COMPARISON OF METHODS FOR PROJECTING NONROAD EQUIPMENT ACTIVITY LEVELS

Revised Draft Report

Prepared for:

Office of Mobile Sources
U.S. Environmental Protection Agency
Ann Arbor, MI 48105

Prepared by:

E.H. Pechan & Associates, Inc.
3500 Westgate Drive, Suite 103
Durham, NC 27707

September 1997

EPA Contract No. 68-D3-0035
Work Assignment No. III-107
Pechan Report No. 97.09.004/1807

CONTENTS

CONTENTS (continued)

TABLES AND FIGURES

ACRONYMS AND ABBREVIATIONS

ATV	all-terrain vehicle
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
CARB	California Air Resources Board
CNG	compressed natural gas
CO	carbon monoxide
DMV	Department of Motor Vehicles
DOC	Department of Commerce
DOE	Department of Energy
E-GAS	Economic Growth Analysis System
EIA	Energy Information Administration
EPA	United States Environmental Protection Agency
EPS	Emissions Preprocessor System
FHWA	Federal Highway Administration
GDP	gross domestic product
GSP	gross State product
hp	horsepower
LPG	liquified petroleum gas
MAD	mean absolute deviation
MSA	Metropolitan Statistical Area
NEVES	Nonroad Engine and Vehicle Equipment Study
NO_x	oxides of nitrogen
OMS	Office of Mobile Sources
OTAG	Ozone Transport Assessment Group
PSR	Power Systems Research
REMI	Regional Economic Models, Inc.
RIA	Regulatory Impact Analysis
SCC	source category code
SIC	Standard Industrial Classification
SIP	State Implementation Plan
USDA	U.S. Department of Agriculture
VOC	volatile organic compounds
WEFA	Wharton Econometrics Forecasting Association

CHAPTER I
INTRODUCTION

Projected emission inventories are developed by establishing base year emission parameters (e.g., source populations and in-use activity levels), forecasting growth in these parameters, and accounting for the effectiveness of current and future emission controls in the projection year. The U.S. Environmental Protection Agency's (EPA's) Office of Mobile Sources (OMS) is currently developing a State Implementation Plan (SIP)-related nonroad source emissions model (NONROAD). To support the development of this model, Pechan has examined potential methods for projecting nonroad in-use activity through the year 2050. Alternative methods were analyzed based on evaluation criteria consistent with specifications for EPA's NONROAD. It is important to note that the projection methods described in this report estimate in-use activity changes, and not overall changes in emissions because the effects of future controls will be incorporated elsewhere in the model.

A. BASE YEAR IN-USE NONROAD ENGINE APPLICATION POPULATIONS

Power Systems Research, Inc. (PSR) is a recognized leader in global market research of nonroad engine applications. Through more than 15 years of research, PSR has developed the *North American Engine PartsLink Data Base*, which employs engine replacement rate and other information to estimate engine parts consumption profiles. The main clients for PSR's data base are engine and equipment manufacturers and suppliers. As a component of *PartsLink*, PSR has developed annual nonroad engine populations by application, horsepower (hp), engine type (i.e., spark-ignition or compression-ignition), and number of strokes per engine cycle (2 or 4). Pechan is performing an evaluation of the *PartsLink* engine/equipment population data under Task 1A of this work assignment; alternative methods for developing base year populations are being examined under Task 1B.

Nonroad engine applications are typically classified according to equipment categories, or market segments, so that applications with similar engine characteristics and use patterns can be analyzed (in this case, projected) on a collective basis. The following are the nonroad equipment segments defined by PSR:

- Agriculture
- Construction
- General Industrial
- Lawn and Garden
- Marine
- Material Handling
- Pumps and Compressors
- Recreational Products
- Welders and Generators

The purpose of EPA's Nonroad Engine and Vehicle Equipment Study (NEVES) was to estimate 1990 nonroad engine population and other parameters (e.g., annual hours of use) for use in developing nonroad source emission inventories (EPA, 1991b). The EPA is developing NONROAD and revisiting its 1990 nonroad population estimates because of increased recognition of the importance of nonroad source emissions. The NEVES is based in part on a previous version of the PSR data base. In some cases, the NEVES equipment segments are different from the most recent *PartsLink* data base segments. For example, airport service equipment was included as a distinct equipment category for the NEVES, while PSR includes these applications in the general industrial category. In addition, there are some additional applications included in PSR's current data base that were not included in the NEVES (e.g., oil field equipment).

As part of this study, Pechan has developed a retrospective analysis comparing estimated 1996 nonroad equipment populations by applying 1990-1996 growth indicators from each of four projection methodologies to 1990 PSR population estimates. Because PSR revised many of its 1990 values from the estimates in the NEVES for this study, Pechan employs PSR's most recent 1990 nonroad population data in the 1990-1996 retrospective analysis.

B. PROJECTING GROWTH IN NONROAD ACTIVITY

Base year populations (N) are a critical input into the following equation, which is used to estimate emissions for a specific nonroad engine application:

$$M_i = N \times HRS \times HP \times LF \times EF_i \qquad \textbf{(Eq. 1)}$$

where:

where:	M_i	=	mass of emissions of i^{th} pollutant during inventory period
	N	=	source population
	HRS	=	annual hours of use
	HP	=	average rated hp
	LF	=	typical load factor
	EF_i	=	average emissions of i^{th} pollutant per unit of use (e.g., grams per hp-hour)

The product of the annual hours of use, the average rated hp, and the load factor is typically termed the "per-source usage rate." The product of the population and the per-source usage rate is commonly referred to as the "activity level." As can be seen from Equation 1, changes in activity may occur due to changes in a number of variables. Factors that contribute to in-use activity include the source population (i.e., the number of engines), the annual hours of use, the load factor, and the average rated hp of various applications. Ideally, all variables that contribute to activity growth should be accounted for when projecting nonroad activity. However, due to data and resource constraints, the ability to project the separate activity components is often limited.

In past nonroad source projection efforts, factors such as annual use, load factor, and hp are typically held constant when applying a growth factor to nonroad baseline activity. Therefore, activity growth is expressed only as a source population increase. However, most growth indicators are based on surrogate economic data that represent total nonroad activity. For example, for projections that are based on fuel consumption, the amount of fuel consumed is most appropriately considered a surrogate for total in-use activity, rather than source population alone. In contrast to most growth indicators, engine/equipment sales are strictly associated with source population changes. It is important to note that while fuel use projections may be accounting for total in-use activity, there is no way to accurately determine what proportion of total growth should be assigned to each activity variable (e.g., source population versus annual hours of use).

C. EFFECTS OF NONROAD ENGINE STANDARDS ON EMISSION PROJECTIONS

As stated earlier, the projection methods analyzed in this report only estimate activity level changes. To accurately project emissions, the effects of future controls should also be considered. Replacement of older, higher-emitting engines with newer, lower-emitting engines will reduce emissions. However, scrappage rates of existing engine populations may decline if new engine standards create an incentive for nonroad equipment operators to use existing equipment for longer periods. Other activity level variables that may change due to stricter emission standards for new engines include average rated hp and load factor. Although each of the above factors should be taken into account, an analysis of these factors is beyond the scope of this report.

D. REPORT ORGANIZATION

The remainder of this report is organized as follows. Chapter II discusses current methods used by States and EPA for projecting nonroad activity, as well as additional alternative projection methods identified by Pechan. Chapter III compares the various projection methods using a set of nine evaluation criteria. These criteria are used as a basis for making recommendations for selecting a projection methodology for incorporation into NONROAD. One of these criteria is the empirical validity of each method based on the results of a 1990-1996 retrospective analysis comparing four of the alternative methods to 1996 PSR population data. Chapter IV summarizes recommendations based on a critical comparison of the alternative projection methods. Chapter V lists the references consulted during preparation of this report. Appendix A presents the 1990-1996 retrospective analysis of alternative projection methods.

CHAPTER II
METHODS FOR PROJECTING NONROAD IN-USE ACTIVITY

This chapter discusses three currently used and three alternative methodologies for projecting nonroad in-use activity levels.

A. OVERVIEW

As stated in the previous chapter, a number of activity level variables affect future nonroad emission levels. Activity level changes, which may include changes in source population, annual hours of use, average rated hp, and load factor, are affected by marketplace conditions. For example, the personal watercraft population at any point in time is related to economic conditions – assuming everything else equal, as personal income increases, more people can afford to purchase such equipment. Personal watercraft use is even more sensitive to economic conditions than the population of these nonroad sources. It is not difficult to imagine a swift decline in personal watercraft use due to a sharp increase in gasoline prices, even though the population of such watercraft would, in the near term, remain the same. This contrast between personal watercraft population and use is expected because of the much higher cost and longer time horizon associated with increasing/decreasing watercraft ownership compared to increasing/decreasing watercraft use.

Because of the effect of economic influences on nonroad emission levels, economic projections can be used to estimate the total change in nonroad emissions-producing activity. Increases in economic output for a given emissions-producing sector may result in changes to more than one activity level component (e.g., equipment population and annual hours of use). If data were readily available, it would be preferable to develop specific projections for each activity component, rather than assume that growth occurs in only one activity level component (e.g., equipment population). The importance of this distinction can be illustrated by contrasting an increase in engine population, which results in engine turn-over to cleaner engines, versus an increase in the level of use of existing engines. Readily available economic projections [e.g., Bureau of Economic Analysis' (BEA's) Regional Projections Series] can not be matched to specific activity components. It may be possible to develop projections for these individual activity components. For example, engine/equipment sales or industry employment are economic data that may correlate with in-use population, and therefore, could be used to project changes in that specific activity-level component. However, such a detailed approach would require substantial data collection and is beyond the scope of this analysis.

Because of the level of effort associated with a detailed analysis of each activity level component, past studies have applied simplifying assumptions in projecting emissions based on economic projections. Table II-1 summarizes some recent nonroad sector emission projection efforts. This table is organized into two major sections: (1) studies that only project nonroad source emissions; and (2) studies that project emissions for all

Table II-1. Summary of Recent Nonroad-Related Emission Projection Studies

STUDY	PROJECTION YEARS/ GEOGRAPHIC SCOPE	DATA SOURCE(s)	SIMPLIFYING ASSUMPTION(S)
Nonroad Equipment-Specific Projections			
California Air Resources Board (CARB) Off-Road Mobile Source Emissions Inventory Model (currently on-going, draft reference is EEA, 1997)	1993-2020 (All 58 counties in California)	Varies by equipment category; for all but three equipment categories, estimated growth through multivariate regression analysis of potential surrogate variables (see Table II-3 for details)	All growth is attributed to changes in engine population [engine sales are estimated using scrappage rate information and estimated historical sales (historical sales are estimated using scrappage rate estimates)]; generally employed "top-down" approach of estimating State-level projection and allocating to counties based on historical proportions or surrogate information (the "bottom-up" approach was used for aviation, because data/forecasts were available by airport).
Regulatory Impact Analysis (RIA) of Large Nonroad Compression Ignition Engines (>50 hp) Regulation (EPA, 1994a)	1991-2026 (National)	Estimated 2 percent annual growth rate qualitatively based on projected growth in: gross national product; farm machinery and equipment industry; construction machinery industry; and engines and turbines manufacturing industry (none of these projections were available beyond 2005)	The 2 percent growth in output is assumed equivalent to growth in sales, the average annual output growth rate for the engines covered by the regulation is assumed to be the same as for the industries listed, growth is assumed not to differ by State, and growth after 2005 is assumed to be the same as growth from 1990-2005.
RIA of Emission Standards for New Nonroad Spark Ignition Engines < or =19kW (EPA, 1994b)	1993-2026 (National)	Estimated based on regression of national historical sales data against BEA historical and projected national population estimates	Growth is not assumed to differ by State; for predicted negative sales projections, EPA used the last historical year's sales estimate.
RIA of Air Pollution Standards for New Nonroad Spark-Ignition Marine Engines (EPA, 1996)	1994-2051 (National)	For outboard and inboard/sterndrive engines, estimated based on regression of national historical sales data against per capita income, real interest rate, outboard price, and total boat population in previous year; for personal watercraft and jet boats, for 1994 through 2011, estimated based on average annual sales growth of 4 percent, estimated regulatory price increase and an elasticity of demand of -2.0; for 2012-2051, documentation says that the same equation was used as for 1994-2011, but assuming no change in both sales growth and price increase from 2011	Growth is not assumed to differ by State; for outboard and inboard/sterndrive engines, assumed that all economic variables remain constant for 1994 through 2051 except for a steady 1.25 percent growth in human population and a steady increase in price of controlled outboards engines over nine year regulatory phase-in period.

Table II-1 (continued)

STUDY	PROJECTION YEARS/ GEOGRAPHIC SCOPE	DATA SOURCE(s)	SIMPLIFYING ASSUMPTION(S)
		General Emission Projections	
Clean Air Act Section 812 (Pechan, 1997a)	2000 and 2010 (National)	BEA gross State product [GSP (value added)]; population for lawn and garden equipment and recreational vehicles	State-specific growth factors are applied to emissions to develop pre-CAAA control emissions (therefore, growth reflects total activity level change); post-control emissions are calculated by applying fleet average annual emission reduction percentages based on EPA guidance for State Implementation Plan (SIP) submittals.
Grand Canyon Visibility Transport Commission Region (Smith and Chu, 1994)	2000, 2010, 2020, 2030, and 2040 (Counties in Grand Canyon Visibility Transport Commission region plus Idaho, Washington, and West Texas)	15-region model developed by Regional Economic Models, Inc. (REMI)	County-level growth factors are estimated by apportioning the REMI-derived factors based on 1992 county industrial earnings data from BEA (growth indicators discussed include personal income, employment, and output—unclear which are used and how they are applied to emission inventory data).
Ozone Transport and Assessment Group (OTAG) (Pechan, 1997b)	2007 (National)	BEA GSP (value added); population for lawn and garden equipment and recreational vehicles; State-supplied growth factors	State-specific growth factors are applied to emissions to develop pre-CAAA control emissions (therefore, growth reflects total activity level change); post-control emissions are calculated by applying fleet average annual emission reduction percentages based on EPA guidance for SIP submittals.
Review of Ozone and PM NAAQS and Proposal of Regional Haze Program (Pechan, 1997c)	2010 (National)	BEA GSP (value added); population for lawn and garden equipment and recreational vehicles	State-specific growth factors are applied to emissions to develop pre-CAAA control emissions (therefore, growth reflects total activity level change); post-control emissions are calculated by applying fleet average annual emission reduction percentages based on EPA guidance for SIP submittals.

source categories. The breadth of source category coverage in the studies in (2) necessitated a more generalized approach. All of these studies' nonroad projections either reflect changes in the total activity level or changes to only one of the four activity level components. The following sections describe the data sources and methods that have been applied in past studies to project activity level changes.

B. PROJECTION METHODS CURRENTLY IN USE

This section describes projection methods and data that are currently employed in projecting nonroad source emissions. The three methods described are based on projections developed by the BEA, EPA's Economic Growth Analysis System (E-GAS), and California Air Resources Board (CARB).

1. BEA Regional Projections

The BEA develops projections of numerous economic variables, including personal income, employment, and earnings, at various levels of geographic detail. Projections are available for States, metropolitan statistical areas (MSAs), and BEA economic areas.

The BEA projections are based on the assumption that past economic relationships will continue and that there will be no major policy changes. The State projections are made consistent with National population and labor force projections from the Bureau of the Census and Bureau of Labor Statistics (BLS), respectively. The BEA's projections are also consistent with the unemployment rate projections from the Congressional Budget Office and with mining output projections from the Department of Energy (DOE). The projections for MSAs and BEA economic areas are then made consistent with the State projections (DOC, 1995). The most recent BEA projections, which are described below, were released in July 1995. In the past, BEA has updated its projections every five years. Because of budget constraints, BEA does not plan on developing economic projections in the future.

a. National Projections

The BEA's mid-term National projections (i.e., from 1995 to 2000) are derived from an econometric model, which contains models for each of the 50 States, the District of Columbia, and the Nation. For variables that differ significantly between States, such as employment, the State/District of Columbia models are summed to obtain "bottom-up" National projections. The National model projects variables such as prices, which do not differ considerably between States. These mid-term projections are then used to modify the projections for the first year of the long-term projections, which are developed for 2000, 2005, 2010, 2015, 2025, and 2045. The same projections of population, labor force, and unemployment rate are incorporated into the National long-term projections. The long-term projections are prepared on the basis of historical trends in economic relationships among variables. The long-term projections of personal income and earnings are mainly based on projections of gross domestic product (GDP). The projections of GDP are derived from projections of a succession of population and labor-force variables. The industry-level employment, GDP, and earnings projections are mainly based on historical trends in each industry's share of the all-industry total (DOC, 1995).

Figure II-1 displays the major steps employed in developing the long-term National GDP projections. The first step is to project the civilian labor force based on the Bureau of the Census' projected civilian adult noninstitutional population and the BLS' projected labor force participation rates. The second step estimates total civilian employment based on the projected rate of unemployment from the Congressional Budget Office. Total employment is then determined by summing total civilian employment with projected military employment. The National employment projections, which are on a number of employed persons basis, are then adjusted to conform to the State employment projections, which are on a jobs basis. The third step projects employment by industry by multiplying total employment by each industry's projected share of total jobs, which is projected based on the rates of change in the BLS projections of these shares. The industry-level GDP projections are developed based on the employment projections in three additional steps. First, the ratio of GDP per job in an industry to GDP per job for all industries is projected on the basis of historical trends in the ratio. Second, this projected ratio is multiplied by the projected GDP per job for all industries to yield the projected GDP per job in the industry. Third, this projected product is multiplied by the projected employment in the industry to yield the projected GDP in the industry.

b. State Projections

The BEA's mid-term State projections are derived from State econometric models, which are generally based on economic and demographic relationships for each State and the Nation. For example, in each State's econometric model, State employment affects population and vice-versa. Interactions between States are reflected by a set of trade indices. For example, changes in employment in a State with projected industrial growth also affects employment in other States. The State projections are then modified to be consistent with the Congressional Budget Office's projected National full-employment unemployment rate. When the State long-term projections for employment by industry for 2000 differ from the State mid-term projections, the long-term projections are modified. This assures that the mid-term and long-term projections estimates of GSP are consistent. The long-term projections are mainly based on historical trends in economic relationships for each State and between each State and the Nation. The projections of employment by industry are based on relationships between "basic" industries that mainly serve National markets and "nonbasic" industries that mainly serve State markets. The projections of GSP and earnings by industry are based on the projected employment by industry.

