APPENDIX B – EPA NONROAD MODEL DESCRIPTION

A. Background

The NONROAD model provides a tool for EPA, States, regional air pollution organizations, and local air pollution control agencies to use in estimating pollution from nonroad vehicles and equipment for State Implementation Plans (SIPs), as required by the 1990 Clean Air Act Amendments, and other regulatory needs. NONROAD2005 is the latest version of the model, which calculates past, present and future emission inventories (in terms of tons of pollutants of pollutants) for all nonroad equipment categories except commercial marine, locomotives, and aircraft. Fuel types included in the model are gasoline, diesel fuel, compressed natural gas (CNG), and liquefied petroleum gas (LPG, or propane). The model estimates exhaust and evaporative hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), particulate matter (PM), sulfur dioxide (SO_2), and carbon dioxide (CO_2). The model user may select a specific geographic area (i.e., national, state, or county) and time period (i.e., annual, monthly, seasonal or daily) for analysis. When used by a person who is competent in understanding vehicle emissions and developing estimates of emission levels, the model can be useful for developing estimates of nonroad vehicle/equipment population and emission inventories, if there are no better information sources (e.g., specific fleet population and hours of use data) available.

The information for this appendix was derived largely from EPA report number EPA4200-R-05-021, *"Geographic Allocation of Nonroad Engine Population Data to the State and County Level"*, December, 2005. The intent of this appendix is to illustrate the process and source information used by NONROAD to develop equipment populations and activity factors that, in turn, are used to calculate emission inventories. Readers can then compare the source data and calculation methodology from NONROAD with other data sources in order to assess alternatives for developing specific nonroad equipment populations and emission inventories, and select the best approach to suit the intended purpose.

With some exceptions, the model uses national engine population data from Power Systems Research (PSR), a company that tracks the sales and populations of all types of engines sold in the U.S. Since PSR also matches the engines to the equipment in which they are used, the term "equipment populations" will be used for the purpose of this discussion. PSR provides the most comprehensive national nonroad equipment population data currently available. PSR updates these data on a yearly basis. In some cases, EPA has used population data from other sources other than PSR when such a source is available and found to be more accurate than the PSR data. For some types of equipment, NONROAD uses equipment sales or population data from industry sources or state registration information.

The PSR database also geographically allocates equipment populations from the national to the county level and then aggregates the county-level populations to generate state totals. However, the methods and data that PSR uses to perform these allocations have only been explained in general terms, since PSR considers their methods to be proprietary information. Since EPA wants the methods that it uses to allocate equipment populations in NONROAD to be fully understood by the public, it was decided to use publicly available data as much as possible to serve as factors to allocate the national PSR equipment populations to the county level. State

and local users may elect to substitute well-documented specific local (i.e., county, nonattainment area) equipment population data gathered by conducting surveys or from some other local source that they believe is more accurate.

B. Allocating Activity Versus Engine Population

One central feature of the NONROAD model is that it uses the same methods to allocate engine populations, engine activity, and engine emissions to specific geographic areas. To the extent that engines are operated at the same power level and for the same number of hours in all areas, the distribution of engine populations will match the distribution of engine activity and engine emissions. In general, population, activity, and emissions will tend to track one another, since emissions are a direct function of engine activity and the conditions that stimulate increased engine activity are likely to stimulate increased engine populations.

In reality, however, the geographic distribution of nonroad engines may differ from the geographic distribution of emissions from those engines. The amount of activity that each piece of nonroad equipment of a given type experiences can vary from area to area as a result of variations in local economies, weather patterns, or other local conditions. For example, agricultural equipment and residential lawnmowers may experience more use per year in areas with longer growing seasons; construction equipment is likely to be used more intensively in areas experiencing an economic boom and less intensively where the economy is not as robust.

Currently, NONROAD is capable of handling only one activity level for each equipment type across all parts of the U.S. As a result, the model uses the same factors to allocate engine populations and their associated activity. Wherever possible, EPA has sought indicators of engine activity, since it is engine activity that results in emissions (except for diurnal and hot soak emissions, which are more closely related to engine populations). In some cases, however, EPA was unable to find a suitable activity indicator and had to rely on population indicators as a surrogate for engine activity.

