the Small Business Administration (SBA) in classifying businesses as large or small, depending on the number of employees. ATV manufacturers have the NAICS sub-classification 3369993101, and must have fewer than 500 employees to be considered a small business. In addition to manufacturers, there are a number of importers of ATVs, which fall under NAICS code 42111, which also includes importers of automobiles, trucks, motorcycles and motor homes. To be classified as a small business by SBA, an importer must have fewer than 100 employees.

We contracted with ICF Consulting to help us characterize the off-highway recreational vehicle market.[6] Using data which included the Power Systems Research (PSR) Database, Dun & Bradstreet (D&B) Market Identifiers Online Database, and information from the Motorcycle Industry Council (MIC), our contractor identified 16 manufacturers of ATVs. These can be found in Table 2.4.1. Six large manufacturers, Honda, Polaris, Kawasaki, Yamaha, Suzuki, and Arctic Cat accounted for approximately 98 percent of all U.S. ATV production in calendar year 2000.

The 10 other manufacturers accounted for the remaining two percent of U.S. production in 2000. Only three of these are non-U.S.-owned. Available D&B data on numbers of employees for five of the companies show that they are small businesses according to the SBA definition.

There are also some 17 firms that import ATVs. Thirteen of these are U.S.-owned. Dun and Bradstreet data on numbers of employees are available for four of these companies, and indicate that these are small businesses according to the SBA definition. Since none of these had more than 40 employees and two had less than 20 employees, it seems safe to assume that the others are also small businesses according to the SBA definition.

Table 2.4.-1
ATV Manufacturers/Importers

Firm Name	Type
ATK	IMPORTER
COSMOPOLITAN MOTORS	IMPORTER
D.R.R. INC.	IMPORTER
E-TON DISTRIBUTION LP	IMPORTER
HOFFMAN GROUP INC.	IMPORTER
J & J SALES	IMPORTER
JEHM POWERSPORTS	IMPORTER
KASEA MOTORSPORTS	IMPORTER
MANCO PRODUCTS	IMPORTER

MOTORRAD OF NORTH AMERICA	IMPORTER
PANDA MOTORSPORTS	IMPORTER
POWERGROUP INTERNATIONAL ALPHASPORTS	IMPORTER
REINMECH MOTOR COMPANY, LTD	IMPORTER
TRANSNATIONAL OUTDOOR POWER LLC	IMPORTER
TWS-USA, INC	IMPORTER
ULTIMAX LCC	IMPORTER
UNITED MOTORS OF AMERICA, INC	IMPORTER
AMERICAN SUNDIRO	MANUFACTURER
ARCTIC CAT, INC.	MANUFACTURER
BOMBARDIER	MANUFACTURER
CANNONDALE CORP - BEDFORD	MANUFACTURER
HONDA AMERICAN MANUFACTURING	MANUFACTURER
HYOSUNG MOTORS AND MACHINERY	MANUFACTURER
INTERNATIONAL POWERCRAFT	MANUFACTURER
KAWASAKI MOTORS CORPORATION	MANUFACTURER
KEEN PERCEPTION INDUSTRIES	MANUFACTURER
MOSS	MANUFACTURER
PANDA MOTORSPORTS	MANUFACTURER
POLARIS INDUSTRIES	MANUFACTURER
ROADMASTER /FLEXIBLE FLYER	MANUFACTURER
SUZUKI	MANUFACTURER
TAI LING MOTOR COMPANY	MANUFACTURER
YAMAHA MOTOR MANUFACTURING CORP.	MANUFACTURER

2.4.1.1 Engine Manufacturers

Four of the major ATV producers, Honda, Kawasaki, Yamaha and Suzuki, are both engine and equipment manufacturers. In addition, Suzuki produces engines for Arctic Cat, and in fact owns a significant amount of Arctic Cat common stock. Hyosung Motors and Machinery and the Tai Ling Motor company also use Suzuki engines in ATVs that are sold in the U.S. Although Polaris produces some of its own engines, a substantial number are supplied by Fuji Heavy Industries, primarily an auto and truck manufacturer, and its U.S. subsidiary, Robin Industries. Polaris owns a substantial amount of Robin common stock.