For basic industries in each State, employment projections are developed based on the historical trend in the State's share of total National employment in the industry. The projections are based on the assumption that the factors that affected the State's historical employment share in the past (e.g., relative wage rates) will continue to affect the share, though less strongly, in the future. Therefore, the rate of change in the State's employment share will slow. This assures that no industry in a State will have an unreasonably large or small share of National employment in the industry at the end of the projection period. For nonbasic industries, employment projections are based on the projected basic industry employment because the level of State nonbasic industry demand is determined by its total basic industry activity. The nonbasic industry location quotient is used to tie the projections of employment in each industry to the basic industry

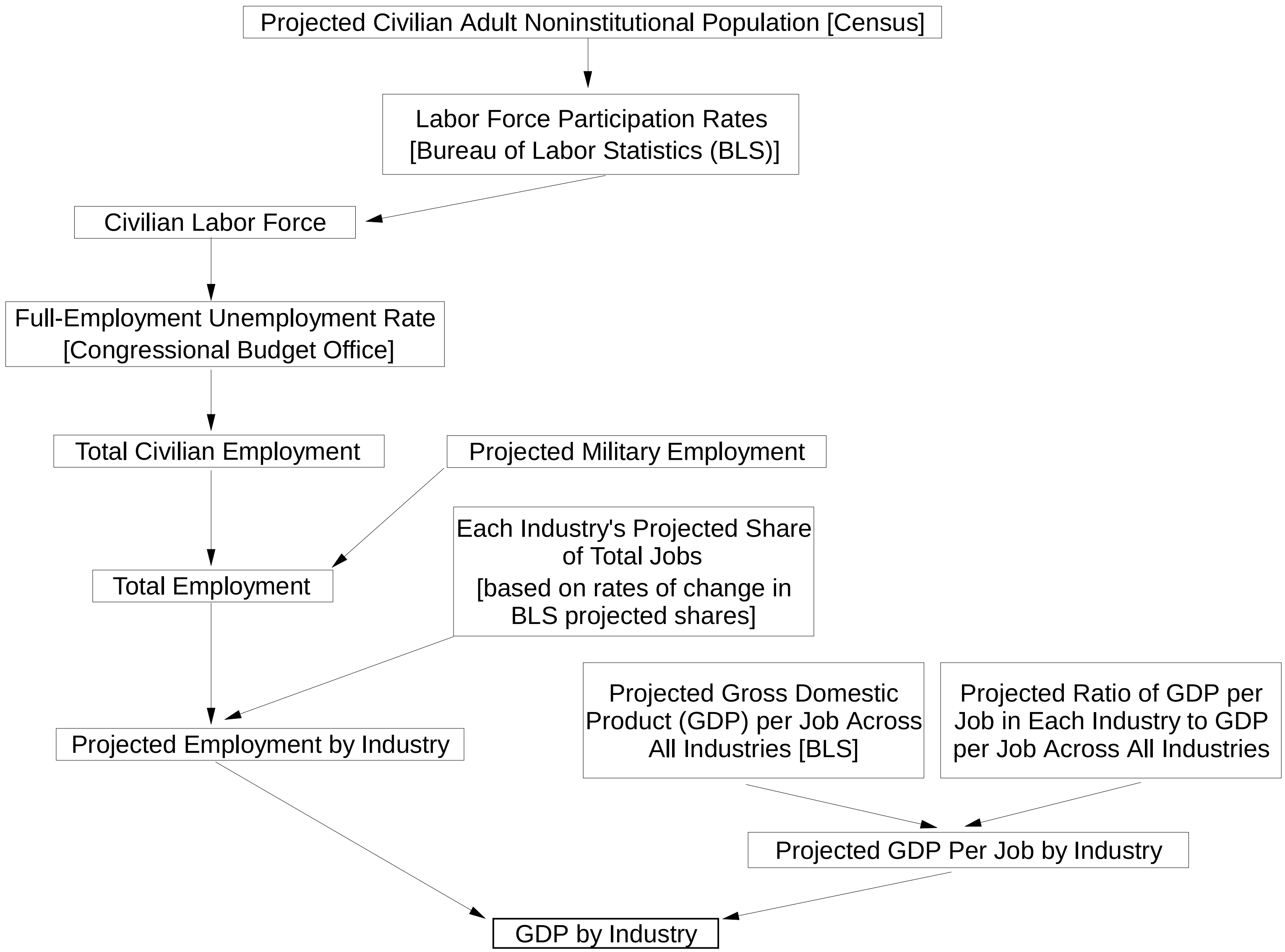

Figure II-1. Steps Employed in Developing BEA's Long-Term National GDP Projections

employment projections. This quotient is the ratio of a nonbasic industry's share of State total employment to that industry's share of National total employment. The projections of the location quotient for each industry are based on historical trends for the industry. Over the projection period, the BEA dampened or reversed the location quotient trend in cases where it had historically diverted from unity.

The projections of total employment for each State are developed from the projections of nonbasic industry location quotients, the projections of basic industry shares of employment in the industry on a National basis, and the projections of National employment by industry. The projections of State-level GSP by industry are prepared in three steps:

(1) Project the ratio of State GSP per job in an industry to National GSP per job in the industry based on historical trends in the ratio;

(2) Multiply the projected ratio in (1) by the projected National GSP per job in the industry to yield the projected State GSP per job in the industry; and

(3) Multiply the projected State GSP per job projected in (2) by the projected State employment in the industry to yield the projected State GSP in the industry.

c. Application of BEA Projections to Nonroad Engine Applications

The BEA State-level projections are an EPA-approved source of data for use in projecting emissions (EPA, 1991a). The BEA projections have been used in a number of EPA studies [such as the Ozone Transport and Assessment Group (OTAG) and Clean Air Act Section 812 studies] to project growth in nonroad engine/vehicle emissions.

The EPA's projections guidance notes that projections of product output (use) represent the best possible data for projecting emissions. Projections of nonroad engine/equipment use are not available. The EPA guidance notes that the next best data source is projections of value added, which is the market value of goods and services produced.[1] As noted above, GSP (value added) projections are available from the BEA. The key to the use of the BEA projections is matching available BEA sectors with nonroad sectors. Table II-2 presents the BEA growth factors used in projecting nonroad emissions for the Clean Air Act Section 812 Prospective Analysis (Pechan, 1997a).

For the Section 812 study, all but four nonroad sectors used State-level GSP data to project nonroad emissions. The GSP data represent the market value of the goods and services produced by the labor and property located in a State, which is the State equivalent of GDP. The table indicates that population data are used to project emissions for some source categories. The assignment of population growth as a surrogate for specific equipment types is based on the notion that there is no industry-specific GSP growth factor that is expected to trend with the activity levels of these equipment types. For example, because most lawn and garden equipment is used by homeowners, and

[1] Other potential methods listed in EPA's projections guidance include use of industrial earnings and employment data.

Table II-2. Bureau of Economic Analysis (BEA) Growth Factors Used to Project Nonroad Emissions in the Clean Air Act Section 812 Prospective Analysis

NONROAD SEGMENT	BEA SECTOR
Airport Service Equipment	Transportation by Air [Standard Industrial Classification (SIC) 45]
Construction Equipment*	Construction (SIC 15, 16, and 17)
Farm Equipment*	Farm (SIC 01)
Industrial Equipment*	Total Manufacturing
Lawn & Garden Equipment*	Population
Light Commercial Equipment	Total Manufacturing
Logging Equipment	Agricultural Services, Forestry, Fisheries (SIC 07, 08, and 09)
Recreational Marine Vessels	Population
Commercial Marine Vessels	Water Transportation (SIC 44)
Recreational Vehicles*	Population
Military Aircraft	Federal, Military
Commercial Aircraft	Transportation by Air (SIC 45)
Civil Aircraft	Transportation by Air (SIC 45)
Railroads	Railroad Transportation (SIC 40)

* - Nonroad segment to be included in nonroad engine model; segments to be included in the model that are not shown in this table are: Material Handling; Pumps and Compressors; Welders and Generators; and Marine (applications for these nonroad segments are included in other nonroad segments in this table – e.g., most pumps and compressor applications are included in the light commercial equipment segment).

not by specific sectors in the economy (with the exception of the landscaping industry), population growth was selected as the surrogate for lawn and garden equipment growth. Due to resource constraints associated with projecting every emission source category, the Section 812 study projected emissions at the nonroad segment level, and not the nonroad application level.

Appendix Table A-1 presents a match between PSR nonroad applications and BEA sectors. This match was developed for use in the 1990-1996 retrospective analysis. Because this match was developed at the application level, for some nonroad equipment segments, there is more than one BEA growth factor employed. For example, the General Industrial segment contains equipment that is used in diverse industries. Instead of applying one BEA growth indicator for the General Industrial category, equipment applications are matched to the most relevant industry's growth indicator. For example, refrigeration/air conditioning equipment is matched with the food manufacturing industry.

2. E-GAS

The E-GAS is an EPA-developed model originally designed to provide growth factors for use in forecasting volatile organic compound (VOC), oxides of nitrogen (NO_x), and carbon monoxide (CO) emissions for ozone nonattainment and attainment areas. The source-specific growth factors generated by E-GAS can serve as input to the Emissions Preprocessor System (EPS) for the Urban Airshed Model (EPA, 1995). The model consists of three-tiers: a National economic tier, a regional economic tier, and a growth factor tier, which are described below.

a. National Economic Tier

To begin running the E-GAS model, it is necessary to specify one of two National macroeconomic forecasts: the Wharton Econometric Forecast Associates (WEFA) forecast or the BLS forecast. The BLS forecast is calibrated to include the current National business cycles using the latest National forecast from the University of Michigan's Research Seminar in Quantitative Economics. The WEFA produces quarterly forecasts under low growth, base case, high growth, and cyclical growth scenarios (the base case forecast is incorporated into E-GAS). Due to its structure, the regional forecasts from E-GAS maintain a consistent assumption about National economic growth.

b. Regional Economic Tier

Output from E-GAS' National tier becomes input into the regional tier, which incorporates regional models developed by Regional Economic Models, Inc. (REMI). The regional economic tier consists of dynamic regional models that simulate the interaction between 14 major sectors of the economy to produce estimates of employment and value added for 210 sectors of the economy. The regional economic tier permits growth factors to differ between rural and urban areas by developing separate forecasts for ozone nonattainment and attainment areas of each State. Information on local policies can be directly entered into E-GAS, permitting assessment of the effects of nonattainment area policies on surrounding areas.

c. Growth Factor Tier

Regional economic tier output becomes input into the growth factor tier. This tier consists of several modules, including:

- A fuel choice module;
- A utility energy module;
- A vehicle miles traveled (VMT) module; and
- A physical output module.

The growth factor tier also includes a crosswalk that translates growth factors from the above modules into growth by source category code (SCC). This crosswalk is important because most emission inventories are categorized by SCC. Outputs from the regional economic tier are used to produce sub-State-level estimates of fuel consumption, VMT, and physical output. For the larger VOC-emitting sources, the physical output module projects growth in physical output from value added estimates generated by the regional economic tier. For nonroad engine application SCCs, E-GAS growth factors are generally based on the value added projections from REMI's regional models.

d. Application of E-GAS Projections to Nonroad Engine Applications

Although the original purpose of E-GAS was to develop factors for projecting VOC, NO_x, and CO emissions, the nonroad sector E-GAS factors are not pollutant-specific, and therefore can be used to project all pollutants. Appendix Table A-2 displays the E-GAS growth indicators for the nonroad segments/applications of interest in this study. For the most part, the correspondence between SCCs and PSR applications was developed by EPA. Appendix A provides further details on how these two were matched.

3. CARB

The CARB is developing a new model of off-road mobile source emissions (OFFROAD), which includes the nonroad applications of interest to EPA. The base year of the model is 1993. The base year populations in the model are derived from PSR and several other data sources, including a series of Booz-Allen & Hamilton, Inc. studies, specific to California. There are 14 general equipment categories included in the CARB inventory model. These 14 equipment categories are:

- Lawn and Garden Equipment;
- Light Commercial Equipment (0-50 hp);
- Recreational Equipment;
- Industrial Equipment;
- Construction and Mining Equipment;
- Farm Equipment;
- Logging Equipment;
- Airport Ground Support Equipment;
- Pleasure Craft;
- Commercial and Government Vessels;
- Transport Refrigeration Units;
- Locomotive and Rail Operations;
- Aircraft: Commercial, Military, and General Aviation; and
- Agricultural Aircraft.

CARB's model includes two equipment categories that are not planned for EPA's model: (1) Aircraft: Commercial, Military, and General Aviation – Landing and Takeoff Operations; and (2) Agricultural Aircraft – Aircraft Operations Below 3,000 feet.

Current plans for CARB's nonroad model are to use growth factors presented in a 1994 California State University at Fullerton (Cal State) report (Agrawal, 1997). These growth factors were developed for each of the 58 counties in the State for the period 1993-2020 based on 1970-1992 historical data (Puri and Kleinhenz, 1994). Projections are based on regression analysis of economic activity data that correspond to the off-road equipment categories included in the study. Table II-3 matches equipment categories with the variables used in developing the regression equations.

Staff at CARB indicated that plans were to replace the Cal State growth factors developed for counties in the South Coast and Bay Area Air Basins with growth factors prepared by the South Coast and Bay Area Air Quality Management Districts. Because work is on-going on the OFFROAD model, CARB has not obtained these growth factors or specifically determined how they will be incorporated into the model. Because the South Coast and Bay Area data and methods are likely to be specific to the counties involved for at least some of the equipment categories, no evaluation of their factors is conducted in this analysis.

Table II-3. Growth Indicators by CARB Off-Road Equipment Category

CARB Off-Road Equipment Category	Growth Indicator/Explanatory Variable(s)
Farm	Constant dollar gasoline and diesel farm fuel expenditures: estimated using farm fuel expenditures in previous 2 periods, plus producer price index for fuel, plus dummy variable to account for unusual events (e.g., Arab oil embargo); gasoline/diesel breakdown based on projected trend in National data from the U.S. Department of Agriculture's (USDA's) *Agricultural Statistics*
Recreational Boats	Gasoline and diesel boat registrations: estimated using State-level population and personal income per capita (county allocations are based on distribution of the Department of Motor Vehicles (DMV) registrations for 1993); gasoline-diesel breakdown is based on observations of typical motor type by size of boat - only about 1% are diesel-powered), a check of data sources indicated that there was no need to adjust registration series to account for counties that may not have boating activity.
Commercial Boats	(Except for offshore oil supply, see recreational boats); Barrels per year of offshore oil production: estimated using State-level producer price index for petroleum, U.S. oil production, real U.S. per capita income, and a dummy variable to account for a structural break in the series (estimates were constrained by level of projected oil reserves), the State-level data were disaggregated to county-level based on share of State-wide oil production in 1992
Recreational Vehicles	All-terrain vehicle (ATV), motorcycle, snowmobile, and 4-wheel drive vehicle registrations: estimated using State-level population and personal income per capita projections (allocated to counties based on the distribution of DMV off-highway vehicle registrations in 1993)
Lawn and Garden	Residential-number of households: estimated using county household projections; Commercial-nominal value of commercial construction: estimated based on the historical relationship between households and construction levels
Non-Farm Equipment (includes mining, logging, construction, commercial and industrial material handling, and material handling in transportation)	Total employment in related industries: used DRI/McGraw-Hill projections of total employment in: Logging (SIC 08); Mining (10); Construction (SICs 15, 16, and 17); Rail Transportation (SIC 40); Trucking and Warehousing (SIC 42); Water Transportation (SIC 44); and Air Transportation (SIC 45). The gasoline-diesel breakdown was projected using a modified moving average and trends in use for two fuels from Department of Energy (DOE) and State of California data
Ships	Shipping employment: DRI/McGraw-Hill employment projections for SIC 44 (Water Transportation)
Civil Aircraft	Flight operations (take-offs and landings): used forecasts of takeoffs and landings by airport from FAA's *Terminal Area Forecasts* for 1993-2005 growth, 2006-2020 growth was projected based on extension of series using the trend in the forecast (other methods were used to disaggregate data into commercial, air taxi, and general aviation categories)
Military Aircraft	(Except for disaggregation, the same as Civil Aircraft)
Locomotives	Railroad employment: DRI/McGraw-Hill employment projections for SIC 40 (Railroad Transportation)

A concordance between the growth factors developed by Cal State and the CARB off-road model equipment categories has not yet been developed (Agrawal, 1997). For the retrospective analysis of alternative projections methods, it is necessary to develop a match between the Cal State growth factors and the equipment categories planned for EPA's nonroad model. Appendix Table A-5 presents the concordance developed for the 1990-1996 retrospective analysis.

Based on draft documentation of the inputs for the CARB model, growth indicators are assumed to equal source population growth rates (EEA, 1997). In order to calculate the model year distribution of engines in future years, engine sales are estimated based on future populations, equipment life, and a number of assumptions. It is important to distinguish growth in source population from growth in sales. Assuming a two percent population growth indicator, for example, the next year's sales increase by the amount which will increase the overall equipment population by two percent. Because of engine retirement, this percentage sales increase will be greater than the overall percentage increase in population. In the example provided in the draft CARB model input documentation, a base population of 100,000, with an equipment life of 10 years, and annual population growth of 2 percent, results in total populations of 102,000, 104,040, and 108,243 in years 1, 2, and 4, respectively; equipment sales in these years are 11,010; 12,058; and 12,214.