C. Methodology

NONROAD is designed to use various types of economic and industry information that can be related to equipment population or activity to distribute national equipment populations and their associated activity to the state and county level. For example, commercial equipment is allocated in direct proportion to the number of wholesale employees in each county. This surrogate information constitutes a geographic allocation factor. The model can use a single allocation factor for entire categories of nonroad equipment, or it can use separate factors for one or more equipment types within a category.

The model calculations assume that each piece of equipment of a given type experiences the same annual activity (i.e., hours/year). This reduces the allocation problem to one of allocating engine populations. In essence, the allocation factor serves as a measure of relative population and activity.

To optimize model speed it is designed to only allocate down one level from the input level of equipment populations. To do a county-level run, the model needs to start from state

population files. Therefore national equipment populations are pre-allocated to state population input files outside of the model. Thus, when a state-level model run is chosen, no additional allocation is needed during the model run, since that state population file can be used directly. For most equipment types, where the same allocation surrogate is used for both national-to-state and state-to-county levels of allocation, the state population files are developed by (a) adding up the state-to-county allocation factors for each surrogate and each state, and then (b) calculating the ratio of that state total to the U.S. total for each surrogate (which is the national-to-state allocation factor), and finally (c) multiplying that national-to-state allocation factor by the total national population, using the appropriate surrogate for each type of equipment. This can be expressed as shown in the following equation.

$$(Equip.\ Population)_{state} = (Equip.\ Population)_{national}\ X\ \frac{Sum(Surrogates_{counties\ in\ state})}{Surrogate_{national}}$$

During a county-level model run, the state-to-county allocation factors are applied to the state equipment population inputs to calculate the output county-level equipment populations, as shown below.

$$(Equip.\ Population)_{county} = (Input\ Equip.\ Population)_{state}\ X\ \frac{Surrogate_{county}}{Surrogate_{state}}$$

There are a few equipment types that use a modified form of the above method. As explained in more detail below in the sections covering each equipment type, snowmobiles, ATV's, offroad motorcycles, and recreational marine equipment use an equipment-specific method to allocate from national to state (done outside of the model) and then use the above method to allocate from state to county within the model.

D. Sources and Types of Data

There are three basic types of data that are potentially useful as allocation factors: human population and its associated income and housing data, business activity, and geographic data. Most of these data are available from the U. S. Census Bureau or other federal agencies, except for data concerning construction activity and some industry-provided data for state populations of motorcycles and ATVs, which are discussed separately below. Information from the U. S. Census Bureau is especially attractive for use in the NONROAD model because census data undergo rigorous statistical analyses and quality assurance reviews.

POPULATION DATA

The U. S. Census Bureau conducts a nationwide census on a decennial basis. The census includes data on population, housing (e.g., number of homes by type, number of occupants per home), and income. The most recent census available at the time the most recent allocations for NONROAD were updated occurred in 2000, but the Census Bureau also produces annual estimates of human population and housing based on population growth trends. To be consistent with the latest County Business Pattern (CBP) data, NONROAD2005 uses the 2002 population and housing estimates.

BUSINESS ACTIVITY DATA

The U.S. Census Bureau publishes an annual report called County Business Patterns, which tracks the number of establishments and employees for various types of businesses and industries at the national and county level categorized according to the North American Industry Classification System (NAICS). NONROAD2005 uses 2002 CBP data where available. Prior versions of NONROAD used CBP data that were based on the Standard Industrial Code (SIC) system of industry categorization. EPA also used County Business Pattern indicators for the 1991 Nonroad Engine and Vehicle Emissions Study (NEVES) to allocate state-level populations to the county level.

The U.S. Census Bureau in cooperation with the U.S. Department of Agriculture also conducts a Census of Agriculture every five years in those years ending with "2" or "7," so the most recent surveys were done in 1997 and 2002.

GEOGRAPHIC DATA

Geographic data include factors related to an area's location or physical characteristics. Such factors include water or land surface area, weather data, and land use data. Such data are available from government agencies such as the U. S. Census Bureau, the National Oceanographic and Atmospheric Administration (NOAA), and the U. S. Geological Survey (USGS).