Other engine manufacturers include Rotax, which is a subsidiary of Bombardier Inc., a large Canadian company. Bombardier is primarily a snowmobile manufacturer, but has recently

entered the ATV market. Bombardier/Rotax also produces engines for a wide variety of other applications, including snowmobiles, motorcycles, ATVs, personal water craft (PWC), utility vehicles and aircraft. A few small ATV manufacturers use Briggs or Kohler utility engines, but these are covered by EPA's Small Spark Ignition (SI) Engine regulations and are not included in this analysis [7]

2.4.1.2 Equipment Manufacturers

Four of the six major ATV manufacturers, Honda, Kawasaki, Yamaha and Suzuki, are primarily automobile and/or on-highway motorcycle manufacturers who also produce ATVs, off-highway motorcycles, snowmobiles, PWC and other non-highway vehicles. Polaris and Arctic Cat are major snowmobile manufacturers, in addition to producing ATVs. Polaris also produces on-highway motorcycles and Arctic Cat produces PWC.

Of the remaining 10 producers, 5 are classified as large businesses, and 5 are classified as small businesses. As noted above, Bombardier is a large Canadian snowmobile manufacturer that has recently entered the ATV market. Cannondale is a large American bicycle manufacturer that has also recently entered the ATV market. Hyosung and Tai Ling are large Far Eastern manufacturers, who also manufacture motorcycles and motorscooters (in the case of Hyosung). Roadmaster/Flexible Flyer is primarily a large bicycle and toy manufacturer which also produces youth ATVs that are sold in large discount stores. The 17 importers and 5 small manufacturers either import completed ATV's or assemble them in this country from imported parts.

2.4.2 Applications

As noted above, ATVs are used for recreational and other purposes. Examples of non-recreational uses are for hauling and towing on farms, ranches or in commercial applications. Some ATVs are sold with attachments that allow them to take on some of the functions of a garden tractor or snow blower. ATVs are also used for competitive purposes, although not to the same extent as off-highway motorcycles.

2.4.3 Engine Design and Operation

The majority of ATVs sold in the U.S. are powered by single-cylinder, four-stroke cycle engines of less than 40 horsepower, operating under a wide variety of operating conditions and load factors. Engine displacements range from 50cc for an entry-level youth model to 660cc for a high-performance adult model, but more than three-fourths of them fall in the 200-500cc range.

2.4.3.1 Two-Stroke vs Four-Stroke Cycle Engine Usage

According to statistics compiled by our contractor, more than 92 percent of all ATVs produced for US consumption use four-stroke cycle engines. However, estimates provided by MIC reduce this percentage to 88 percent. Of the six major manufacturers, only Polaris, Suzuki and Yamaha used two-stroke cycle engines at all. The remainder of the two-stroke engines in

ATVs sold in U.S. are found in entry-level or youth models, which are imported from the Far East, or assembled in this country from imported parts. In general two-stroke engines are less expensive to produce than four-stroke engines, thus providing a marketing advantage in the youth and entry-level categories. We estimate that two-strokes make up roughly twenty percent of the market when the imported youth models are included.

2.4.3.2 Use of Engines in Other Applications

Although a few ATV engine lines have been used in other applications, such as some smaller on- and off-highway motorcycles, manufacturers have stated that ATV engines are normally designed only for use in ATVs. ATV engines may share certain components with motorcycles, snowmobiles and PWC, but many major components such as pistons, cylinders and crankcases differ within given engine displacement categories.

2.4.3.3 Customer Concerns

Except for the competitive segment of the market, performance seems to be somewhat less important to ATV purchasers than it is to purchasers of snowmobiles or off-highway motorcycles. Most youth models, which form a significant portion of the market, are normally equipped with governors or other speed-limiting devices. Performance can be important for some of the higher-end adult models, but handling is also an important consideration, particularly when riding in dense wooded areas. Durability and reliability are also important to the customer, but perhaps not as important as price.

The price of an ATV can ranges from about $1,200 for an entry-level youth model to around $7,000 or more for a large, high performance machine. ATVs, like other recreational vehicles, are basically discretionary purchases, although utility may enter into the equation more often than in the case of off-highway motorcycles or snowmobiles.. Cost is an important factor, particularly in the youth or entry-level segments of the market, and significant cost increases could cause people to spend their discretionary funds in other areas.