This method contrasts with other projection methods; some of which do not calculate engine populations by model year. By applying growth indicators to base year emissions, the Section 812 study and other EPA studies covering all source categories, have assumed growth applies to total activity levels. The algorithm for projecting emissions in the Section 812 study was:

$$EMIS_Y = EMIS_{90} * GFAC_Y * \left[1 - CE_Y * PE_Y\right] \qquad \textbf{(Eq. 2)}$$

where:

$EMIS_Y$ = emissions in projection year y
$EMIS_{90}$ = 1990 emissions
GFAC = growth factor for projection year y
CE_Y = control efficiency for projection year y
PE_Y = penetration rate for projection year y

The control efficiency is a function of the percentage reduction or decrease in emission rate expected through new engine standards and the fraction of emissions covered through fleet turnover. The penetration rate accounts for the fraction of emissions from affected engine types [generally resulting from horsepower (hp) cutoffs] in a broad engine category (e.g., construction). These effects were accounted for in the Section 812 study through the use of fleet average annual emission reduction percentages based on EPA SIP guidance (Lorang, 1994).

The method employed in EPA's large nonroad compression ignition engines (greater than 50 hp) regulatory impact analysis, estimates future year engine populations by model year, and calculates future year populations by applying an annual 2 percent growth factor and engine survival rates to a base year model year population (EPA, 1994a). This method always results in an annual population growth of 2 percent or less (less in earlier years due to the combination of engine survival rates and model year distributions based on actual historical sales data). This projection method contrasts with the CARB approach described above. Employing the EPA method with the assumptions used in the CARB example [i.e., year 0 sales are equal to base population divided by equipment life (100,000/10 years), and the annual economic growth rate is 2 percent)], estimated sales in years 1, 2, and 4 would be 10,200; 10,404; and 10,824 (based on the assumption that economic growth is equal to sales growth). The gap between the CARB and EPA methods' sales estimates continues to increase as additional projection years are estimated.

C. ADDITIONAL PROJECTION METHODS INVESTIGATED

The following discusses three additional potential projection methods: time series regression analysis of fuel sales/consumption data; DOE's Energy Information Administration's (EIA's) *Annual Energy Outlook* fuel use projections; and the BLS' employment/output projections.

1. Time-Series Regression Analysis of Fuel Sales/Consumption

An alternative nonroad projection method is based on the extrapolation of historic trends in fuel consumption. Fuel consumption data are developed by EIA and the Federal Highway Administration (FHWA) by category of use (e.g., marine). Linear regression analysis could be performed on a time series of historic data to predict future sales or consumption of fuel. For the purposes of this discussion, fuel sales and fuel consumption are assumed to correlate with changes in nonroad activity levels.[2]

a. Distillate Fuel Sales

The EIA currently publishes fuel oil sales data in the annual publication, *Fuel Oil and Kerosene Sales, 1988-1995* (EIA, 1996). Formerly, the data were published in *Petroleum Marketing Monthly (1984-1987), Petroleum Supply Annual (1981-1982)*, and *Energy Data Reports (1979-1980)* (EIA, 1988; EIA, 1983; EIA, 1982)). Fuel sales data were collected before 1979, but the development of the Fuel Oil Identification Survey in 1979 coincided with the selection of a more complete and representative sample than prior years. Therefore, any time series used for a regression analysis would use 1979 data as the starting point.

Diesel fuel sales are generally not available; however, diesel sales are reported separately from total distillate sales for the farm and military sectors. Distillate sales volumes for EIA sectors that correspond to several specific nonroad categories (e.g., agriculture, construction, and marine) are available. In addition to diesel fuel, distillate oil includes No. 1 and No. 2 heating oils and No. 4 fuel oil. As with other projection methods, fuel sales data are not available for each specific nonroad application. In these cases, fuel consumption data from a broad category would be assumed to be the best indicator of fuel consumption by a specific nonroad segment. For example, industrial distillate fuel use would be assumed to be the best available surrogate for distillate use in all pump and

[2] To the extent that PSR's historical data can be considered valid, it may be possible to test this assumption by relating the fuel consumption data to historical PSR population/activity data.

compressor applications. Appendix Table A-3 presents a correspondence table between the nonroad segments/applications and the fuel-consuming sectors defined by EIA. This table was developed as part of the retrospective analysis.

b. Gasoline Consumption

Historic nonroad gasoline consumption data are available from Tables MF-21A and MF-24 in the FHWA publication, *Highway Statistics* (FHWA, 1996). Definitions are not provided for the gasoline-consuming sectors reported in *Highway Statistics*. The publication acknowledges that complete and uniform classification of nonhighway use is not possible due to differences among the States as to what classes of nonhighway use are eligible for refunds and exemptions and because some eligible refunds are not applied for. The FHWA notes that nonhighway uses of gasoline were therefore estimated or data were obtained from other sources, which were not specified.

Based on the gasoline-consuming sector descriptions in *Highway Statistics*, Pechan has matched sectors with nonroad segments to be included in EPA's NONROAD model. Appendix Table A-4 lists the best available surrogate reported in *Highway Statistics* for each nonroad segment.

c. Application of Fuel Use Data to Nonroad Equipment

Pechan has compiled historic State-level distillate/diesel sales and gasoline consumption for the nonroad-related sectors of interest. These sectors have been matched to nonroad segments/applications as shown in Tables A-3 and A-4. Time-series regressions could be developed using these National fuel sales/consumption data as the dependent variable and year of data as the independent variable. State-level projections may also be performed and compared to National projections. For the 1990-1996 retrospective analysis, the 1990-1995 average annual growth rate was calculated by consuming sector and State. These growth rates were assumed to reflect the average annual growth rate over the 1990-1996 period, and were applied to the 1990 PSR population data to estimate the 1996 equipment populations. Appendix A provides additional details on the retrospective analysis.

2. *Annual Energy Outlook* Projections

The EIA has developed fuel use projections for each year up to the year 2015 in its *Annual Energy Outlook* (EIA, 1997). These projections generally correspond to very broad categories of fuel consumption – residential, commercial, industrial, transportation, and electric generator use. Because of the lack of detail available in these broad categories, these projections are deemed unsuitable for use in the NONROAD model and are not analyzed further. It should be noted, however, that this report also includes projections of the number of households, which could potentially be used as growth indicators for specific nonroad segments/applications (e.g., lawn and garden equipment).

3. BLS Output/Employment Projections

The BLS compiles output and employment projections for 183 industry sectors that are roughly equivalent to 2- and 3-digit SIC codes. The output is expressed in terms of gross duplicated product, which includes GDP, as well as intermediate goods and services produced for use in further production. These projections are updated every other odd-numbered year in the November issue of *Monthly Labor Review*. The projections have a 10- to 15-year span—currently the forecasts go to 2005.

Because the projections of industry output are available only for the year 2005, a procedure would need to be developed to estimate these values for pre- and post-2005 years. In addition, these projections are only produced on a National level. Because these projections are only available for one year, are only available at a National level, and are not value added measures (since they double-count intermediate goods and services), they are not deemed appropriate for use in the NONROAD model and are not analyzed further.

CHAPTER III
COMPARISON OF ALTERNATIVE PROJECTION METHODS

Nine evaluation criteria have been established to facilitate comparisons between the four alternative potential nonroad activity projection methodologies analyzed in this report. The list of nine criteria can be organized into three major categories: validity, specificity, and ease of implementation. Each of these categories, which are discussed below, are evaluated on a "1" to "3" scale, where a "3" signifies that a method is ranked as "excellent" for that criteria, a "2" indicates that a method is ranked as "satisfactory" for that criteria, a "1" signifies that a method is ranked as "poor" for that criteria.

A. EVALUATION CRITERIA

1. Validity

The criteria under the validity category are used to evaluate the theoretical and empirical legitimacy of the alternative methodologies. Two criteria are evaluated:

Theoretical validity—The soundness of the theoretical basis for each projection methodology is evaluated by this criterion. Questions that are asked in assigning a ranking for this criterion, include: Are the projections based on a defensible and generally accepted forecasting technique? Are the surrogates used in a certain projection method likely to be representative of activity for the nonroad segment or application?

Empirical validity—In order to test the empirical validity of each methodology, a retrospective analysis is conducted that projects 1990 PSR population data to 1996. The performance of each method is assessed by comparing the projection results with actual 1996 PSR population data.

2. Specificity

The specificity category includes the following criteria which are used to determine the ability of the alternative methods to make projections at the most specific level possible:

Geographic specificity—The geographic level of detail for each methodology is assessed under this criterion. For example, projections prepared at a county-level are rated higher than projections only available at a State level.

Source specificity—This criterion evaluates how specific the growth indicator is relative to the emissions source to be projected. For example, some methods provide indicators that apply to PSR's nonroad segments. Nonroad application-specific indicators (e.g., railroad transportation) are preferred over segment-specific indicators (e.g., general industrial).

Temporal specificity—The temporal nature of each projection methodology is assessed under this criterion. Questions that are asked in assigning a ranking for this criterion include: What are the time intervals in the data used to make projections? Will interpolation of data be required to make projections on an annual basis?

3. Ease of Implementation

The criteria under this third category are used to establish the relative level of effort associated with each alternative methodology, and include the following:

Data availability—This criterion measures how readily the data in each projection methodology can be accessed and employed.

Frequency of data updates—This criterion is measured based on how often the projections data are updated to reflect new information (e.g, annually, every 2 years, every 5 years, etc.)?

Documentation—The documentation criterion assesses to what extent the projection data and methods used to develop the data are documented, and thereby facilitate peer review.

Level of effort—This criterion ranks the methods according to the amount of resources (including staff time and purchase of data) expected to be involved in implementing each methodology.

B. DETAILED EVALUATION OF NONROAD PROJECTION ALTERNATIVES

1. BEA Regional Projections

VALIDITY		
Theoretical		2
Empirical		2
	Total Score	4

Theoretical validity—The theoretical validity of the BEA regional projections is assigned a rating of "2." Urging a high theoretical validity ranking are the following: 1) the relatively long period that BEA has been developing regional projections; 2) the use of internal consistency checks between independent sets of projections (e.g., mid-term and long-term) developed in compiling the final set of projections; and 3) the extensive use of BEA's estimates by EPA in past studies. In general, the BEA's long-term projections (2000+) are based on historical economic trends and relationships, the use of econometric models to determine mid-term projections (1995 to 2000), and the use of the mid-term projections as an independent check on the long-term projections. It is also important to note that all of BEA's projections are consistent with National population, labor force, unemployment rate, and mining output forecasts developed by other Federal government agencies. It is important to note that a significant theoretical limitation of the BEA method is that it is based on an *assumed* relationship between particular economic variables and nonroad activity levels.

Empirical validity—In order to test the empirical soundness of each methodology, a retrospective analysis was conducted by projecting the 1990 PSR population data to 1996. Based on the results of this analysis, an overall empirical validity score of "2" is assigned to the BEA projections. Details of this analysis are discussed in Appendix A.

SPECIFICITY		
Geographic		2
Source		1
Temporal		2
	Total Score	5

Geographic specificity—Because BEA GSP data are only available at a State-level, they are assigned a ranking of "2" on the geographic specificity scale. [Although BEA earnings data are available at a more specific level of detail (MSAs) than the BEA GSP projections (States), the earnings data are only available by 1-digit SIC code and EPA guidance notes that earnings data are less preferred than GSP data in projecting emission inventories.]

Source specificity—The BEA projections are roughly equivalent to PSR's nonroad segment-level. There are some instances, however, where they are sufficiently detailed to provide a match with a specific PSR application (e.g., BEA's "transportation by air" category matched with PSR's "aircraft support" application). A ranking of "1" is assigned to the BEA projections for the source specificity criterion.

Temporal specificity—State-level BEA GSP projections are available for 1998, 2000, 2005, 2010, 2015, 2025, and 2045. Because data are not available for every year, it would be necessary to develop estimates in intervening years. In addition, the NONROAD model parameters specified by EPA, call for projection capability up through 2050. Therefore, it would be necessary to extrapolate the BEA series for an additional 5 years. Given these considerations, a temporal specificity ranking of "2" is assigned.

EASE OF IMPLEMENTATION	
Data Availability	3
Frequency of Data Updates	1
Documentation	3
Level of Effort	3
Total Score	10

Data availability—BEA's State GSP projections are readily available in electronic form. They can be purchased in hard-copy form for $14 or on 2 computer diskettes for $40. (Pechan already has these computer diskettes in-house). A data availability ranking of "3" is assigned to this criterion.

Frequency of data updates—In the past, BEA has updated its regional projections series on a five-year cycle. Due to budget cutbacks, however, BEA does not currently plan on updating its GSP regional projections. Therefore, a "1" ranking is assigned for this criterion.

Documentation—The BEA projections methods are well-documented in several Department of Commerce *Survey of Current Business* articles, and have undergone substantial review over the years. Because available documentation will facilitate peer review, a ranking of "3" is assigned for this criterion.

Level of effort—Given the electronic format and availability of a BEA sector/PSR application concordance, developed for the retrospective analysis, the BEA projections are assigned a ranking of "3" for the level of effort criterion.

2. E-GAS Projections

VALIDITY	
Theoretical	2
Empirical	2
Total Score	4

Theoretical—The theoretical validity of the E-GAS regional projections is assigned a rating of "2." This rating is based on a combination of factors. Pointing toward a high theoretical score are: 1) the fact that REMI has been developing and refining its regional modeling techniques over a nearly 20-year period; 2) the dynamic, interlinked modeling approach REMI employs assures that State and National projections are consistent; and 3) validation of the model's construct based on historical analysis (Treyz, Richardson, and Shao, 1992). However, an important theoretical weakness of the model is that it is based on an *assumed* relationship between particular economic variables and nonroad activity levels. For some PSR applications, for example, E-GAS includes separate growth factors by engine cycle or hp range. For example, many of the 2-stroke gasoline farm equipment applications use population as the growth indicator, whereas the 4-stroke gasoline, and diesel use farm value added projections. Based on the E-GAS documentation this assignment was not made based on empirical evidence indicating such a distinction.

Empirical—In order to test the empirical soundness of each methodology, a retrospective analysis was conducted by projecting the 1990 PSR population data to 1996 using E-GAS growth indicators. Based on the results of this analysis, an overall empirical validity score of "2" is assigned to the E-GAS projections. Details of this analysis are discussed in Appendix A.

SPECIFICITY		
Geographic		2
Source		2
Temporal		1
	Total Score	5

Geographic specificity—E-GAS projections are available for ozone nonattainment areas and for the attainment portions of States. This provides some additional detail that is not available from BEA, however a ranking of "2" is assigned for E-GAS geographic specificity because it does not provide county or sub-county level projections.

Source specificity—The E-GAS projections are listed by SCC. However, based on an application of the growth indicators for the retrospective analysis, the projections are not always SCC-specific. For example, E-GAS projections for the same application do not typically differ by fuel type (e.g., gasoline and diesel). Based on this information, the source specificity of E-GAS is considered to be a "2."

Temporal specificity—Current E-GAS projections capability runs up through 2015. Although it is possible to extrapolate the trends in the E-GAS projections out to 2050, this may not be advisable given the long-time frame and elimination of the internal consistency that is built into the REMI model. However, E-GAS has the capability to be updated annually as new National projections are released. A temporal specificity of "1" is assigned to E-GAS based on the availability of annual estimates up through 2015.

EASE OF IMPLEMENTATION	
Data Availability	3
Frequency of Data Updates	2
Documentation	3
Level of Effort	3
Total Score	11

Data availability—The E-GAS model is readily available in electronic form. It can be downloaded from EPA's web site at "http://www.epa.gov/ttn/chief/ei_data.html#psd." A data availability ranking of "3" is therefore assigned for this projection method.

Frequency of data updates—E-GAS has been updated on an irregular schedule. For example, version 2.0 was released in August 1994, version 3.0 was released in August 1995, work is expected to commence in the Fall of 1997 on the next version of E-GAS. Therefore, a "2" ranking is assigned for this criterion.

Documentation—The development of the REMI models that underlie E-GAS is well-documented, and, since REMI documentation has been published in peer-reviewed journals, these models have already undergone substantial review. However, it is not clear that the crosswalk portion of E-GAS has undergone much review. The crosswalk is important for the nonroad sector because most of the nonroad SCC growth indicators are based on value added data which originates at the SIC code level. The SIC-SCC crosswalk, therefore, determines which SIC code data are used as a surrogate for nonroad application data. Because the REMI models themselves are well documented and have undergone peer review, a ranking of "3" is assigned for this criterion.

Level of effort—The current version of E-GAS is available as a menu-driven DOS-oriented model; current plans are to develop a Windows-based model. Given the electronic format and no cost availability of the E-GAS projections, and the availability of a preliminary SCC/PSR concordance developed as part of the retrospective analysis for this project, a ranking of "3" is assigned for the level of effort criterion. (It should be noted that this concordance is not complete, as there are a few SCCs that are not matched to PSR applications.)

3. CARB Nonroad Projections

Chapter II describes the development of nonroad projections developed by California State University at Fullerton for use by CARB. With the exception of the South Coast and Bay Area Air Quality Management Districts, the Cal State growth indicators are planned for use in CARB's OFFROAD model. As described in Chapter II, these projections are often based on data that are specific to California. As such, they can not be directly transferred for use in EPA's NONROAD model. Because of this, the following evaluation is based on the application of CARB's projection method, and not the projections themselves.

In general, CARB's projection method is to employ econometric techniques to statistically relate nonroad activity changes to economic data for which projections are available. The fact that CARB's method has not yet been employed outside of California, creates some difficulties in assigning criteria rankings. For example, data availability can not be accurately assessed until the econometric techniques have been applied on a National basis. In such cases, the criteria ranking is estimated, and identified as lacking the specific information to conclusively rank this criterion.