When using the US Census County Business Patterns data to allocate to the county level, there are sometimes a few counties in a state where the individual county data have been withheld to avoid disclosing data of individual companies. In such cases, the value is included in the state total, and in some cases the county entry will give a range, such as 100-249 employees. EPA was able to generate county allocations for the missing counties using the state total missing value (i.e., the state total value minus the sum of the available individual county values). This total missing value was then distributed to the appropriate counties using one of the following methods. If no ranges had been given in the source data, then the state total missing value was distributed equally to each of the counties where data had been withheld. If ranges were available, then the midpoint of the range for each county was assigned to the county (e.g., 175 for the 100-249 range), and then these values within each state were normalized to force the sum of the withheld county data to be equal to the total missing value for that state.

E. Allocation of Specific Populations of Equipment Categories/Types

The allocation indicators that EPA has examined and selected for use in NONROAD2005 are discussed below.

RESIDENTIAL LAWN AND GARDEN EQUIPMENT (EXCEPT SNOWBLOWERS)

To allocate lawn and garden equipment used by private households, NONROAD uses U.S. Census data on one- and two-unit housing (i.e., single family homes and duplexes) by county. Structures containing more than two units tend to be condominiums or apartments that use commercial lawn care services. One- and two-unit housing information was used as an

allocation factor in the NEVES, and an analysis of this set of data during the writing of the NEVES showed that it was a good predictor of lawn and garden equipment populations. In addition, EPA has not been able to find an alternative type of data to use as an allocation factor for residential lawn and garden equipment that offers the high quality, the necessary county-level detail, and the predictive strength of one and two unit housing data from the U.S. Census Bureau.

One- and two-unit housing is most properly thought of as a population allocation factor for residential lawn and garden equipment. The population of such equipment in an area should be roughly proportional to the number of single and double housing units in the area, since the average household occupying such units would have the average probability of owning any given type of lawn and garden equipment. But the amount of use such equipment experiences may vary considerably from area to area based on such variables as the average size of yards, length of growing season, and amount of rainfall. Allocation factors based on residential lawn and garden equipment gasoline consumption, tons of yard waste removed, or the land area occupied by single and double housing units could, in principle, provide a more direct measure of activity. However, the information regarding such potential activity allocation factors are either not available, of questionable quality, or subject to confounding influences that make that potential allocation factor even less reliable for estimating nationwide equipment populations than the one currently used in NONROAD. Therefore, the model continues to use one and two unit single family housing data and estimates from the Census Bureau.

COMMERCIAL LAWN AND GARDEN EQUIPMENT (EXCEPT SNOWBLOWERS)

To allocate commercial lawn and garden equipment NONROAD2005 uses the number of employees in landscaping services (NAICS code 561730) from the 2002 CBP database. Earlier versions of NONROAD, as well as the 1991 NEVES study used number of employees in landscape and horticultural services (CBP SIC 78) to allocate commercial lawn and garden equipment. An analysis performed during the preparation of the NEVES showed the number of employees in landscape and horticultural services to be a good predictor of commercial lawn and garden equipment populations. In addition, EPA does not know of any other sources to adequately serve as a geographic allocation factor for commercial lawn and garden equipment.

The number of employees in landscape and horticultural services is better suited for allocating the population of commercial lawn and garden equipment than the activity associated with this type of equipment. The level of mechanization in the landscape services industry is likely to be reasonably constant from county to county. By contrast, the number of hours per year that the average piece of commercial lawn and garden equipment operates is likely to vary considerably from county to county as a result of different growing seasons and rainfall patterns. Reliable information on allocation factors more directly related to activity levels, such as gallons of fuel consumed per county and year by commercial lawn and garden equipment, are not available.

One caveat for using the number of employees in landscape and horticultural services to geographically allocate commercial lawn and garden equipment populations is that this factor does not include municipal employees that perform landscape maintenance duties for schools, parks, and other properties owned and maintained by local governments. The implicit

assumption used in NONROAD is that the population and activity level of such equipment is proportional to commercial lawn and garden equipment population and activity levels.