2.5 Off-Highway Motorcycles

Off-highway motorcycles, commonly referred to as “dirt bikes,” are designed specifically for use on unpaved surfaces. As such, they have certain characteristics in common, such as a large amount of clearance between the fenders and the wheels, tires with aggressive knobby tread designs, and they lack some of the equipment typically found on highway motorcycles, e.g., lights, horns, turn signals, and often mufflers. They are thus not normally able to be licensed for on-highway use. There are a limited number of motorcycles, known as dual-purpose motorcycles, that can be used for both on- and off-highway purposes. These can be licensed for highway use, and so fall under the current highway motorcycle regulations, assuming that they are powered by engines of 50cc or larger displacement. Off-highway motorcycles are used for recreational riding, but substantial numbers are also used for competition purposes. Some in fact can be used for little else, e.g., machines that are designed for observed trials competition, which have no seats in

the conventional sense of the term, and engine characteristics that are totally unlike those of most other motorcycles. Only a few thousand observed trials bikes are produced each year.

Our contractor found that production of off-highway motorcycles produced for sale in the U.S. has averaged about 110,000 units between 1995 and 1999. As is the case with ATVs, off-highway motorcycle production has increased considerably in later years, to more than 150,000 units in 1999, and assumed to be the same or higher for 2000, although the exact numbers were not available at the time of preparation of this analysis. Since many states do not require registration of off-highway motorcycles, it is difficult to estimate a total population at any given time.

2.5.1 Manufacturers

Motorcycle manufacturers are classified under the NAICS system as code 336991, Motorcycle, Bicycle and Parts Manufacturers. Motorcycle manufacturers have the subcode 3369913, which includes manufacturers of scooters, mopeds and sidecars. To be classified as a small business, the manufacturer must have fewer than 500 employees. Motorcycle Importers are classified as subcode 4211101, which also includes automobile importers, and has an SBA cutoff of 100 employees to be considered a small business.

Our contractor has identified 24 manufacturers of off-highway motorcycles. These can be found in Table 2.5.1. Five large manufacturers, Honda, Kawasaki, Yamaha, Suzuki, and KTM. accounted for approximately 85 percent of all production for sale in the U.S. in calendar year 2000. These are all companies that manufacture automobiles and/or on-highway motorcycles, motorscooters, ATVs, and PWC as well as off-highway motorcycles. Honda is by far the largest producer of off-highway motorcycles, with over 45 percent of the total production for sale in the U.S. Figure 2.5.1 shows the market shares for the top five and the other producers

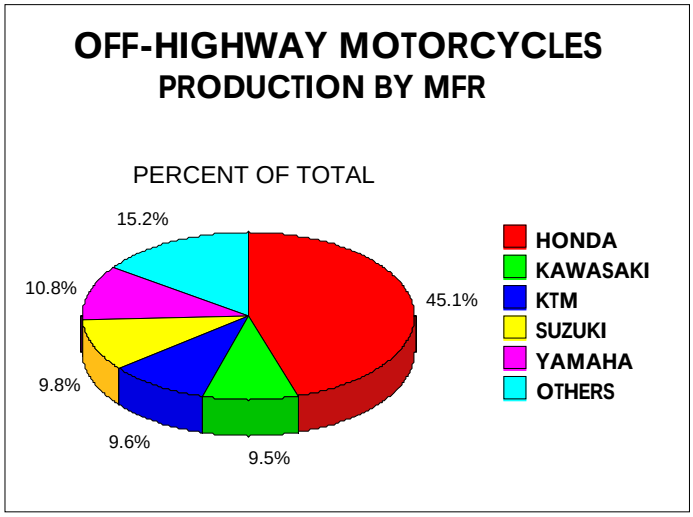

Figure 2.5.1

The 19 other manufacturers accounted for the remaining 15 percent of production for U.S. sale. Six of these firms, accounting for approximately 3 percent of total production for the U.S. market, are located in this country. Dun and Bradstreet employee data are available for four of the six U.S. manufacturers, indicating that these are small businesses according to the SBA definition.

Our contractor has also identified 16 off-highway motorcycle importers. Eight of these

are U.S.-owned. Dun and Bradstreet data are available for five of the eight U.S. importers, indicating that they are small businesses. Again, it seems likely that all eight are small businesses.