VALIDITY	
Theoretical	3
Empirical	2
Total Score	5

Theoretical validity—The CARB projections are assigned a theoretical validity of "3" because they are based on sound theory and econometric methods. Unlike the BEA and E-GAS methods, which also use economic data to make activity projections, the CARB method employs statistical analysis to test whether there is a historical relationship between each specific nonroad activity and surrogate economic data. Although the BEA and E-GAS economic output-based methods are theoretically valid, it is likely that variables other than industry output (e.g., personal income for recreational equipment) are better indicators of growth for specific nonroad applications. Until statistical analysis is conducted, it is impossible to determine the variable(s) that provide the best correlation. Because the CARB method requires that such an analysis be conducted, it is rated a "3" on this criterion, versus the "2" ranking that the BEA and E-GAS methods are assigned.

Empirical validity—In order to test the empirical soundness of each methodology, a retrospective analysis was conducted by projecting the 1990 PSR population data for California to 1996 using the county-level CARB growth indicators. Based on the results of this analysis, an overall empirical validity score of "2" is assigned to the CARB projections method. Details of this analysis are discussed in Appendix A.

SPECIFICITY	
Geographic	3
Source	3
Temporal	3
Total Score	9

Geographic specificity—Unlike the other three methods analyzed, CARB's growth indicators are county-specific. Depending on data availability, it may or may not be possible to develop growth indicators at this level for each State using CARB's methods. It is difficult to tell, because some of the data sources were specific to California (e.g., registration data from the State's Department of Motor Vehicles). (In conducting the research for this report, one source of county-level data was identified for agricultural applications – *Census of Agriculture* fuel use.) Because, unlike the other projection methods, CARB's method enables the development of county-level projections, a ranking of "3" is assigned for geographic specificity.

Source specificity—The CARB projections were developed for 10 equipment categories. In some cases, categories are extremely broad (e.g., non-farm equipment). It is likely that more specific projections could be developed. The ability to develop such projections will be constrained by the identification and availability of data that correlates with nonroad application activity. Due to resource constraints, it was not possible to identify such data. For the purpose of this analysis, a ranking of "3" is assumed as data are no less available for this exercise as for any of the other 3 methods evaluated.

Temporal specificity—There is no inherent constraint on the number of years that CARB's methods could be used to project activity. As with all projection methods, of course, the longer the projection period, the more error that is introduced. A ranking of "3" is assigned for temporal specificity.

EASE OF IMPLEMENTATION	
Data Availability	1
Frequency of Data Updates	2
Documentation	3
Level of Effort	1
Total Score	7

Data availability—Without extensive research and regression analysis, it is difficult to determine the extent to which data availability concerns affect the use of CARB's method on a National basis. It is possible that data limitations may constrain the ability to develop statistically significant relationships with variables for which projections are available. Until the analysis is conducted, it is impossible to determine whether this will be a problem. Because of this uncertainty, a preliminary ranking of "1" is assigned for this criterion.

Frequency of data updates—This criterion is assigned a ranking of "2" based on the likely availability of annual data to update the regression equations coupled with the time-consuming nature of the development of revised equations.

Documentation—Documentation for the CARB growth indicators is excellent. However, the documentation ranking must be based on the level of documentation for the application of the CARB method on a National basis. Because this step was beyond the scope of this analysis, the level of documentation for this method can be decided by EPA. A ranking of "3" is assumed in this analysis based on the assumption that EPA will want to facilitate peer review by providing thorough documentation of this method.

Level of effort—There is no question that this method will require the greatest level of effort of all of the projection methods evaluated. This method will require delineating variables to potentially represent each application, researching the availability of data for each variable, and conducting regression analysis for these variables. If the results from initial regressions are unsatisfactory, it may be necessary to develop numerous regressions for each application. A level of effort ranking of "1" is therefore assigned to CARB's methods.

4. Time-Series Regression of Fuel Sales/Consumption Data

VALIDITY		
Theoretical		2
Empirical		1
	Total Score	3

Theoretical validity—The theoretical validity of the use of time series regressions of fuel consumption data is assigned a rating of "2" based on the following considerations. First, at least at the State level, the underlying validity of some of the fuel consumption data are questionable. For example, while 1993 and 1995 gasoline consumption for construction use in Washington State is seven million gallons, in 1994, consumption is zero. Second, time series regression is not as analytically defensible as other regression analyses that explicitly identifies and models the variables that correlate with the phenomena. For example, a time series regression of recreational gasoline use only reflects the historical relationship between time and use, whereas econometric regression relates recreational gasoline with variable(s) that are intuitively related to such use (e.g., real per capita income). For use in projections, econometric regressions can incorporate projections of the independent variables that are statistically related to the dependent variables (e.g., real per capita income), whereas time series regressions are limited to extrapolating the historical trend.

Empirical validity—In order to test the empirical soundness of each methodology, a retrospective analysis was conducted that projects the 1990 PSR population data to 1996 using the average annual growth rates in State-level gasoline and diesel sales/consumption data between 1990 and 1995. Due to time and resource constraints, actual time series regressions were not developed to test the empirical validity of this method. Because time-series regression-based projections simply extrapolate the historical data trend, one expects that the regression-based projections would be less accurate than the use of actual historical 1990 and 1995 fuel use data. Based on the results of the retrospective analysis, an overall empirical validity score of "1" is assigned to the time series regression of fuel use. Details of this analysis are discussed in Appendix A.

SPECIFICITY		
Geographic		2
Source		2
Temporal		2
	Total Score	6

Geographic specificity—The fuel use regression projections are potentially available for each State. However, as mentioned above, some of the fuel use data appear suspect for certain States and time periods. Because of these anomalies, it may be necessary to either estimate data for some years or shorten the time frame on which some State's regressions are run. For the purpose of this analysis, it is assumed that the fuel use regressions would yield projections for each State. Therefore, a ranking of "2" is assigned for geographic specificity.

Source specificity—Except for a couple of fuel use categories, the fuel use regressions can only be matched with broad nonroad segments (see Appendix Tables A-3 and A-4). However, unlike the BEA and E-GAS projections, fuel use regression projections provide the ability to develop separate growth indicators for gasoline and diesel fuel. This would be of particular importance with applications that may be undergoing a significant shift from gasoline use to diesel use. Based on this information, the source specificity of time series fuel use regressions is assigned a ranking of "2."

Temporal specificity—There is no inherent constraint on the number of years that a time series regression could be used to project activity. However, as with all projection methods, the further out one projects, the more error one introduces. This is of particular concern with simple time series regression, where no attempt is made to identify variables that correlate with the activity change, and thus past historical trends are the only determinant in the projections. A temporal specificity of "2" is assigned to the time series regressions of fuel use.

EASE OF IMPLEMENTATION		
Data Availability		2
Frequency of Data Updates		2
Documentation		1
Level of Effort		1
	Total Score	6

Data availability—As discussed earlier, fuel use data to develop time series regressions are readily available in published form from the FHWA's *Highway Statistics* and a series of EIA publications. Before resource constraints precluded development of the regression equations, much of the historical data series had been gathered by Pechan and can be made available to EPA in electronic form. Because some additional data must be compiled before the regressions can be run, a data availability ranking of “2” is assigned for this criterion.

Frequency of data updates—This criterion is assigned a ranking of “2” based on the availability of annual data to update the regression equations coupled with the time-consuming nature of the development of revised equations.

Documentation—Documentation for the EIA estimates is satisfactory (describe here where documentation is and what that documentation says). However, documentation for the FHWA’s gasoline estimates is practically nonexistent. In fact, the only information provided on the data is that because of reporting inconsistencies it was necessary for FHWA to develop some data from sources other than tax revenues and to estimate some data. There is no documentation for the time series regression equations since they have not yet been developed. Therefore, a ranking of “1” is assigned for this criterion.

Level of effort—Assuming that the time series regressions are developed at the State-level (rather than National level), and given the need for data estimation given some State-level data anomalies, a level of effort ranking of “1” is assigned for this criterion.

CHAPTER IV
RECOMMENDATIONS

A. CONCLUSIONS

Table IV-1 summarizes the evaluation of alternative nonroad activity projection methods. Based on the values in Table IV-1, CARB's projection methods are recommended for use in the nonroad study. CARB's projection methods are preferred because they can be developed for the geographic, temporal, and source levels desired for this effort. Such greater detail includes the development of application, fuel-, and county-specific growth indicators that are not available from E-GAS. There are, however, two major concerns associated with the use of CARB's methods:

1) The additional level of effort required to obtain the necessary data and estimate the regression equations; and

2) The possibility that data limitations will constrain the analysis to less than the ideal level of detail.

Table IV-1 also presents the criterion rankings as two subtotals. The first subtotal is the summation of the rankings for the validity and specificity criterion; the second subtotal is the summation of the rankings for the ease of implementation rankings. These subtotals indicate that the CARB methods are the most defensible, but also, because they require the most effort as the indicators need to be developed and tested, are the most time-consuming to implement. It is very difficult to provide an estimate of the level of effort required to develop the econometric projections because the level of detail that they will actually be produced at (e.g., application, county, and fuel type) is unclear since the availability of data and the outcome of the statistical analysis can not be accurately estimated without developing the projections. As a very rough estimate, Pechan suggests that development of the econometric indicators would require at least 500 person-hours.

If resources do not permit the econometric approach, then either the BEA or E-GAS methods provide acceptable alternatives. The BEA methods provide valid estimates that are much less detailed on a source and geographic basis than the econometric estimates are expected to be. However, BEA has projections out to 2045, a much longer time period than E-GAS. Because they are official Federal government economic projections that have been developed and used for many years, they are well-documented and established. However, because they are not expected to be produced in the future, they will not provide a way to update the projections in the future.

The E-GAS methods provide valid, reasonably detailed projections for nonroad categories. E-GAS is an established method; the REMI models that underlie the value added and population projections that are used for the nonroad applications have been tested and peer-reviewed. There are a few issues concerning use of E-GAS that should be addressed, however:

- The E-GAS crosswalk will need to be augmented to include SCCs/equipment applications that have not yet been included (e.g., refrigeration/AC).

- The E-GAS crosswalk should be peer-reviewed concerning which economic growth indicators are assigned to which nonroad applications [e.g., the use of different growth indicators for some 2-stroke gasoline farm equipment (population) versus 4-stroke gasoline farm equipment (farm) should be reviewed].

- E-GAS currently does not provide growth indicators for Alaska and Hawaii; these should either be added to E-GAS or else BEA's GSP indicators could be used;

- E-GAS does not provide county-specific growth indicators (the greatest level of detail in the E-GAS growth indicators is ozone nonattainment versus attainment areas), if no attempt is made to project at the county-level, the base year county proportions will remain static throughout the projection period; and

- E-GAS currently provides growth factors up through 2015; projections would need to be developed for later years to achieve EPA's goal of projecting to 2050.

Table IV-1. Summary Evaluation of Alternative Projection Methods

CRITERION	BEA	E-GAS	FUEL USE	CARB
Theoretical Validity	2	2	2	3
Empirical Validity	2	2	1	2
Geographic Specificity	2	2	2	3
Source Specificity	1	2	2	3
Temporal Specificity	2	1	2	3
Sub-total	9	9	9	14
Data Availability	3	3	2	1
Frequency of Data Updates	1	2	2	2
Documentation	3	3	1	3
Level of Effort	3	3	1	1
Sub-total	10	11	6	7
TOTAL	19	20	15	21

B. ISSUES FOR FURTHER STUDY

1. Distribution of Growth Among Activity Level Components

As alluded to earlier, past projection methodologies have either assumed that growth is attributable to increases in source population, sales (as distinct from increases in source population in that sales includes replacement of retired sources), or total activity level changes. The total activity level assumption is most defensible because average rated hp, annual hours of use, and load factors also may change over time (in fact, PSR updates these values periodically). Unfortunately, data limitations have precluded the projection of each variable into the future. The only source of historical data for these variables that has been identified is PSR's owner/operator survey. For some source categories, additional work may provide insight into trends in each of the four activity level variables, and whether certain readily available economic projections (e.g., industry employment) trend with specific activity level components (e.g., in-use population). For other source categories, historical data may not be available to make these determinations. As noted in the Task 1A report, changes in any of these variables affect equipment turnover, which affects source populations. It may be useful for EPA to determine whether these data can be obtained from PSR, and whether alternative information sources (e.g., trade associations) provide historical data series of these variables.

2. Geographic Detail

It would be best to estimate projections using "bottom-up" methods, wherein projections are based on data specific to each emissions source. Because of the large number of nonroad sources, data and resource constraints preclude this approach. In fact, most of the nonroad equipment categories in the CARB OFFROAD model rely on a "top-down" approach even though the model only requires data for California counties. Data limitations have precluded a county-specific inventory of the following variables that affect nonroad emissions in each county: rated hp; annual hours of use; and load factor. Because of data constraints, past studies have applied National level data for these variables to all U.S. counties. For example, NEVES assumed that average annual hours of use are the same throughout the country.

Except for the CARB method, which is modeled at the county-level, none of the projection methodologies provide the ability to develop individual county-level projections. It is important to note, however, that the CARB projections are often developed at the State-level and then allocated to counties based on the latest historical year's data for the surrogates used in the projections. As part of this effort, Pechan was unable to conduct an exhaustive search for county-level historical data for potential use in developing county-specific projections. However, Pechan has identified fuel use data from the *Census of Agriculture* and the Federal Aviation Administration's *Air Traffic Activity* as two potential county-level data sources. Although the county-level econometric approach is the most defensible, it is resource-intensive.

If resource constraints preclude the county-level econometric approach, two alternative methods can be used to develop county-specific projections from the State-level growth indicators. The first alternative, which is the most analytically rigorous, involves the development of time-series regressions of the ratio of each county's activity to total State activity. The second alternative is the shift-share approach, which is based on the assumption that the historical rate of change in each county's share of State activity will hold over the concomitant projection period. The following equation provides an example of how the shift-share approach would be employed to project county-level activity five years in the future:

$$A_{ic}^{t+5} = A_{ic}^{t} \, (A_{is}^{t+5}/A_{is}^{t}) * [(A_{ic}^{t} / A_{is}^{t}) / (A_{ic}^{t-5}/A_{is}^{t-5})] \qquad \textbf{(Eq. 3)}$$

where A = activity indicator; t = time; i = industry; c = county; and s = state.

The EPA has stipulated the need for projections over the 1990-2050 time period. Because the shift-share approach relies on data for a compatible historical period (i.e., 1930-1990), complete data for implementing this method are not likely to be available. For years before data are available, the shift-share approach would keep the rate of change constant at the value for the final data point available.

When historical county-level data are not available for a particular application, estimating future county shares of State growth will not be an option. In these instances, each county's base year share of State activity would be assumed to stay constant over the projection period (given the fact that some counties are likely to grow much faster than others, this is not likely to be a valid assumption over such a long time frame).

3. Regulatory Effects on Engine Turnover

None of the projection methods analyzed in this report take into account potential regulatory effects on engine turnover. Although the increased cost of new engines due to emission control regulations may create an incentive to increase equipment life, there is no readily available information to characterize this potential effect. As noted above, modeling the effect of regulations on projections is beyond the scope of this analysis. If EPA wants to account for this effect, further efforts will be necessary to characterize the effect that regulations have on each of the activity level components and to incorporate these effects into EPA's NONROAD model.

4. Projection Method Based on PSR Data

As alluded to above in Section 1, the PSR *PartsLink* data base is a potentially rich source of historical data for many activity level variables. The purpose of the retrospective analysis was to compare projections developed from readily available information sources with actual 1990 and 1996 PSR estimates. Therefore, this report did not evaluate the use of PSR data in a separate projections methodology.

After obtaining a consistent set of historical data from PSR, it would be possible to statistically test potential relationships between PSR's data and variables for which projections are available. Any such relationships that are established could then be used to independently project specific activity level variables. For example, industry employment may be found to specifically trend with in-use nonroad populations, while industry output may be correlated with annual average hours of use.

The PSR population data are estimates, which are based on PSR's methods, survey data, and assumptions. Pechan recently conducted a qualitative evaluation of the PSR *PartsLink* data base (Pechan, 1997d). This evaluation was qualitative because of the proprietary nature of the PSR data that underlies its data base. It should be noted that although the PSR data base is the best single-source of nonroad source population and activity level data, Pechan's evaluation recommends a few ways to improve upon PSR's data base.

CHAPTER V
REFERENCES

Agrawal, 1997: Agrawal, Arachana, personal communication with Andy Bollman, E.H. Pechan & Associates, Inc. August 8, 1997.

DOC, 1995: U.S. Department of Commerce, Bureau of Economic Analysis, "Regional and State Projections of Economic Activity and Population to the Year 2005," *Survey of Current Business*. July 1995.

EEA, 1997: Energy and Environmental Analysis, Inc., *Documentation of Input Factors for the New Off-Road Mobile Source Emissions Inventory Model*, Prepared for Air Resources Board, Sacramento, CA. February 1997.

EIA, 1982: U.S. Department of Energy, Energy Information Administration, *Energy Data Reports*, "Deliveries of Fuel Oil and Kerosene," DOE/EIA-0113, Washington, DC. 1982 (and 1981).

EIA, 1983: U.S. Department of Energy, Energy Information Administration, *Petroleum Supply Annual, Volume 1*, DOE/EIA-0340/1, Washington, DC. 1983 (and 1982).

EIA, 1988: U.S. Department of Energy, Energy Information Administration, *Petroleum Marketing Monthly* (various years), DOE/EIA-0380, Washington, DC. 1988 and earlier years.

EIA, 1996: U.S. Department of Energy, Energy Information Administration, *Fuel Oil and Kerosene Sales* (various years), DOE/EIA-0535, Washington, DC. 1996 and earlier years.

EIA, 1997: U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 1997: With Projections to 2015*, DOE/EIA-0383(97), Washington, DC. January 1997.

EPA, 1991a: U.S. Environmental Protection Agency, *Procedures for Preparing Emissions Projections*, EPA-450/4-91-019, Office of Air Quality Planning and Standards, Research Triangle Park, NC. July 1991.