SNOWBLOWERS

Allocating snowblower populations and activity levels requires the use of allocation factors that account for the impact of climatic differences among regions, in addition to the factors used to allocate residential and commercial lawn and garden equipment. Put simply, snowblower populations and activity levels depend on snowfall. Snowblower populations in warm-weather states like Florida, Louisiana, and Hawaii should be zero. Snowblowers may be present in parts of states such as Texas and California because part of their territories receive snow (e.g., Texas Panhandle, Sierra Nevada Mountains in California), while snowblower populations in other parts of the state should be zero.

Therefore, the allocation of snowblowers in the NONROAD model involves estimating which counties in the U. S. receive enough snowfall to call for the use of snowblowers. This was done by overlaying a map of the U. S. from NOAA showing ranges of long-term average snowfall amounts on top of a map of U. S. counties and making an informed judgment about the minimum annual amount of snowfall that would correspond to the use of snowblowers. EPA has chosen a minimum snowfall of 15 inches based on discussions with snowblower manufacturers and by the mapping process mentioned above. The same allocation factors that are used for other lawn and garden equipment types (i.e., the number of single and duplex family housing units for residential snowblowers and the number of employees in landscaping services for commercial snowblowers) are used to allocate snowblowers, except that counties that do not receive at least 15 inches of snow on average have their allocation factors set to zero so that no snowblowers are allocated to those counties or erroneously included in the total state populations.

CONSTRUCTION EQUIPMENT

Initially, EPA planned to use the number of employees engaged in construction by county (CBP SIC 15) to geographically allocate construction equipment. However, early comments from some stakeholders correctly pointed out that using this indicator could lead to errors in estimating construction equipment population and activity in a county because construction employees and equipment move from project to project, often crossing county lines. In some parts of the country, such as the Northeast, construction employees and equipment may cross state lines quite frequently. The CBP data only reflect where construction employees and establishments are headquartered, not where they work.

An alternative indicator of construction equipment activity is the dollar value of construction. The U. S. Census Bureau collects and maintains such data, but only at the level of metropolitan statistical areas (MSAs) instead of counties. However, EPA was able to obtain construction valuation data by county from McGraw-Hill Construction (formerly F.W. Dodge Company).

Dollar value of construction provides a good reflection of activity, since there is a proportional relationship between the dollar value of construction and the amount of construction

activity in a given area. Also, using the dollar value of construction by county as an allocation factor distributes construction equipment to where it is actually being used, as opposed to where it is headquartered. Furthermore, this indicator provides a reasonable allocation factor for construction equipment populations: competitive forces encourage construction companies to obtain the maximum return on their investments in costly pieces of construction equipment by maximizing their use as much as possible, thereby strengthening the correlation between construction activity and construction equipment population.

For NONROAD2005 the construction allocation methodology has been enhanced by adjusting the construction value data to account for the different cost of construction in different geographic areas. This has been done to address the issue that a given amount of construction activity in a high cost area (e.g., New York City or Alaska) would show up as greater construction value than the same amount of construction activity in a lower cost area. The data used for this adjustment process was the 2003 construction cost Area Modification Factors (AMFs) published by the Craftsman Book Company.

These construction AMFs are provided by Craftsman for many cities around the U. S. and as averages for entire states, but they are not provided for every county. Since different counties within a state can have substantially different costs of construction (e.g., Queens County, New York City versus Chautauqua County at the western end of the state), it did not make sense to apply the state average to the entire state. Therefore AMFs were determined using a Geographic Information System (GIS) approach to apply data from the closest cities for each county. Each city value (for which Craftsman provided data) was assigned to a single point location (the population centroid defined by the U. S. Census). Each U. S. county was assigned to a single point location, also defined by the population centroid of the U. S. Census. The AMF value for each county was then estimated from the city data by an oct-angle search. The area around each county was divided into eight equal angle sectors, and the eight cities closest to the county centroid (one city in each sector) were identified. The AMF value for the county was then estimated by weighting together the eight values using a weighting factor equal to the inverse of the distance squared, so that closer points were more heavily weighted.