Table 2.5.-1
U.S. Off-Highway Motorcycle Manufacturers/Importers

Firm Name	Type
ACTION POLINI	IMPORTER
BETA USA	IMPORTER
CODY RACING PRODUCTS	IMPORTER
COSMOPOLITAN MOTORS INC.	IMPORTER
CRE IMPORTS/E-LINE ACCESSORIES	IMPORTER
GAS GAS NORTH AMERICA	IMPORTER
HUSQVARNA USA	IMPORTER
KASEA MOTORSPORTS	IMPORTER
KTM SPORTMOTORCYCLE USA, INC.	IMPORTER
MIDWEST MOTOR VEHICLES, INC.	IMPORTER
TRANSNATIONAL OUTDOOR POWER, LLC	IMPORTER
TRYALS SHOP	IMPORTER
TWS-USA INC.	IMPORTER
U.S. MONTESA	IMPORTER
UNITED MOTORS OF AMERICA	IMPORTER
VOR MOTORCYCLES USA	IMPORTER
AMERICAN DIRT BIKE INC. (U.S.)	MANUFACTURER
ATK MOTORCYCLES (U.S.)	MANUFACTURER
BETAMOTOR SPA (ITALY)	MANUFACTURER
CAGIVA MOTORCYCLE SPA (ITALY)	MANUFACTURER
CANNONDALE CORP - BEDFORD (U.S.)	MANUFACTURER
CCM MOTORCYCLES LTD (U.K.)	MANUFACTURER
COBRA MOTORCYCLE MFG. (U.S.)	MANUFACTURER
GAS GAS MOTOS SPA (SPAIN)	MANUFACTURER
HM MOTORCYCLES (U.S.)	MANUFACTURER
HONDA MOTORCYCLES (JAPAN)	MANUFACTURER
HUSABERG MOTOR AB (SWEDEN)	MANUFACTURER
HYOSUNG MOTORS AND MACHINERY (KOREA)	MANUFACTURER
KAWASAKI HEAVY INDUSTRIES (JAPAN)	MANUFACTURER
KTM SPORT MOTORCYCLE AG (AUSTRIA)	MANUFACTURER
LEM MOTOR SAS (ITALY)	MANUFACTURER
MADFAST MOTORCYCLES (IRELAND)	MANUFACTURER
MINSK MOTOVELOZAVOD (BELARUS)	MANUFACTURER
MONTESA-HONDA ESPANA, SA (SPAIN)	MANUFACTURER
PIAGGIO GROUP (ITALY)	MANUFACTURER
POLINI (ITALY)	MANUFACTURER
REV! MOTORCYCLES (U.S.)	MANUFACTURER
SUZUKI (JAPAN)	MANUFACTURER
TAI LING MOTOR COMPANY LTD. (TAIWAN)	MANUFACTURER
VOR MOTORI (ITALY)	MANUFACTURER

YAMAHA MOTOR COMPANY LTD. (JAPAN)	MANUFACTURER

2.5.1.1 Engine Manufacturers

For the majority of off-highway motorcycles, the vehicle manufacturer is also the engine manufacturer. However, a few motorcycle manufacturers use engines produced by other firms. ATK Motorcycles and CCM Motorcycles Ltd. use Bombardier/Rotax engines, while the Tai Ling Motor Company uses Suzuki engines. A Spanish manufacturer, Gas Gas Motos, SA, noted primarily for its observed trials machines, produces some of its own engines and buys others from Cagiva, a large Italian manufacturer. One U.S. manufacturer, Rokon, markets a low-production trail motorcycle resembling a large motorscooter, which is intended for hunters and fishermen. Rokon uses industrial-type engines made by Honda and other manufacturers which again would fall under the EPA Small SI regulations. Rokon is therefore not included here.

2.5.1.2 Equipment Manufacturers

Our contractor has identified some 24 firms that manufacture off-highway motorcycles for the U.S. market. Six of these are U.S. manufacturers. With the exception of Connondale, which is primarily a bicycle manufacturer, all of them produce only motorcycles. Italy has five manufacturers. One of these, Cagiva, is mainly a producer of on-highway motorcycles. Piaggio is primarily a motorscooter manufacturer; Betamotor makes motorscooters and trials bikes. Lem and Polini manufacturer youth motorcycles. Spanish manufacturers of off-highway motorcycles that are imported to the U.S. include Gas Gas, primarily an observed trials bike manufacturer, and Montesa, which is owned by Honda. Other manufacturing companies whose products are imported into the U.S. market are also found in Austria, Belarus, Ireland, Korea, Sweden, Taiwan, and the United Kingdom. KTM, an Austrian company with a U.S. branch, is one of the five major producers for the U.S. market.