EPA, 1991b: U.S. Environmental Protection Agency, Office of Air and Radiation, *Nonroad Engine and Vehicle Emission Study*, EPA-21A-2001, Ann Arbor, MI. November 1991.

EPA, 1994a: U.S. Environmental Protection Agency, Office of Air and Radiation, "Regulatory Impact Analysis and Regulatory Support Document, Control of Air Pollution; Determination of Significance for Nonroad Sources and Emission Standards for New Nonroad Compression-Ignition Engines at or Above 37 Kilowatts (50 Horsepower)," Washington, DC. May 27, 1994.

EPA, 1994b: U.S. Environmental Protection Agency, Office of Air and Radiation, "Draft Regulatory Impact Analysis and Regulatory Support Document, Control of Air Pollution; Emission Standards for New Nonroad Spark-Ignition Engines at or Below 19 Kilowatts," Washington, DC. April 1994.

EPA, 1995: U.S. Environmental Protection Agency, National Risk Management Research Laboratory, *Economic Growth Analysis System: Version 3.0 Reference Manual*, Final Report, EPA-600/R-95-132a, Research Triangle Park, NC. August 1995.

EPA, 1996: U.S. Environmental Protection Agency, Office of Air and Radiation, "Regulatory Impact Analysis, Control of Air Pollution; Emission Standards for New Nonroad Spark-Ignition Marine Engines," Washington, DC. June 1996.

FHWA, 1996: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (1995 and earlier years), Washington, DC. November 1996 and earlier annual editions.

Lorang, 1994: Lorang, Philip A., "Future Nonroad Emission Reduction Credits for Court-Ordered Nonroad Standards," Memorandum to U.S. Environmental Protection Agency Regional Offices, Office of Air and Radiation, U.S. Environmental Protection Agency. November 17, 1994.

Pechan, 1997a: E.H. Pechan & Associates, Inc., "Emission Projections for the Clean Air Act Section 812 Prospective Analysis," External Review Draft, Prepared for Industrial Economics, Inc., Cambridge, MA. February 12, 1997.

Pechan, 1997b: E.H. Pechan & Associates, Inc., "Ozone Transport Assessment Group (OTAG) Emissions Inventory Development Report, Volume III: Projections and Controls," Draft Report, Prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC. June 1997.

Pechan, 1997c: E.H. Pechan & Associates, Inc., "2010 Clean Air Act Amendment Baseline Emission Projections for the Integrated Ozone, Particulate Matter, and Regional Haze Cost Analysis," Prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Innovative Strategies and Economics Group, Research Triangle Park, NC. July 17, 1997.

Pechan, 1997d: E.H. Pechan & Associates, Inc., "Evaluation of Power Systems Research (PSR) Nonroad Population Data Base," Prepared for U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI. September 1997

Puri and Kleinhenz, 1994: Puri, Anil K. and Robert A. Kleinhenz, California State University at Fullerton, *A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020*, Final Report, Prepared for California Air Resources Board, California Environmental Protection Agency. October 1994.

Smith and Chu, 1994: Smith, A.E. and H.Q. Chu, "Grand Canyon Visibility Transport Commission, County Level Economic Drivers Report," Decision Focus, Incorporated, Mt. View, CA. January 9, 1994.

Treyz, Richardson, and Shao, 1992: Treyz, George I., D.S. Rickman, and G. Shao, "Forecasting and Simulation Model," *International Regional Science Review*, Vol. 14, No. 3. 1992.

APPENDIX A
RETROSPECTIVE ANALYSIS OF ALTERNATIVE PROJECTION METHODS

The purpose of this appendix is to describe the methods employed and the results of a retrospective analysis of the alternative projection methods discussed in this report. Four separate projection methods were tested for their ability to forecast 1990 Power Systems Research (PSR) nonroad populations to 1996:

- Bureau of Economic Analysis' (BEA) most recent regional projections series;
- Economic Growth Analysis System (E-GAS) Version 3.0;
- Department of Energy (DOE)/Federal Highway Administration (FHWA) fuel data; and
- California Air Resources Board (CARB) methods.

As a first step, in-use populations for two years, 1990 and 1996, were obtained from PSR. PSR populations are available by State, nonroad application, fuel type [gasoline, diesel, compressed natural gas (CNG), liquified petroleum gas (LPG)], strokes per cycle for gasoline engines (two versus four), and horsepower range. Due to resource constraints and the fact that three of the four projection methods do not provide hp-specific projections, for the purposes of this analysis, the projections were applied at the application and fuel type levels (and for gasoline engines, at the 2-stroke and 4-stroke engine cycle level).

Growth factors representing the 1990 to 1996 change were then compiled for each projection method. 1990-1996 BEA growth factors were estimated based on gross state product (GSP) projections by industry. The BEA industry used to project growth for each PSR application is presented in Table A-1. Because the latest BEA projections are based off of historical data for 1993 and the first projection year available was 1998, Pechan interpolated the value for 1996 based on the 1993 data and the 1998 data/projection. The annual growth rate between the 1990 historical data and the projected 1996 value was computed and used in the retrospective analysis.

E-GAS contains SCC-specific growth factors that reflect changes in nonroad populations between 1990 and 1996. Table A-2 presents all relevant nonroad SCCs and corresponding PSR applications. The surrogate used by E-GAS to project populations for 1996 is also indicated. The EPA provided Pechan with a file matching most of the PSR equipment application codes with SCCs. The CNG and LPG SCCs within these applications were not included in this concordance, however. For the 1990-1996 retrospective analysis, Pechan assigned growth indicators to these applications based on the growth factors for 4-stroke gasoline engines within each application. For three of the PSR applications (59-Tillers; 70-Chainsaws; and 96-Shredders), there are two SCCs for a given application and fuel type. These two SCCs represent different hp ranges (e.g., one for equipment with less than 5 hp, and one for equipment with more than 5 hp). As described above, Pechan conducted the retrospective analysis using State-level totals across all hp ranges. For the three application/fuel type combinations with more than one SCC, Pechan selected the SCC representing the hp range with the larger 1990 population.

The EPA file did not assign SCCs to PSR's Sailboat Auxiliary (79) and Outboard Engines (99) applications. In addition, the latest version of E-GAS does not have growth factors matched to the following SCCs, which apparently were added after the latest version of E-GAS was developed:

- 12 (Oil Field Equipment);
- 13 (Underground Mine Equipment);
- 14 (Refrigeration/AC);
- 44 (Irrigation Sets); and
- 80 (Railway Maintenance).

Resource constraints precluded the efforts needed to match the above applications to E-GAS growth indicators. To assure that comparisons between the four alternative projection methods are meaningful, Pechan did not project populations for these equipment types using any of the alternative projection methods. In addition, E-GAS does not contain State-specific growth factors for Alaska and Hawaii. As a result, nonroad populations associated with these two States were also excluded from the retrospective analysis.

For the fuel use projections, it was not possible to develop regression equations for each application at either the State or National level because of resource constraints. Fuel use growth factors were calculated by 1) estimating the average annual growth in fuel sales or consumption between 1990 and 1995 (since 1995 is the most current year with published data); 2) adding the annual average growth to the 1995 fuel sales or consumption figure to estimate values for 1996; and 3) developing a growth factor to reflect the change in sales or consumption from 1990 to 1996. Diesel or distillate sales were obtained from DOE's EIA, and gasoline consumption was obtained from the FHWA. The DOE and FHWA categories used as surrogates for PSR diesel and gasoline (as well as CNG and LPG) categories/applications are presented in Tables A-3 and A-4, respectively.

The CARB projections are specific to the 58 counties in California. Therefore, the CARB projections were applied to PSR California source populations at the county-level. This retrospective analysis, therefore, only compares the CARB projection estimates to California estimates from each of the three other projection methods. Table A-5 presents a concordance between CARB's growth indicators and PSR's equipment applications. This concordance was specifically developed for this analysis; CARB has not yet developed a concordance for use with the nonroad equipment applications in their OFFROAD model.

National-level Comparisons

Comparisons between actual (i.e., PSR) and forecasted populations were made for the following fuel/engine types: diesel; 2-stroke gasoline; 4-stroke gasoline; CNG; and LPG. Table A-6 displays the comparison of 1996 PSR national populations with forecasted national populations. CARB projection methods are specific to California, and were therefore not included in this first set of comparisons.

Because the accuracy of the projections at the national level may mask substantially different estimates at the State or application-level, two additional analyses were conducted. For each projection method, separate sets of mean absolute deviations (MADs) were calculated based on the difference between the 1996 PSR data and the projected 1996 values at (1) the State-level; and (2) the application level. The MAD is defined as the average of the absolute deviations of the observed value from the predicted value.

To calculate the MAD for the State-level comparison, the absolute difference between predicted and actual State totals is computed, and these differences are summed and divided by the number of observations (in this case, the number of States). The following equation is used:

$$MAD = \frac{\sum_{s=1}^{n} |A_s - F_s|}{n} \quad \textbf{(Eq. 4)}$$

where: MAD = mean absolute deviation
A_s = 1996 PSR total for each State analyzed
F_s = predicted total for each State analyzed
n = number of States analyzed

PSR populations for each application, including all relevant States, were then compared to forecasted populations. To calculate the MAD for the application-based comparison, the absolute difference between predicted and PSR national application totals is computed, and these differences are summed and divided by the number of PSR applications analyzed:

$$MAD = \frac{\sum_{a=1}^{n} |A_a - F_a|}{n} \quad \textbf{(Eq. 5)}$$

where: MAD = mean absolute deviation
A_a = 1996 PSR national total for each application analyzed
F_a = predicted national total for each application analyzed
n = number of applications analyzed

Table A-7 summarizes the results of the retrospective analysis by comparing populations on a State basis. The sum of deviations (A) is calculated by: 1) first calculating the absolute difference between actual and predicted populations for all applicable equipment types within each State; and 2) adding these absolute differences. The MAD is then calculated by dividing the sum of deviations (A) by the number of States (B). The mean 1996 State population (D) across all applications was computed, and the MAD is expressed as a percentage of the mean 1996 State population in the last column (E). In a similar manner, Table A-8 provides results of the analysis when comparing specific equipment application populations across all States.

For all comparisons except one, both the BEA and E-GAS projections have a smaller MAD than the fuel use projections. The one exception is for application-specific CNG populations. In this case, the FHWA fuel use data were the most accurate predictor for CNG populations as measured by the application-specific MAD. It should again be noted, though, that specific data were not available for CNG and LPG populations (i.e., assumptions were made that changes in gasoline consumption reflected changes in CNG and LPG consumption). Therefore, results of projecting CNG and LPG populations have added uncertainty. When considering all fuel types and all applications, BEA and E-GAS demonstrated better predicting ability than the fuel data.

The above comparisons were made across all PSR applications and market segments. In other words, projection methods were not tested for their ability to project each specific segment/application (e.g., the agricultural segment applications). However, due to marked differences in PSR and predicted populations, one specific case was examined further. 1996 diesel populations projected from DOE data were significantly higher than populations estimated according to BEA and E-GAS. In examining the differences in national PSR and predicted populations within each application, this large deviation appeared to occur primarily in applications projected using data corresponding to DOE's "other off-highway" sector. Growth factors developed for "other off-highway" fuel use were applied to the following equipment types, included in PSR's lawn and garden market segment:

PSR Code	Application Name
56	Snowblower
59	Tillers
63	Lawn/Garden Tractors
66	Leaf Blowers/Vacuums
67	Commercial Turf Equipment
76	Other Lawn and Garden
82	Rear Engine Rider
88	Front Mowers
96	Shredders

An additional comparison for diesel populations was performed across the three various projection methods, excluding the above PSR applications (as well as the original seven applications not represented by E-GAS). Table A-9 presents the results of this analysis when comparing populations according to applications.

According to the results in Table A-9, DOE fuel data are still less accurate than BEA and E-GAS methods for forecasting 1990 diesel populations to 1996. However, the DOE results are now much more comparable to the other methods. Projection method comparisons among the various PSR market segments (e.g., agricultural, construction) may point to one specific projection method that is the most accurate for each. However, when analyzing the methods with respect to all potential nonroad categories that will be included in EPA's future nonroad model, 1990 populations projected using BEA indicators most closely approximated 1996 PSR nonroad engine populations. E-GAS was in many cases equal or only slightly less accurate than BEA in predicting populations.

California Comparisons

Because CARB's projection methodology is only applied to California, a separate set of comparisons were performed to test the ability of each of the four methods to project California equipment populations. Table A-10 compares 1996 PSR national populations with forecasted national populations. Since the data corresponded to only one State, the MADs for each method were only compared by fuel type/application. Table A-11 summarizes the results of the retrospective analysis by comparing MADs calculated across applications. It should be noted that when summed for the State of California, the county-level 1990 application populations used in the CARB methods analysis were slightly different from the 1990 State-level populations used in the retrospective analysis of the other three projection methods. This discrepancy is also indicated in Column D of Table A-11, which shows a slightly different mean 1996 application population for CARB versus the other three methods. Because of time and resource constraints, further examination of the cause for this discrepancy was not possible. Despite these differences, a relative measure of the accuracy of various methods can be estimated by comparing the four methods' MAD as a percentage of the mean 1996 State population.

Table A-11 shows that for diesel populations, the BEA method is a slightly better predictor of 1996 populations than CARB and E-GAS methods. Based on the results for 2-stroke and 4-stroke gasoline applications, the CARB method is by far the most accurate. As with the national comparison, fuel data were determined to be the least accurate for predicting all types of applications for California. BEA and E-GAS were determined to be the most accurate for forecasting CNG and LPG populations, respectively, but the results for these fuel types should be viewed with caution, since growth factors developed for 4-stroke gasoline were applied to these populations.

1990-1996 National Percentage Population Change by Growth Indicator

Table A-12 displays the national percentage population change by growth indicator for 1990-1996. The values in these tables do not represent the indicators employed in the analysis, but rather, were calculated from the projected 1996 equipment populations, which are based on the application of the State-specific growth indicators in the retrospective analysis. Several potential growth indicators are not shown in this table because Pechan did not have 1990 population data for the equipment applications that they would be used to project (e.g., BEA's growth indicator for mining does not appear because Pechan did not have a 1990 source population for the PSR application that this indicator is matched to – underground mine equipment). Because the CARB indicators were county-specific and only applied to the State of California, no composite national growth indicators are shown for these indicators.

Caution should be exercised in making conclusions about the underlying source data from these methods. For example, it is possible that only a few States with high proportions of total national equipment account for some of the large discrepancies in national values between methods. Another possible explanation for wide discrepancies in these national values is how the PSR applications are matched with indicators. For example, although all Tillers were assigned the Population indicator from BEA, E-GAS employs its Farm industry indicator for 4-stroke gasoline Tillers. This distinction is particularly important because Tillers account for more than 65 percent of total equipment assigned to the E-GAS Farm equipment indicator.

Table A-1. BEA Growth Indicators Used in Retrospective Analysis

	PSR APPLICATION		BEA INDUSTRY	
PSR SEGMENT	CODE	DESCRIPTION	CODE	DESCRIPTION
AGRICULTURE	98	2-Wheel Tractors	11	Farm
	55	Ag Mowers	11	Farm
	45	Ag Tractor	11	Farm
	49	Balers	11	Farm
	47	Combines	11	Farm
	44	Irrg Sets	11	Farm
	46	Oth Ag/Eq	11	Farm
	69	Sprayers	11	Farm
	48	Swathers	11	Farm
CONSTRUCTION	37	Bore/Drill Rigs	20	Construction
	57	Cem/Mtr Mixes	20	Construction
	27	Cranes	20	Construction
	31	Crwlr Dozers	20	Construction
	97	Crwlr Loaders	20	Construction
	60	Dumpers/Tenders	20	Construction
	28	Excavators	20	Construction
	24	Forest Equip.	34	Lumber
	30	Graders	20	Construction
	68	Off-Hwy Tractors	20	Construction
	40	Off-Hwy Trucks	20	Construction
	36	Oth Const	20	Construction
	41	Pavers	20	Construction
	35	Paving Eq	20	Construction
	61	Plate Compactors	20	Construction
	39	Rollers	20	Construction
	84	Rough Trn Forklfts	20	Construction
	32	R/T Dozer	20	Construction
	33	R/T Loader	20	Construction
	29	Scrapers	20	Construction
	38	S/S Loader	20	Construction
	95	Tampers/Rammers	20	Construction
	43	Trac/Ldr/Bckhoe	20	Construction
	42	Trenchers	20	Construction
	13	Undrgrnd Mine Equip	15	Mining
GENERAL INDUSTRIAL	81	Aircraft Support	51	Air Transportation
	26	Chippers/Grinders	79	Population
	77	Concrete/Ind Saws	20	Construction
	34	Crush/Proc Equip	20	Construction
	20	Locomotive	47	Railroad Transportation
	12	Oil Fld Eq	17	Oil and Gas Extraction
	74	Oth Gen Indust	21	Manufacturing
	14	Refrigeration/AC	23	Food Manufacturing
	80	Rlwy Maint	47	Railroad Transportation
	21	Scrub Swpr	21	Manufacturing
	62	Spec Veh/Carts	79	Population

Table A-1 (continued)