The Dodge data includes the dollar value of residential, commercial, and industrial building construction, as well as road and other public works-related heavy construction. The construction of the various types of buildings accounts for a large portion of the total dollar value of construction. However, according to a survey of construction activity in Houston conducted by Environ in 1998, road and other types of heavy construction constituted a much larger share of actual equipment activity per dollar valuation compared to the construction of residential, commercial, and industrial buildings. This apparent discrepancy can be explained by the fact that, once the land is cleared and graded, heavy construction equipment is not used much in the construction of the actual building, which also usually accounts for the majority of the project's cost. The trends in the Environ survey compared favorably to a study conducted by Sierra Research in 1993 that estimated the relative activity of construction equipment based on fuel cost per project dollar valuation derived from the 1987 Census of Construction Industries. Therefore, EPA weighted the various categories of the Dodge construction dollar value data based on the Environ survey of Houston construction activity.

The heavier weighting given to road and other types of infrastructure construction generally tended to decrease the allocation of construction equipment to urban counties and increase the allocation of this equipment to suburban and adjacent rural counties. This stands to reason, since the road and other infrastructure systems in urban counties tend to be largely established but are still being developed in outlying counties where suburban sprawl continues to take place.

One known shortcoming of the construction equipment allocation methodologies used in NONROAD is that the allocation does not account for the use of construction equipment in non-construction applications. For example, landfill and surface mining operations are known to be substantial users of certain types of construction equipment, such as wheel loaders, crawler-dozers, excavators, and off-highway trucks. These operations, especially surface mining, tend to be more geographically limited than construction operations, and they are also tend to involve intensive (often two-shift) ongoing (multi-year) operation, compared to construction projects that tend toward less continuous use of equipment with much shorter project duration. Thus, in counties where there are substantial landfill and/or surface mining operations, the NONROAD allocation methodology is likely to underestimate construction equipment emissions.

AGRICULTURAL EQUIPMENT

For this category, EPA considered using the number of employees involved in agricultural work by county as an allocation factor (CBP SIC 78), as was used in the NEVES. However, this allocation indicator may not correlate well with either agricultural activity or agricultural equipment populations. A small number of agricultural employees in a county could cause the model to underestimate the population and activity of agricultural equipment if the predominant type of farming in that county is highly automated or relies on migrant labor that is recorded as being based in a different county. Conversely, a large number of agricultural employees in a county could cause the model to overestimate the population and emissions of agricultural equipment if the predominant type of farming is labor intensive or if migrant labor is recorded as being based in the county.

Instead of using farm employee data, EPA chose to use the acreage of cropland harvested by county to allocate agricultural equipment populations. This same indicator has been used in all versions of NONROAD. The data on harvested acres is obtained from the U. S. Census Bureau's USA Counties database, or more recently from the Census Bureau web site. Using the amount of harvested cropland as an allocation factor provides a good predictor of agricultural equipment activity, since a proportional relationship generally exists between the amount of cropland harvested and how much equipment activity is needed to prepare the land and plant, maintain, and harvest the crops. However, the amount of cropland harvested does not necessarily provide as accurate a predictor of agricultural equipment population as it does for activity for several reasons. First, the same amount of cropland in a county can be plowed, planted and harvested by a few pieces of large equipment or several smaller ones. Second, the amount of equipment present in a county may be more dependent on the number of farms than on the amount of acreage harvested (although this source of inaccuracy in estimating populations may be mitigated by the presence of equipment-sharing arrangements in areas with smaller farms). Since the purpose of NONROAD is to estimate emission levels, and since emissions are

more directly associated with activity levels than with equipment populations, EPA believes that the amount of harvested cropland is an appropriate allocation factor for the NONROAD model.

In cases where a county only contains one or two farms the Census Bureau withholds the county level data to avoid disclosing data for individual farms. In such cases, as an estimate for use in NONROAD2005, the average number of harvested acres per undisclosed county was calculated by subtracting the sum of reported county acres from the state total acres, and dividing that by the number of undisclosed counties in the state. Although imprecise, EPA considers this an improvement over previous versions of NONROAD in which such counties were simply assigned an allocation of zero harvested acres.

One known shortcoming of the agricultural allocation methodology which should be addressed in the future is the treatment of irrigation equipment, since this is highly dependent on factors other than harvested acres. Data is available from the Census of Agriculture on the number of farms and land area being irrigated. Even more importantly the actual irrigation energy cost by type of energy is available at the state level, which would be a very good indicator of relative hp-hours of nonroad engine activity, since electric powered equipment could be ignored.