2.5.2 Applications

As noted above, off-highway motorcycles can be used for recreational purposes or for competition. EPA defines vehicles that are "used solely for competition" as those with features (not easily removable from the vehicle) that would make the vehicle's use in other recreational activities unsafe, impractical, or highly unlikely. EPA's noise regulations also exempt any off-highway motorcycle that is designed and marketed solely for use in closed-course competition.

Certain types of off-highway motorcycles are designed and marketed for closed-course competition. These are commonly known as "motocross bikes." We have information from our contractor indicating that some 12-14 percent of off-highway motorcycles produced from 1996 to 2000 were motocross bikes. Other sources have estimated motocross to be closer to 30 percent of off-highway sales.[8] Other types of competition motorcycles are the observed trials machines mentioned above, which emphasize handling ability rather than speed, and the so-called "enduro bikes." Enduro bikes are designed for cross-country type racing, rather than closed-course competition. As such, they do have need for some of the equipment normally found on non-

racing machines, such as spark arrestors (required by U.S. Forest Service regulations) and at least minimal lighting packages, but are exempt from the muffler requirement contained in the EPA noise regulations.

Whether for competition or recreational use, off-highway motorcycles are operated under transient conditions that include a wide variety of speeds and load factors.

2.5.3 Engine Design and Operation

Off-highway motorcycle engines have traditionally been about two-thirds smaller and less powerful than those used in on-highway cycles. For 2000, about 68 percent of the models produced were less than 300cc displacement, and half of these were 100cc or less. Percentages for the top five producers were approximately the same as for the industry as a whole. The distribution of engine sizes tends to be somewhat bimodal, with another 14 percent of the total falling into the 500-700cc range. (See Figure 2.5.2) This is likely because of the increase in the number of four-stroke engines in recent years, most of which tend to fall in the larger (500-700cc) displacement ranges. Unlike on-highway motorcycles, our contractor found no off-highway engines larger than 700cc.