PSR SEGMENT	PSR APPLICATION CODE	PSR APPLICATION DESCRIPTION	BEA INDUSTRY CODE	BEA INDUSTRY DESCRIPTION
	23	Surfacing Equip	20	Construction
	15	Tact Mil Equip	77	Federal, Military
LAWN AND GARDEN	70	Chainsaws	79	Population
	67	Comm Turf	79	Population
	88	Front Mowers	79	Population
	66	Leaf Blow/Vacs	79	Population
	65	Ln Mowers	79	Population
	63	Ln/Gdn Tractors	79	Population
	76	Oth Ln Gdn	79	Population
	82	Rear Eng Rider	79	Population
	96	Shredders	79	Population
	56	Snowblowers	79	Population
	59	Tillers	79	Population
	53	Trim/Edge/Cutter	79	Population
	75	Wood Spltr	79	Population
MARINE	51	Marine Com	49	Water Transportation
	99	Outboard Engines	79	Population
	50	Powerboats	79	Population
	79	Sailboat Aux	79	Population
MATERIAL HANDLING	64	Aerial Lifts	21	Manufacturing
	18	Forklifts	21	Manufacturing
	19	Oth Mat Hd	21	Manufacturing
	16	Terminal Tractors	51	Air Transportation
PUMPS AND COMPRESSORS	10	Air Compressors	63	Services
	89	Gas Compressors	63	Services
	85	Hyd Power Unit	11	Farm
	58	Pres Washers	63	Services
	11	Pumps	63	Services
RECREATIONAL PRODUCTS	91	All-Terrain Vehicles	79	Population
	94	Golf Carts	79	Population
	93	Mini-Bikes	79	Population
	92	Off-Road Motorcycles	79	Population
	71	Snowmobile	79	Population
WELDERS AND GENERATORS	9	Gentr Sets	63	Services
	73	Lt Plants	20	Manufacturing
	25	Marine Aux	49	Water Transportation
	17	Welders	63	Services

Table A-2. E-GAS Growth Indicators Employed in Retrospective Analysis

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
AG	2265005060	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Irrigation Sets	44		
AG	2260005060	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Irrigation Sets	44		
AG	2270005060	Mobile Sources Off-Highway Vehicle Diesel, Farm Equipment Irrigation Sets	44		
AG	2267005060	Mobile Sources Off-Highway Vehicle LPG, Farm Equipment Irrigation Sets	44		
AG	2268005060	Mobile Sources Off-Highway Vehicle CNG, Farm Equipment Irrigation Sets	44		
AG	2265005015	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Agricultural Tractors	45	Farm	
AG	2267005015	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Agricultural Tractors	45	Farm	1
AG	2268005015	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Agricultural Tractors	45	Farm	1
AG	2270005015	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Agricultural Tractors	45	Farm	
AG	2260005015	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Agricultural Tractors	45	Population	
AG	2268005055	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Other Agricultural Equipment	46	Farm	1
AG	2265005055	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Other Agricultural Equipment	46	Farm	
AG	2270005055	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Other Agricultural Equipment	46	Farm	
AG	2267005055	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Other Agricultural Equipment	46	Farm	1
AG	2260005055	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Other Agricultural Equipment	46	Population	
AG	2268005020	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Combines	47	Farm	1
AG	2267005020	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Combines	47	Farm	1
AG	2270005020	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Combines	47	Farm	
AG	2265005020	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Combines	47	Farm	
AG	2260005020	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Combines	47	Population	
AG	2267005045	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Swathers	48	Farm	1
AG	2265005045	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Swathers	48	Farm	
AG	2268005045	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Swathers	48	Farm	1
AG	2270005045	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Swathers	48	Farm	
AG	2260005045	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Swathers	48	Population	
AG	2265005025	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Balers	49	Farm	
AG	2268005025	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Balers	49	Farm	1
AG	2267005025	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Balers	49	Farm	1
AG	2270005025	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Balers	49	Farm	
AG	2260005025	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Balers	49	Farm	
AG	2265005030	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Agricultural Mowers	55	Farm	
AG	2270005030	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Agricultural Mowers	55	Farm	
AG	2267005030	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Agricultural Mowers	55	Farm	1
AG	2268005030	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Agricultural Mowers	55	Farm	1
AG	2260005030	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Agricultural Mowers	55	Population	

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
AG	2265005035	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Sprayers	69	Farm	
AG	2268005035	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Sprayers	69	Farm	1
AG	2270005035	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Sprayers	69	Farm	
AG	2267005035	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Sprayers	69	Farm	1
AG	2260005035	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Sprayers	69	Population	
AG	2268005010	Mobile Sources Off-Highway Vehicle CNG Farm Equipment 2-Wheel Tractors	98	Farm	1
AG	2267005010	Mobile Sources Off-Highway Vehicle LPG Farm Equipment 2-Wheel Tractors	98	Farm	1
AG	2270005010	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment 2-Wheel Tractors	98	Farm	
AG	2265005010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment 2-Wheel Tractors	98	Farm	
AG	2260005010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment 2-Wheel Tractors	98	Population	
CN	2260009010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Other Underground Mining Equipment	13		
CN	2267009010	Mobile Sources Off-Highway Vehicle LPG Other Underground Mining Equipment	13		
CN	2265009010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Other Underground Mining Equipment	13		
CN	2270009010	Mobile Sources Off-Highway Vehicle Diesel Other Underground Mining Equipment	13		
CN	2268009010	Mobile Sources Off-Highway Vehicle CNG Other Underground Mining Equipment	13		
CN	2260007015	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Logging Equipment Skidders	24	Logging	
CN	2265007015	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Logging Equipment Skidders	24	Logging	
CN	2268007015	Mobile Sources Off-Highway Vehicle CNG Logging Equipment Skidders	24	Logging	1
CN	2270007015	Mobile Sources Off-Highway Vehicle Diesel Logging Equipment Skidders	24	Logging	
CN	2267007015	Mobile Sources Off-Highway Vehicle LPG Logging Equipment Skidders	24	Logging	1
CN	2270002045	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Cranes	27	Construction	
CN	2268002045	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Cranes	27	Construction	1
CN	2260002045	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Cranes	27	Construction	
CN	2267002045	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Cranes	27	Construction	1
CN	2265002045	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Cranes	27	Construction	
CN	2265002036	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Excavators	28	Construction	
CN	2260002036	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Excavators	28	Construction	
CN	2267002036	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Excavators	28	Construction	1
CN	2270002036	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Excavators	28	Construction	
CN	2268002036	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Excavators	28	Construction	1
CN	2268002018	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Scrapers	29	Construction	1
CN	2265002018	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Scrapers	29	Construction	
CN	2270002018	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Scrapers	29	Construction	
CN	2260002018	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Scrapers	29	Construction	
CN	2267002018	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Scrapers	29	Construction	1
CN	2267002048	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Graders	30	Construction	1
CN	2265002048	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Graders	30	Construction	
CN	2270002048	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Graders	30	Construction	
CN	2268002048	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Graders	30	Construction	1

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
CN	2260002048	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Graders	30	Construction	
CN	2260002069	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Crawler Dozer	31	Construction	
CN	2268002069	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Crawler Tractors	31	Construction	1
CN	2267002069	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Crawler Tractors	31	Construction	1
CN	2265002069	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Crawler Tractors	31	Construction	
CN	2270002069	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Crawler Tractors	31	Construction	
CN	2268002063	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Rubber Tire Dozers	32	Construction	1
CN	2265002063	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Rubber Tire Dozers	32	Construction	
CN	2270002063	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Rubber Tire Dozers	32	Construction	
CN	2260002063	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Rubber Tire Dozers	32	Construction	
CN	2267002063	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Rubber Tire Dozers	32	Construction	1
CN	2267002060	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Rubber Tire Loaders	33	Construction	1
CN	2265002060	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Rubber Tire Loaders	33	Construction	
CN	2260002060	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Rubber Tire Loaders	33	Construction	
CN	2268002060	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Rubber Tire Loaders	33	Construction	1
CN	2270002060	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Rubber Tire Loaders	33	Construction	
CN	2267002021	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Paving Equipment	35	Construction	1
CN	2260002021	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Paving Equipment	35	Construction	
CN	2270002021	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Paving Equipment	35	Construction	
CN	2265002021	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Paving Equipment	35	Construction	
CN	2268002021	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Paving Equipment	35	Construction	1
CN	2270002081	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Other Construction Equipment	36	Construction	
CN	2265002081	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Other Construction Equipment	36	Construction	
CN	2268002081	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Other Construction Equipment	36	Construction	1
CN	2260002081	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Other Construction Equipment	36	Construction	
CN	2267002081	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Other Construction Equipment	36	Construction	1
CN	2270002033	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Bore/Drill Rigs	37	Construction	
CN	2260002033	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Bore/Drill Rigs	37	Construction	
CN	2267002033	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Bore/Drill Rigs	37	Construction	1
CN	2265002033	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Bore/Drill Rigs	37	Construction	
CN	2268002033	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Bore/Drill Rigs	37	Construction	1
CN	2268002072	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Skid Steer Loaders	38	Construction	1
CN	2267002072	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Skid Steer Loaders	38	Construction	1

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
CN	2265002072	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Skid Steer Loaders	38	Construction	
CN	2270002072	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Skid Steer Loaders	38	Construction	
CN	2260002072	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Skid Steer Loaders	38	Construction	
CN	2260002015	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Rollers	39	Construction	
CN	2265002015	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Rollers	39	Construction	
CN	2267002015	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Rollers	39	Construction	1
CN	2268002015	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Rollers	39	Construction	1
CN	2270002015	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Rollers	39	Construction	
CN	2265002051	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Off-highway Trucks	40	Construction	
CN	2260002051	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Off-highway Trucks	40	Construction	
CN	2270002051	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Off-highway Trucks	40	Construction	
CN	2267002051	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Off-highway Trucks	40	Construction	1
CN	2268002051	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Off-highway Trucks	40	Construction	1
CN	2265002003	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Asphalt Pavers	41	Construction	
CN	2270002003	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Asphalt Pavers	41	Construction	
CN	2267002003	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Asphalt Pavers	41	Construction	1
CN	2268002003	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Asphalt Pavers	41	Construction	1
CN	2260002003	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Asphalt Pavers	41	Construction	
CN	2260002030	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Trenchers	42	Construction	
CN	2265002030	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Trenchers	42	Construction	
CN	2268002030	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Trenchers	42	Construction	1
CN	2270002030	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Trenchers	42	Construction	
CN	2267002030	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Trenchers	42	Construction	1
CN	2260002066	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Tractors/Loaders/Backhoes	43	Construction	
CN	2265002066	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Tractors/Loaders/Backhoes	43	Construction	
CN	2267002066	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Tractors/Loaders/Backhoes	43	Construction	1
CN	2268002066	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Tractors/Loaders/Backhoes	43	Construction	1
CN	2270002066	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Tractors/Loaders/Backhoes	43	Construction	
CN	2265002042	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Cement & Mortar Mixers	57	Construction	
CN	2270002042	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Cement & Mortar Mixers	57	Construction	
CN	2267002042	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Cement & Mortar Mixers	57	Construction	1
CN	2260002042	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Cement & Mortar Mixers	57	Construction	

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
CN	2268002042	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Cement & Mortar Mixers	57	Construction	1
CN	2265002078	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Dumpers/Tenders	60	Construction	
CN	2268002078	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Dumpers/Tenders	60	Construction	1
CN	2260002078	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Dumpers/Tenders	60	Construction	
CN	2267002078	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Dumpers/Tenders	60	Construction	1
CN	2270002078	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Dumpers/Tenders	60	Construction	
CN	2268002009	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Plate Compactors	61	Construction	1
CN	2267002009	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Plate Compactors	61	Construction	1
CN	2265002009	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Plate Compactors	61	Construction	
CN	2270002009	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Plate Compactors	61	Construction	
CN	2260002009	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Plate Compactors	61	Construction	
CN	2265002075	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Off-Highway Tractors	68	Construction	
CN	2267002075	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Off-Highway Tractors	68	Construction	1
CN	2260002075	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Off-Highway Tractors	68	Construction	
CN	2270002075	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Off-Highway Tractors	68	Construction	
CN	2268002075	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Off-Highway Tractors	68	Construction	1
CN	2265002057	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Rough Terrain Forklifts	84	Construction	
CN	2270002057	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Rough Terrain Forklifts	84	Construction	
CN	2260002057	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Rough Terrain Forklifts	84	Construction	
CN	2267002057	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Rough Terrain Forklifts	84	Construction	1
CN	2268002057	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Rough Terrain Forklifts	84	Construction	1
CN	2270002006	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Tampers/Rammers	95	Construction	
CN	2260002006	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Tampers/Rammers	95	Construction	
CN	2268002006	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Tampers/Rammers	95	Construction	1
CN	2267002006	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Tampers/Rammers	95	Construction	1
CN	2265002006	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Tampers/Rammers	95	Construction	
GI	2267010010	Mobile Sources Off-Highway Vehicle LPG Other Oil Field Equipment	12		
GI	2270010010	Mobile Sources Off-Highway Vehicle Diesel Other Oil Field Equipment	12		
GI	2265010010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Other Oil Field Equipment	12		
GI	2260010010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Other Oil Field Equipment	12		
GI	2268010010	Mobile Sources Off-Highway Vehicle CNG Other Oil Field Equipment	12		
GI	2265003060	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Industrial Equipment AC\Refrigeration	14		
GI	2267003060	Mobile Sources Off-Highway Vehicle LPG Industrial Equipment AC\Refrigeration	14		
GI	2260003060	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Industrial Equipment AC\Refrigeration	14		

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
GI	2268003060	Mobile Sources Off-Highway Vehicle CNG Industrial Equipment AC\Refrigeration	14		
GI	2270003060	Mobile Sources Off-Highway Vehicle Diesel Industrial Equipment AC\Refrigeration	14		
GI	2265003030	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Industrial Equipment Sweepers/Scrubbers	21	Durable & Nondurable Manufacturing	
GI	2260003030	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Industrial Equipment Sweepers/Scrubbers	21	Durable & Nondurable Manufacturing	
GI	2267003030	Mobile Sources Off-Highway Vehicle LPG Industrial Equipment Sweepers/Scrubbers	21	Durable & Nondurable Manufacturing	1
GI	2268003030	Mobile Sources Off-Highway Vehicle CNG Industrial Equipment Sweepers/Scrubbers	21	Durable & Nondurable Manufacturing	1
GI	2270003030	Mobile Sources Off-Highway Vehicle Diesel Industrial Equipment Sweepers/Scrubbers	21	Durable & Nondurable Manufacturing	
GI	2267002024	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Surfacing Equipment	23	Construction	1
GI	2268002024	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Surfacing Equipment	23	Construction	1
GI	2265002024	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Surfacing Equipment	23	Construction	
GI	2260002024	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Surfacing Equipment	23	Construction	
GI	2270002024	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Surfacing Equipment	23	Construction	
GI	2265004065	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Chippers/Stump Grinders	26	Population	
GI	2267004065	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Chippers/Stump Grinders	26	Population	1
GI	2260004065	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Chippers/Stump Grinders	26	Population	
GI	2268004065	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Chippers/Stump Grinders	26	Population	1
GI	2270004065	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Chippers/Stump Grinders	26	Population	
GI	2268002054	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Crushing/Proc. Equipment	34	Construction	1
GI	2260002054	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Crushing/Proc. Equipment	34	Construction	
GI	2267002054	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Crushing/Proc. Equipment	34	Construction	1
GI	2265002054	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Crushing/Proc. Equipment	34	Construction	
GI	2270002054	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Crushing/Proc. Equipment	34	Construction	
GI	2268001060	Mobile Sources Off-Highway Vehicle CNG Recreational Vehicles Specialty Vehicle Carts	62	Population	1
GI	2265001060	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Recreational Vehicles Specialty Vehicle Carts	62	Population	
GI	2270001060	Mobile Sources Off-Highway Vehicle Diesel Recreational Vehicles Specialty Vehicle Carts	62	Population	
GI	2267001060	Mobile Sources Off-Highway Vehicle LPG Recreational Vehicles Specialty Vehicle Carts	62	Population	1
GI	2260001060	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Recreational Vehicles Specialty Vehicle Carts	62	Population	
GI	2270003040	Mobile Sources Off-Highway Vehicle Diesel Industrial Equipment Other General Industrial Equipment	74	Durable & Nondurable Manufacturing	

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
GI	2260003040	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Industrial Equipment Other General Industrial Equipment	74	Durable & Nondurable Manufacturing	
GI	2267003040	Mobile Sources Off-Highway Vehicle LPG Industrial Equipment Other General Industrial Equipment	74	Durable & Nondurable Manufacturing	1
GI	2265003040	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Industrial Equipment Other General Industrial Equipment	74	Durable & Nondurable Manufacturing	
GI	2268003040	Mobile Sources Off-Highway Vehicle CNG Industrial Equipment Other General Industrial Equipment	74	Durable & Nondurable Manufacturing	1
GI	2260002039	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Concrete/Industrial Saws	77	Construction	
GI	2270002039	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Concrete/Industrial Saws	77	Construction	
GI	2268002039	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Concrete/Industrial Saws	77	Construction	1
GI	2265002039	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Concrete/Industrial Saws	77	Construction	
GI	2267002039	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Concrete/Industrial Saws	77	Construction	1
GI	2285002015	Mobile Sources Railroad Diesel Railway Maintenance	80		
GI	2285003015	Mobile Sources Railroad 2-Stroke Gasoline Railway Maintenance	80		
GI	2285006015	Mobile Sources Railroad LPG Railway Maintenance	80		
GI	2285004015	Mobile Sources Railroad 4-Stroke Gasoline Railway Maintenance	80		
GI	2285008015	Mobile Sources Railroad CNG Railway Maintenance	80		
GI	2260008005	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Airport Service Equipment Airport Support Equipment	81	Air Transportation	
GI	2267008005	Mobile Sources Off-Highway Vehicle LPG Airport Service Equipment Airport Support Equipment	81	Air Transportation	1
GI	2270008005	Mobile Sources Off-Highway Vehicle Diesel Airport Service Equipment Airport Support Equipment	81	Air Transportation	
GI	2265008005	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Airport Service Equipment Airport Support Equipment	81	Air Transportation	
GI	2268008005	Mobile Sources Off-Highway Vehicle CNG Airport Service Equipment Airport Support Equipment	81	Air Transportation	1
LG	2260004025	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Trimmers/Edgers/Brush Cutters	53	Population	
LG	2270004025	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Trimmers/Edgers/Brush Cutters	53	Population	
LG	2265004025	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Trimmers/Edgers/Brush Cutters	53	Population	
LG	2267004025	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Trimmers/Edgers/Brush Cutters	53	Population	1
LG	2268004025	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Trimmers/Edgers/Brush Cutters	53	Population	1
LG	2268004035	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Snowblowers	56	Population	1
LG	2260004035	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Snowblowers	56	Population	
LG	2265004035	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Snowblowers	56	Population	
LG	2267004035	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Snowblowers	56	Population	1

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
LG	2270004035	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Snowblowers	56	Population	
LG	2268005040	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Tillers > 5 HP	59	Farm	1
LG	2270005040	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Tillers > 5 HP	59	Farm	
LG	2267005040	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Tillers > 5 HP	59	Farm	1
LG	2265005040	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Tillers > 5 HP	59	Farm	
LG	2260004015	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Rotary Tillers < 5 HP	59	Population	
LG	2268004015	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Rotary Tillers < 5 HP	59	Population	1
LG	2270004015	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Rotary Tillers < 5 HP	59	Population	
LG	2265004015	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Rotary Tillers < 5 HP	59	Population	
LG	2267004015	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Rotary Tillers < 5 HP	59	Population	1
LG	2260005040	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Tillers > 5 HP	59	Population	
LG	2265004055	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Lawn & Garden Tractors	63	Population	
LG	2270004055	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Lawn & Garden Tractors	63	Population	
LG	2268004055	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Lawn & Garden Tractors	63	Population	1
LG	2267004055	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Lawn & Garden Tractors	63	Population	1
LG	2260004055	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Lawn & Garden Tractors	63	Population	
LG	2265004010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Lawn mowers	65	Population	
LG	2270004010	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Lawn mowers	65	Population	
LG	2260004010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Lawn mowers (Residential)	65	Population	
LG	2267004010	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Lawn mowers	65	Population	1
LG	2268004010	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Lawn mowers	65	Population	1
LG	2260004030	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Leafblowers/Vacuums	66	Population	
LG	2270004030	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Leafblowers/Vacuums	66	Population	
LG	2267004030	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Leafblowers/Vacuums	66	Population	1
LG	2265004030	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Leafblowers/Vacuums	66	Population	
LG	2268004030	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Leafblowers/Vacuums	66	Population	1
LG	2265004070	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Commercial Turf Equipment	67	Population	
LG	2260004070	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Commercial Turf Equipment	67	Population	
LG	2270004070	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Commercial Turf Equipment	67	Population	
LG	2268004070	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Commercial Turf Equipment	67	Population	1
LG	2267004070	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Commercial Turf Equipment	67	Population	1

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
LG	2268007005	Mobile Sources Off-Highway Vehicle CNG Logging Equipment Chain Saws > 4 HP	70	Logging	1
LG	2270007005	Mobile Sources Off-Highway Vehicle Diesel Logging Equipment Chain Saws > 4 HP	70	Logging	
LG	2260007005	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Logging Equipment Chain Saws > 4 HP	70	Logging	
LG	2267007005	Mobile Sources Off-Highway Vehicle LPG Logging Equipment Chain Saws > 4 HP	70	Logging	1
LG	2265007005	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Logging Equipment Chain Saws > 4 HP	70	Logging	
LG	2268004020	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Chain Saws < 4 HP	70	Population	1
LG	2260004020	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Chain Saws < 4 HP	70	Population	
LG	2267004020	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Chain Saws < 4 HP	70	Population	1
LG	2265004020	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Chain Saws < 4 HP	70	Population	
LG	2270004020	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Chain Saws < 4 HP	70	Population	
LG	2260004060	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Wood Splitters	75	Population	
LG	2265004060	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Wood Splitters	75	Population	
LG	2270004060	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Wood Splitters	75	Population	
LG	2267004060	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Wood Splitters	75	Population	1
LG	2268004060	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Wood Splitters	75	Population	1
LG	2267004075	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Other Lawn & Garden Equipment	76	Population	1
LG	2260004075	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Other Lawn & Garden Equipment	76	Population	
LG	2265004075	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Other Lawn & Garden Equipment	76	Population	
LG	2270004075	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Other Lawn & Garden Equipment	76	Population	
LG	2268004075	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Other Lawn & Garden Equipment	76	Population	1
LG	2265004040	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Rear Engine Riding Mowers	82	Population	
LG	2267004040	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Rear Engine Riding Mowers	82	Population	1
LG	2268004040	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Rear Engine Riding Mowers	82	Population	1
LG	2270004040	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Rear Engine Riding Mowers	82	Population	
LG	2260004040	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Rear Engine Riding Mowers	82	Population	
LG	2260004045	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Front Mowers	88	Population	
LG	2265004045	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Front Mowers	88	Population	
LG	2270004045	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Front Mowers	88	Population	
LG	2268004045	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Front Mowers	88	Population	1
LG	2267004045	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Front Mowers	88	Population	1
LG	2270007010	Mobile Sources Off-Highway Vehicle Diesel Logging Equipment Shredders > 5 HP	96	Logging	
LG	2267007010	Mobile Sources Off-Highway Vehicle LPG Logging Equipment Shredders > 5 HP	96	Logging	1

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
LG	2260007010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Logging Equipment Shredders > 5 HP	96	Logging	
LG	2268007010	Mobile Sources Off-Highway Vehicle CNG Logging Equipment Shredders > 5 HP	96	Logging	1
LG	2265007010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Logging Equipment Shredders > 5 HP	96	Logging	
LG	2270004050	Mobile Sources Off-Highway Vehicle Diesel Lawn & Garden Equipment Shredders < 5 HP	96	Population	
LG	2267004050	Mobile Sources Off-Highway Vehicle LPG Lawn & Garden Equipment Shredders < 5 HP	96	Population	1
LG	2265004050	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Lawn & Garden Equipment Shredders < 5 HP	96	Population	
LG	2268004050	Mobile Sources Off-Highway Vehicle CNG Lawn & Garden Equipment Shredders < 5 HP	96	Population	1
LG	2260004050	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Lawn & Garden Equipment Shredders < 5 HP	96	Population	
MH	2270008010	Mobile Sources Off-Highway Vehicle Diesel Airport Service Equipment Terminal Tractors	16	Air Transportation	
MH	2260008010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Airport Service Equipment Terminal Tractors	16	Air Transportation	
MH	2265008010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Airport Service Equipment Terminal Tractors	16	Air Transportation	
MH	2267008010	Mobile Sources Off-Highway Vehicle LPG Airport Service Equipment Terminal Tractors	16	Air Transportation	1
MH	2268008010	Mobile Sources Off-Highway Vehicle CNG Airport Service Equipment Terminal Tractors	16	Air Transportation	1
MH	2260003020	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Industrial Equipment Forklifts	18	Durable & Nondurable Manufacturing	
MH	2265003020	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Industrial Equipment Forklifts	18	Durable & Nondurable Manufacturing	
MH	2268003020	Mobile Sources Off-Highway Vehicle CNG Industrial Equipment Forklifts	18	Durable & Nondurable Manufacturing	1
MH	2270003020	Mobile Sources Off-Highway Vehicle Diesel Industrial Equipment Forklifts	18	Durable & Nondurable Manufacturing	
MH	2267003020	Mobile Sources Off-Highway Vehicle LPG Industrial Equipment Forklifts	18	Durable & Nondurable Manufacturing	1
MH	2265003050	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Industrial Equipment Other Material Handling Equipment	19	Durable & Nondurable Manufacturing	
MH	2260003050	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Industrial Equipment Other Material Handling Equipment	19	Durable & Nondurable Manufacturing	
MH	2268003050	Mobile Sources Off-Highway Vehicle CNG Industrial Equipment Other Material Handling Equipment	19	Durable & Nondurable Manufacturing	1
MH	2267003050	Mobile Sources Off-Highway Vehicle LPG Industrial Equipment Other Material Handling Equipment	19	Durable & Nondurable Manufacturing	1
MH	2270003050	Mobile Sources Off-Highway Vehicle Diesel Industrial Equipment Other Material Handling Equipment	19	Durable & Nondurable Manufacturing	
MH	2268003010	Mobile Sources Off-Highway Vehicle CNG Industrial Equipment Aerial Lifts	64	Durable & Nondurable Manufacturing	1
MH	2267003010	Mobile Sources Off-Highway Vehicle LPG Industrial Equipment Aerial Lifts	64	Durable & Nondurable Manufacturing	1

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
MH	2270003010	Mobile Sources Off-Highway Vehicle Diesel Industrial Equipment Aerial Lifts	64	Durable & Nondurable Manufacturing	
MH	2260003010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Industrial Equipment Aerial Lifts	64	Durable & Nondurable Manufacturing	
MH	2265003010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Industrial Equipment Aerial Lifts	64	Durable & Nondurable Manufacturing	
PC	2260006015	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Light Commercial Air Compressors	10	Retail, Wholesale, & Services	
PC	2265006015	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Light Commercial Air Compressors	10	Retail, Wholesale, & Services	
PC	2268006015	Mobile Sources Off-Highway Vehicle CNG Light Commercial Air Compressors	10	Retail, Wholesale, & Services	1
PC	2267006015	Mobile Sources Off-Highway Vehicle LPG Light Commercial Air Compressors	10	Retail, Wholesale, & Services	1
PC	2270006015	Mobile Sources Off-Highway Vehicle Diesel Light Commercial Air Compressors	10	Retail, Wholesale, & Services	
PC	2260006010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Light Commercial Pumps	11	Retail, Wholesale, & Services	
PC	2265006010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Light Commercial Pumps	11	Retail, Wholesale, & Services	
PC	2267006010	Mobile Sources Off-Highway Vehicle LPG Light Commercial Pumps	11	Retail, Wholesale, & Services	1
PC	2270006010	Mobile Sources Off-Highway Vehicle Diesel Light Commercial Pumps	11	Retail, Wholesale, & Services	
PC	2268006010	Mobile Sources Off-Highway Vehicle CNG Light Commercial Pumps	11	Retail, Wholesale, & Services	1
PC	2265006030	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Light Commercial Pressure Washers	58	Retail, Wholesale, & Services	
PC	2267006030	Mobile Sources Off-Highway Vehicle LPG Light Commercial Pressure Washers	58	Retail, Wholesale, & Services	1
PC	2270006030	Mobile Sources Off-Highway Vehicle Diesel Light Commercial Pressure Washers	58	Retail, Wholesale, & Services	
PC	2268006030	Mobile Sources Off-Highway Vehicle CNG Light Commercial Pressure Washers	58	Retail, Wholesale, & Services	1
PC	2260006030	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Light Commercial Pressure Washers	58	Retail, Wholesale, & Services	
PC	2265005050	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Farm Equipment Hydro Power Units	85	Farm	
PC	2267005050	Mobile Sources Off-Highway Vehicle LPG Farm Equipment Hydro Power Units	85	Farm	1
PC	2268005050	Mobile Sources Off-Highway Vehicle CNG Farm Equipment Hydro Power Units	85	Farm	1
PC	2270005050	Mobile Sources Off-Highway Vehicle Diesel Farm Equipment Hydro Power Units	85	Farm	
PC	2260005050	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Farm Equipment Hydro Power Units	85	Population	
PC	2265006020	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Light Commercial Gas Compressors	89	Retail, Wholesale, & Services	
PC	2260006020	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Light Commercial Gas Compressors	89	Retail, Wholesale, & Services	
PC	2270006020	Mobile Sources Off-Highway Vehicle Diesel Light Commercial Gas Compressors	89	Retail, Wholesale, & Services	
PC	2268006020	Mobile Sources Off-Highway Vehicle CNG Light Commercial Gas Compressors	89	Retail, Wholesale, & Services	1
PC	2267006020	Mobile Sources Off-Highway Vehicle LPG Light Commercial Gas Compressors	89	Retail, Wholesale, & Services	1
RP	2268001020	Mobile Sources Off-Highway Vehicle CNG Recreational Vehicles Snowmobiles	71	Population	1
RP	2260001020	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Recreational Vehicles Snowmobiles	71	Population	
RP	2265001020	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Recreational Vehicles Snowmobiles	71	Population	
RP	2267001020	Mobile Sources Off-Highway Vehicle LPG Recreational Vehicles Snowmobiles	71	Population	1
RP	2270001020	Mobile Sources Off-Highway Vehicle Diesel Recreational Vehicles Snowmobiles	71	Population	
RP	2270001030	Mobile Sources Off-Highway Vehicle Diesel Recreational Vehicles All Terrain Vehicles	91	Population	
RP	2268001030	Mobile Sources Off-Highway Vehicle CNG Recreational Vehicles All Terrain Vehicles	91	Population	1
RP	2260001030	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Recreational Vehicles All Terrain Vehicles	91	Population	

Table A-2 (continued)

SEGMENT	SCC	SCC DESCRIPTION	PSR CODE	GROWTH INDICATOR	NOTES
RP	2267001030	Mobile Sources Off-Highway Vehicle LPG Recreational Vehicles All Terrain Vehicles	91	Population	1
RP	2265001030	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Recreational Vehicles All Terrain Vehicles	91	Population	
RP	2267001010	Mobile Sources Off-Highway Vehicle LPG Recreational Vehicles Motorcycles: Off-Road	92	Population	1
RP	2268001010	Mobile Sources Off-Highway Vehicle CNG Recreational Vehicles Motorcycles: Off-Road	92	Population	1
RP	2265001010	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Recreational Vehicles Motorcycles: Off-Road	92	Population	
RP	2260001010	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Recreational Vehicles Motorcycles: Off-Road	92	Population	
RP	2270001010	Mobile Sources Off-Highway Vehicle Diesel Recreational Vehicles Motorcycles: Off-Road	92	Population	
RP	2267001040	Mobile Sources Off-Highway Vehicle LPG Recreational Vehicles Minibikes	93	Population	1
RP	2270001040	Mobile Sources Off-Highway Vehicle Diesel Recreational Vehicles Minibikes	93	Population	
RP	2260001040	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Recreational Vehicles Minibikes	93	Population	
RP	2265001040	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Recreational Vehicles Minibikes	93	Population	
RP	2268001040	Mobile Sources Off-Highway Vehicle CNG Recreational Vehicles Minibikes	93	Population	1
RP	2270001050	Mobile Sources Off-Highway Vehicle Diesel Recreational Vehicles Golf Carts	94	Population	
RP	2268001050	Mobile Sources Off-Highway Vehicle CNG Recreational Vehicles Golf Carts	94	Population	1
RP	2267001050	Mobile Sources Off-Highway Vehicle LPG Recreational Vehicles Golf Carts	94	Population	1
RP	2260001050	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Recreational Vehicles Golf Carts	94	Population	
RP	2265001050	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Recreational Vehicles Golf Carts	94	Population	
WG	2270006005	Mobile Sources Off-Highway Vehicle Diesel Light Commercial Generator Sets	9	Retail, Wholesale, & Services	
WG	2265006005	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Light Commercial Generator Sets	9	Retail, Wholesale, & Services	
WG	2267006005	Mobile Sources Off-Highway Vehicle LPG Light Commercial Generator Sets	9	Retail, Wholesale, & Services	1
WG	2268006005	Mobile Sources Off-Highway Vehicle CNG Light Commercial Generator Sets	9	Retail, Wholesale, & Services	1
WG	2260006005	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Light Commercial Generator Sets	9	Retail, Wholesale, & Services	
WG	2270006025	Mobile Sources Off-Highway Vehicle Diesel Light Commercial Welders	17	Retail, Wholesale, & Services	
WG	2265006025	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Light Commercial Welders	17	Retail, Wholesale, & Services	
WG	2260006025	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Light Commercial Welders	17	Retail, Wholesale, & Services	
WG	2268006025	Mobile Sources Off-Highway Vehicle CNG Light Commercial Welders	17	Retail, Wholesale, & Services	1
WG	2267006025	Mobile Sources Off-Highway Vehicle LPG Light Commercial Welders	17	Retail, Wholesale, & Services	1
WG	2265002027	Mobile Sources Off-Highway Vehicle Gasoline, 4-Stroke Construction Equipment Signal Boards	73	Construction	
WG	2267002027	Mobile Sources Off-Highway Vehicle LPG Construction Equipment Signal Boards	73	Construction	1
WG	2260002027	Mobile Sources Off-Highway Vehicle Gasoline, 2-Stroke Construction Equipment Signal Boards	73	Construction	
WG	2268002027	Mobile Sources Off-Highway Vehicle CNG Construction Equipment Signal Boards	73	Construction	1
WG	2270002027	Mobile Sources Off-Highway Vehicle Diesel Construction Equipment Signal Boards	73	Construction	

Notes: 1 - Used growth indicator for SCC associated with 4-stroke gasoline within same type of equipment; for example, for 2267006005 (LPG light commercial generator sets) used 2265006005 (gasoline, 4-stroke light commercial generator sets)
Only those PSR applications with a 1990 and/or 1996 equipment population have growth indicators listed in this table.

Key: AG Agriculture
CN Construction

Table A-2 (continued)

GI	General Industrial
LG	Lawn and Garden
MR	Marine
MH	Material Handling
OT	Other
PC	Pumps and Compressors
RP	Recreational Products
WG	Welders and Generators

Table A-3. Correspondence Between PSR Nonroad Segments/Applications and Energy Information Administration Distillate Fuel Oil-Consuming Sectors

PSR Segment[1]	PSR Application	Corresponding EIA Sector	EIA Sector Definitions
Agriculture	All	Farm[2]	Includes sales for use in tractors, irrigation pumps and other agricultural machinery, as well as fuel used for crop drying, smudge pot fuel, space heating of buildings (including farm houses), cooking, and any other use by the agriculture industry.
Construction	All	Off-highway: Construction	Includes sales for use in construction equipment such as earthmoving equipment, road-building equipment, cranes, stationary generators, air compressors, etc.
General Industrial	Oil Field Equipment	Oil Company	Includes sales for operation of drilling equipment, other field or refinery operations, and space heating at petroleum refineries, pipeline companies, and oil-drilling companies.
	Railway Maintenance; Locomotive[3]	Railroad	Includes sales for fueling trains, operating railroad equipment, space heating of buildings, and other operations.
	Tactical Military Equipment[3]	Military[2]	Includes sales for operation of machinery, space heating, fueling of vessels and trucks, and other operations by the U.S. Armed Forces.
	All other	Industrial	Includes sales to mines, smelters, and plants engaged in producing manufactured products, processing and assembling goods, etc. Also includes space heating, but excludes oil company use.
Material Handling Pumps/Compressors Welders/Generators	All All All	Industrial	Includes sales to mines, smelters, and plants engaged in producing manufactured products, processing and assembling goods, etc. Also includes space heating, but excludes oil company use.
Lawn & Garden	All	Off-highway: Other	Includes sales for off-highway uses other than construction, including logging.
Recreational Products	All	NA[4]	
Marine	All	Vessel bunkering	Includes sales for the fueling of commercial or private boats, such as pleasure craft, fishing boats, tugboats, and ocean-going vessels, including vessels operated by oil companies.