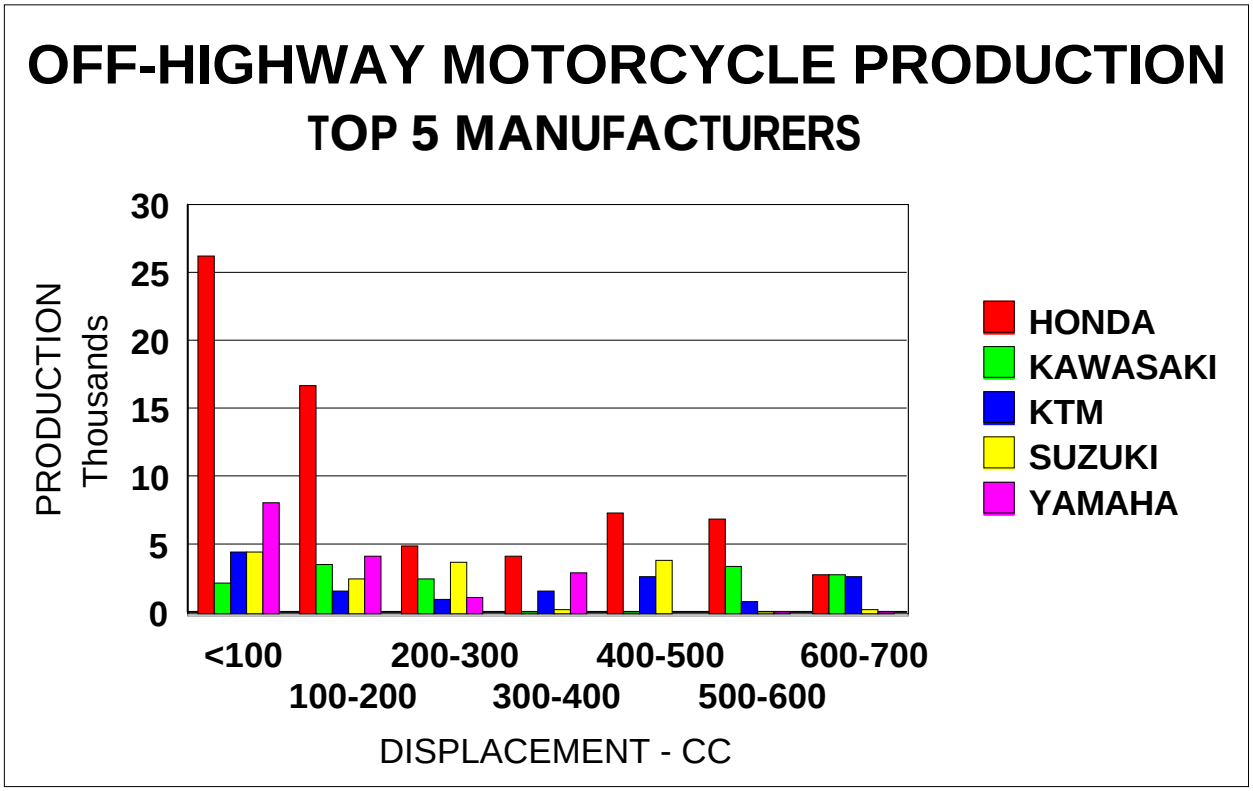

Figure 2.5.2

2.5.3.1 Two-Stroke vs Four-Stroke Cycle Engine Usage

Data from our contractor, using the PSR database, indicate that slightly more than half of the off-highway motorcycles produced for sale in the United States are powered by four-stroke cycle engines. However, estimates from MIC place the percentage of two-stroke sales at more than 60 percent. The percentage of two-strokes varies considerably by manufacturer. Honda, which accounts for more than 45 percent of this production, is predominantly a four-stroke manufacturer. Four-strokes comprise about two-thirds of its production. For Yamaha, the percentage is about 57 percent. The remainder of the foreign and domestic producers make more two-stroke engines than four-strokes. For the other top-five producers, KTM, Kawasaki and Suzuki, the percentage of two-stroke engines varies from 58 to 72 percent, and can be even higher (up to 100 percent) for some of the remaining manufacturers on the list.

Two-stroke engines are normally used in two primary applications: (1) racing machines, because they tend to have a higher power-to-weight ratio than four-stroke engines (this is important for competition, especially in the smaller displacement classes), and (2) youth model or entry-level motorcycles, because two-strokes are cheaper to produce than four-strokes. Since youth or entry-level motorcycles also tend to have smaller displacement engines, the higher power-to-weight ratio of the two-stroke tends to provide a little better performance. However, there has been a growing tendency in recent years for manufacturers to bring out more new four-stroke engines, particularly in the higher displacement ranges. This is also true in their competition lines.

2.5.3.2 Use of Engines in Other Applications

Only a few engine lines, primarily among the top five producers, are used in both off-highway and on-highway motorcycles. Part of the reason for this is because over half of the off-highway bikes use two-stroke engines, whereas there are almost no two-stroke engines to be found in on-highway motorcycles. Also, as noted above, off-highway motorcycles generally have much smaller displacement engines than their on-highway counterparts. Off-highway motorcycle engines are closer in terms of engine size to ATV engines. However, ATVs also use predominantly four-stroke engines and these are not as likely to be highly-tuned for performance as are many off-highway motorcycle engines.

2.5.3.3 Customer Concerns

Performance is highly important to motocross and other racers. The competitive segment is consistent in its demand for machines with higher power-to-weight ratios that will make them more competitive in racing circles. Light weight is an important aspect of this equation, since it allows easier handling in difficult situations, in addition to increasing performance. Performance is also important in other portions of the market as well. There seems to be a certain amount of status involved in owning a really high-performance machine, and this may outweigh some of the disadvantages of ownership. Durability and reliability may be of less importance to this type of consumer, although they are important to professional racers.

Except for a few dual-purpose machines, off-highway motorcycles are purely recreational in nature, and not suitable for day-to-day personal transportation. Unless the purchaser is an all-out competition model customer, price can therefore be an important consideration to an off-highway motorcycle purchaser. The price of a dirt bike can range from about $1,500 for a 50cc entry-level model to $8,000 for a larger high performance machine. Along with other recreational machines, off-highway motorcycles are discretionary purchases. Significant cost increases could therefore result in decreased sales of these motorcycles, as potential customers turned to other recreational opportunities for spending their discretionary income. Again, this is most likely in the youth/entry level segment of the market. At the other end of the spectrum, cost is relatively unimportant to the high-end motocross or other competitors.

Chapter 2 References

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