[1]Nonroad segments defined according to Power Systems Research (PSR) classification.
[2]Diesel-specific sales data are available for this application.
[3]PSR data do not show a population estimate for this application.
[4]Not applicable. According to PSR, no diesel engine applications fall within this category.

Table A-4. Correspondence Between Nonroad Segments and Gasoline-Consuming Sectors Reported in *Highway Statistics*

Nonroad Segment[1]	Corresponding Highway Statistics Sector
Agriculture	Agricultural
Construction	Construction
General Industrial Material Handling Pumps/Compressors Welders/Generators	Industrial & commercial
Lawn & Garden	Public nonhighway
Recreational Products	Public nonhighway
Marine	Marine

[1]Nonroad segments defined according to Power Systems Research (PSR) classification.

Table A-5. CARB Growth Indicators Used in Retrospective Analysis

PSR SEGMENT	PSR CODE	PSR DESCRIPTION	CARB TABLE NO. (GASOLINE)	CARB TABLE NO. (DIESEL)	CARB GROWTH INDICATOR DESCRIPTION
WG	9	Welders and Generators	18	19	Non-farm Equipment
PC	10	Air Compressors	18	19	Non-farm Equipment
PC	11	Pumps	18	19	Non-farm Equipment
GI	12	Oil Field Equipment	18	19	Non-farm Equipment
CN	13	Underground Mine Equip	18	19	Non-farm Equipment
GI	14	Refrigeration/AC	18	19	Non-farm Equipment
GI	15	Tactical Military Equip.	(No PSR population data)		
MH	16	Terminal Tractors	18	19	Non-farm Equipment
WG	17	Welders	18	19	Non-farm Equipment
MH	18	Forklifts	18	19	Non-farm Equipment
MH	19	Other Material Handling	18	19	Non-farm Equipment
GI	20	Locomotive	(No PSR population data)		
GI	21	Scrubber/Sweeper	18	19	Non-farm Equipment
GI	23	Surfacing Equipment	18	19	Non-farm Equipment
CN	24	Forest Equipment	18	19	Non-farm Equipment
WG	25	Marine Auxiliary	(No PSR population data)		
GI	26	Chippers/Grinders	18	19	Non-farm Equipment
CN	27	Cranes	18	19	Non-farm Equipment
CN	28	Excavators	18	19	Non-farm Equipment
CN	29	Scrapers	18	19	Non-farm Equipment
CN	30	Graders	18	19	Non-farm Equipment
CN	31	Crawler Dozers	18	19	Non-farm Equipment
CN	32	R/T Dozer	18	19	Non-farm Equipment
CN	33	R/T Loader	18	19	Non-farm Equipment
GI	34	Crush/Proc Equipment	18	19	Non-farm Equipment
CN	35	Paving Equipment	18	19	Non-farm Equipment
CN	36	Other Construction	18	19	Non-farm Equipment
CN	37	Bore/Drill Rigs	18	19	Non-farm Equipment
CN	38	S/S Loader	18	19	Non-farm Equipment
CN	39	Rollers	18	19	Non-farm Equipment
CN	40	Off-Hwy Truck	18	19	Non-farm Equipment
CN	41	Pavers	18	19	Non-farm Equipment
CN	42	Trenchers	18	19	Non-farm Equipment

Table A-5. (continued)

PSR SEGMENT	PSR CODE	PSR DESCRIPTION	CARB TABLE NO. (GASOLINE)	CARB TABLE NO. (DIESEL)	CARB GROWTH INDICATOR DESCRIPTION
CN	43	Tractor/Loader/Backhoe	18	19	Non-farm Equipment
AG	44	Irrigation Sets	1	2	Farm Equipment
AG	45	Ag Tractor	1	2	Farm Equipment
AG	46	Other Ag/Eq	1	2	Farm Equipment
AG	47	Combines	1	2	Farm Equipment
AG	48	Swathers	1	2	Farm Equipment
AG	49	Balers	1	2	Farm Equipment
MR	50	Powerboats	(No PSR population data)		
MR	51	Marine Commercial	(No PSR population data)		
LG	53	Trim/Edge/Cutter	16	17	Lawn and Garden (16-residential, 17-commercial)
AG	55	Ag Mowers	1	2	Farm Equipment
LG	56	Snowblower	16	17	Lawn and Garden (16-residential, 17-commercial)
CN	57	Cem/Mtr Mixers	18	19	Non-farm Equipment
PC	58	Pres Washers	18	19	Non-farm Equipment
LG	59	Tillers	16	17	Lawn and Garden (16-residential, 17-commercial)
CN	60	Dumpers/Tenders	18	19	Non-farm Equipment
CN	61	Plate Compactors	18	19	Non-farm Equipment
GI	62	Spec Veh/Carts	18	19	Non-farm Equipment
LG	63	Ln/Gdn Tractors	16	17	Lawn and Garden (16-residential, 17-commercial)
MH	64	Aerial Lifts	18	19	Non-farm Equipment
LG	65	Ln Mowers	16	17	Lawn and Garden (16-residential, 17-commercial)
LG	66	Leaf Blow/Vacs	16	17	Lawn and Garden (16-residential, 17-commercial)
LG	67	Comm Turf	16	17	Lawn and Garden (16-residential, 17-commercial)
CN	68	Off-Hwy Tractors	18	19	Non-farm Equipment
AG	69	Sprayers	1	2	Farm Equipment
LG	70	Chainsaws	16	17	Lawn and Garden (16-residential, 17-commercial)
RP	71	Snowmobile	14	14	Recreational Vehicles, ATV/Snowmobile
WG	73	Lt Plants	18	19	Non-farm Equipment
GI	74	Oth Gen Industrial	18	19	Non-farm Equipment
LG	75	Wood Spltr	(No PSR population data)		
LG	76	Oth Ln Gdn	16	17	Lawn and Garden (16-residential, 17-commercial)
GI	77	Concrete/Ind Saws	18	19	Non-farm Equipment

Table A-5. (continued)

PSR SEGMENT	PSR CODE	PSR DESCRIPTION	CARB TABLE NO. (GASOLINE)	CARB TABLE NO. (DIESEL)	CARB GROWTH INDICATOR DESCRIPTION
MR	79	Sailboat Aux	9	10	Recreational Boats
GI	80	Rlwy Maintenance	21	21	Locomotives
GI	81	Aircraft Support	3	3	Civil Aircraft, Jet
LG	82	Rear Eng Rider	16	17	Lawn and Garden (16-residential, 17-commercial)
CN	84	Rough Trn Forklifts	18	19	Non-farm Equipment
PC	85	Hyd Power Unit	18	19	Non-farm Equipment
LG	88	Front Mowers	16	17	Lawn and Garden (16-residential, 17-commercial)
PC	89	Gas Compressors	18	19	Non-farm Equipment
RP	91	All-Terrain Vehicles	14	14	Recreational Vehicles, ATV/Snowmobile
RP	92	Off-Road Motorcycles	14	14	Recreational Vehicles, ATV/Snowmobile
RP	93	Mini-Bikes	(No PSR population data)		
RP	94	Golf Carts	14	14	Recreational Vehicles, ATV/Snowmobile
CN	95	Tampers/Rammers	18	19	Non-farm Equipment
LG	96	Shredders	16	17	Lawn and Garden (16-residential, 17-commercial)
CN	97	Crawler Loaders	(No PSR population data)		
AG	98	2-Wheel Tractors	1	2	Farm Equipment
MR	99	Outboard Engines	9	10	Recreational Boats

Note: Although each application that is matched in this table, shows both a gasoline and diesel match, according to the PSR data base, there may not always be both gasoline and diesel equipment in each category.

Description of CARB Tables

1 - Farm Equipment, Gasoline (millions of constant dollars)
2 - Farm Equipment, Diesel (millions of constant dollars)
3 - Civil Aircraft, Jet (flight operations)
4 - Civil Aircraft, Piston (flight operations)
5 - Civil Aircraft, Turboprop (flight operations)
6 - Military Aircraft, Jet (flight operations)
7 - Military Aircraft, Piston (flight operations)
8 - Military Aircraft, Turboprop (flight operations)
9 - Recreational Boats, Gasoline (DMV registrations)
10 - Recreational Boats, Diesel (DMV registrations)
11 - Commercial Boats, Gasoline (DMV registrations)
12 - Commercial Boats, Diesel (DMV registrations)
13 - Commercial Boats, Offshore Oil Production (barrels per year)
14 - Recreational Vehicles, ATV/Snowmobiles (DMV registrations)
15 - Recreational Vehicles, 4-Wheel Drive (DMV registrations)
16 - Lawn and Garden Equipment, Commercial (commercial construction dollars)
17 - Lawn and Garden Equipment, Residential (households)
18 - Non-farm Equipment, Gasoline (employment)
19 - Non-farm Equipment, Diesel (employment)
20 - Shipping (employment)
21 - Locomotive (employment)

Key:

AG Agriculture
CN Construction
GI General Industrial
LG Lawn and Garden
MR Marine
MH Material Handling
OT Other
PC Pumps and Compressors
RP Recreational Products
WG Welders and Generators

Table A-6. Comparison of 1996 PSR National Populations with Forecasted Populations

FUEL TYPE	PSR 1996 Population	PSR 1990-1996%	BEA 1996 Population	BEA 1990-1996%	E-GAS 1996 Population	E-GAS 1990-1996%	Fuel Data 1996 Population	Fuel Data 1990-1996%
Diesel	7,350,772	26.9	6,662,752	15.0	6,263,891	8.1	15,019,954	159.2
Gasoline, 4-stroke	68,765,651	18.3	64,469,973	10.9	62,280,719	7.2	46,447,656	-20.1
Gasoline, 2-stroke	61,977,933	16.8	56,728,751	6.9	56,753,755	7.0	39,877,955	-24.8
CNG	52,780	32.4	46,734	17.2	45,153	13.3	48,922	22.7
LPG	120,598	26.5	106,228	11.4	104,728	9.9	136,130	42.8
Total	138,267,734	18.1	128,014,438	9.3	125,448,606	7.1	101,530,617	-13.3
% Difference from 1996 PSR Population	--		-7.4%		-9.3%		-26.6%	

Table A-7. State-Level Comparison of Alternative Projection Methods

Method	Fuel	Sum of Deviations (A)	No. of States (B)	Mean Absolute Deviation (C = A/B)	Mean 1996 State Population (D)	MAD as % of Mean State Population (E=C/D *100)
BEA	Diesel	751,106	49	15,329	150,016	10
E-GAS	Diesel	1,086,881	49	22,181	150,016	15
Fuel Data	Diesel	11,171,702	49	227,994	150,016	152
BEA	Gasoline, 4-stroke	6,344,297	49	129,475	1,185,615	11
E-GAS	Gasoline, 4-stroke	6,553,923	49	133,754	1,185,615	11
Fuel Data	Gasoline, 4-stroke	25,593,994	49	522,326	1,185,615	44
BEA	Gasoline, 2-stroke	5,295,180	49	108,065	2,383,769	5
E-GAS	Gasoline, 2-stroke	5,346,262	49	109,107	2,383,769	5
Fuel Data	Gasoline, 2-stroke	23,665,449	49	482,968	2,383,769	20
BEA	CNG	6,144	49	125	1,077	12
E-GAS	CNG	7,627	49	156	1,077	14
Fuel Data	CNG	37,035	49	756	1,077	70
BEA	LPG	15,648	49	319	2,461	13
E-GAS	LPG	15,870	49	324	2,461	13
Fuel Data	LPG	91,642	49	1,870	2,461	76

Table A-8. Application-Level Comparison of Alternative Projection Methods

Method	Fuel	Sum of Deviations (A)	No. of Applications (B)	Mean Absolute Deviation (C = A/B)	Mean 1996 Application Population (D)	MAD as % of Mean Appl. Population (E=C/D *100)
BEA	Diesel	974,478	59	16,517	124,589	13
E-GAS	Diesel	1,276,592	59	21,637	124,589	17
Fuel Data	Diesel	11,044,270	59	187,191	124,589	150
BEA	Gasoline, 4-stroke	10,216,825	58	176,152	1,403,381	13
E-GAS	Gasoline, 4-stroke	10,302,442	58	177,628	1,403,381	13
Fuel Data	Gasoline, 4-stroke	23,428,927	58	403,947	1,403,381	29
BEA	Gasoline, 2-stroke	10,158,133	26	390,697	1,264,857	31
E-GAS	Gasoline, 2-stroke	10,171,508	26	391,212	1,264,857	31
Fuel Data	Gasoline, 2-stroke	22,635,440	26	870,594	1,264,857	69
BEA	CNG	12,753	4	3,188	13,195	24
E-GAS	CNG	13,884	4	3,471	13,195	26
Fuel Data	CNG	10,551	4	2,638	13,195	20
BEA	LPG	16,862	9	1,874	13,400	14
E-GAS	LPG	17,060	9	1,896	13,400	14
Fuel Data	LPG	25,987	9	2,887	13,400	22

Table A-9. Comparison of PSR and Predicted Diesel Populations, Excluding PSR Applications Matched to DOE's Off-Highway Distillate Sales Category

1996 Population Source	1996 National Diesel Population	Mean Absolute Deviation[1]
PSR	6,756,516	Not applicable
BEA	6,296,007	14,950
E-GAS	5,896,297	20,997
Fuel Data	5,129,820	34,908

[1]The number of applications used to calculate the MAD was 50.

Table A-10. Comparison of 1996 PSR California Populations with Forecasted Populations

	PSR		CARB		BEA		E-GAS		Fuel Data	
FUEL TYPE	1996 Population	1990-1996%	1996 Population	1990-1996%	1996 Population	1990-1996%	1996 Population	1990-1996%	1996 Population	1990-1996%
Diesel	944,102	25.7	769,134	2.4	832,716	10.9	768,265	2.3	291,606	-61.2
Gasoline, 4-stroke	7,164,398	18.4	6,661,295	10.0	6,587,309	8.8	6,448,750	6.5	3,666,744	-39.4
Gasoline, 2-stroke	7,658,585	16.4	7,441,025	13.1	7,162,589	8.8	7,026,746	6.8	4,045,046	-38.5
CNG	4,706	34.6	2,762	-21.0	3,862	10.5	3,659	4.7	1,302	-62.7
LPG	12,389	25.9	8,751	-11.1	9,910	0.7	10,297	4.6	3,666	-62.8
Total	15,784,180	17.8	14,882,967	11.1	14,596,386	8.9	14,257,718	6.4	8,008,363	-40.2
% Difference from 1996 PSR Population	--		-5.7%		-7.4%		-9.3%		-26.6%	

Table A-11. Application-level Comparison of Alternative Projection Methods for California

Method	Fuel	Sum of Deviations (A)	No. of Applications (B)	Mean Absolute Deviation (C = A/B)	Mean 1996 Application Population	MAD as % of Mean Appl. Population
BEA	Diesel	111,386	59	1,888	16,002	12%
CARB	Diesel	143,045	59	2,424	15,461	16%
E-GAS	Diesel	175,837	59	2,980	16,002	19%
Fuel Data	Diesel	652,496	59	11,059	16,002	69%
CARB	Gasoline, 4-stroke	286,256	57	5,022	121,887	4%
BEA	Gasoline, 4-stroke	577,089	58	9,950	123,524	8%
E-GAS	Gasoline, 4-stroke	715,648	58	12,339	123,524	10%
Fuel Data	Gasoline, 4-stroke	3,497,654	58	60,304	123,524	49%
CARB	Gasoline, 2-stroke	24,105	26	927	287,120	0%
BEA	Gasoline, 2-stroke	495,996	26	19,077	294,561	6%
E-GAS	Gasoline, 2-stroke	631,839	26	24,301	294,561	8%
Fuel Data	Gasoline, 2-stroke	3,613,539	26	138,982	294,561	47%
BEA	CNG	844	4	211	1,177	18%
E-GAS	CNG	1,047	4	262	1,177	22%
CARB	CNG	1,404	4	351	1,042	34%
Fuel Data	CNG	3,404	4	851	1,177	72%
E-GAS	LPG	2,092	8	262	1,549	17%
BEA	LPG	2,479	8	310	1,549	20%
CARB	LPG	3,286	8	469	1,720	27%
Fuel Data	LPG	8,723	8	1,090	1,549	70%

Table A-12. 1990-1996 National Percentage Population Change by Growth Indicator

Growth Indicator	BEA	E-GAS	DOE (Diesel only)	FHWA (Gasoline only)
Air Transportation	36.7	14.0		
Construction	7.2	5.8	7.2	-8.1
Farm (Agriculture)	19.6	7.2	-5.7	76.1
Industrial			-21.3	
Industrial/Commercial				25.6
Logging		8.2		
Lumber	-4.3			
Manufacturing (Durable and Nondurable Manufacturing)	11.0	9.7		
Off-Highway			2,774.7	
Population	6.8	6.8		
Public Nonhighway				-24.8
Services	17.2			
Retail, Wholesale, and Services		12.9		