RECREATIONAL MARINE EQUIPMENT

Because the county in which the equipment is purchased, registered, and/or stored may not be the same county where the equipment is used, the geographic allocation of recreational marine equipment presents a significant challenge. An urban or suburban county where a boat is sold, registered, and/or stored may not contain a body of water that can support recreational marine traffic, or water bodies near where a boat owner lives may be overcrowded. Small and medium sized recreational marine craft, which constitute most of the recreational marine fleet, can be transported by trailer over a wide area, further complicating matters. Thus, sales and registration data are not sufficient to accurately allocate recreational marine equipment to the county level. Due to these complexities of allocating recreational boats, EPA developed a composite approach to make use of the best available data at each level of allocation.

To allocate the national recreational boat population to the state level NONROAD uses data from a 1992 gasoline consumption distribution developed by the U. S. Department of Energy's Oak Ridge National Laboratory (ORNL) for use in its 1994 Nonhighway Gasoline Use Estimator Model. The ORNL gasoline consumption distribution is also used by the Federal Highway Administration (FHWA) to estimate annual fuel consumption for boats in states for which no gasoline tax records are available. Because the fuel consumption distribution data directly relate to total boat activity and emissions, it would also be useful to apply it for state-to-county allocation, but the data are not available below the state level.

To allocate the recreational boat population and activity from the state to county level NONROAD uses water surface area data by county from the U.S. Census Bureau. Additionally, since water surface area alone does not distinguish between the differences in usage patterns for the different types of boats (personal watercraft, outboards, and sterndrive/inboards), the water surface allocation factors are adjusted according to the differences in how far each kind of boat

tends to operate from the shore. NONROAD assumes that personal watercraft and boats with outboard engines operate within a quarter mile off the coast, while boats with sterndrive/inboard engines operate up to two miles off the coast. The effect of this modification is to allocate a greater number of larger boats to coastal counties, while the allocation of personal watercraft and outboards will tend to shift toward rivers and lakes in inland counties.

In NONROAD2005 some corrections have been made to the calculation of coastal area water surface. It was discovered that in certain cases (especially Great Lakes states) the water area included in the basic county boundaries (prior to adding the 1/4 or 2 mile from the coast) actually already included a large portion of the coastal water body, well beyond the 2 mile intended maximum. A good example of this would be a county on the eastern shore of Lake Michigan, for which the legal county boundary is in the middle of Lake Michigan, roughly 50 miles from the shore. This error was then worsened by adding on the additional 1/4 or 2 mile wide segment. This has been corrected using a different dataset that reflects the difference between inland versus coastal water areas.

Even with the enhancements applied to the water surface area data, it should be noted that there are some limitations in the use of water surface as an allocation indicator. For instance, it does not make a distinction between navigable bodies of water and those that are too shallow for boating or have obstructions through which boats are unable to pass. Also, water surface area does not account for convenience of location (proximity to areas of significant population) or the recreational quality of the water body (which includes such factors as its attractiveness for fishing, its visual appeal, and its water quality), both of which could be expected to affect a body of water's recreational marine activity per unit area. Another limitation is that water surface area alone does not account for access restrictions that may prevent boating or limit the number of boats permitted to operate on a given body of water.

In earlier model releases prior to draft NONROAD2002 water surface area alone was used for recreational marine allocation at all levels, including national to state. One main reason EPA switched to the fuel consumption approach described above is that use of water surface area alone results in an over-allocation of boating equipment to some states that have long coastlines, such as Michigan. In addition, a highly disproportionate share of boating equipment had been allocated to Alaska, since much of its coastline and bodies of water are either inaccessible and/or inhospitable to recreational boating.

EPA hopes to continue to investigate ways to improve upon the water surface area allocation method currently used in the model and also explore whether there might be other methods and data available to use in NONROAD to better allocate the population of recreational marine equipment for all of the counties in the U. S. Local surveys of recreational boating activity, focusing on factors such as marina and boat ramp usage, offer the most accurate means to assess boat populations and activity at the county level.

RECREATIONAL EQUIPMENT (EXCEPT FOR SNOWMOBILES AND GOLF CARTS)

The allocation of recreational equipment, such as all terrain vehicles (ATVs) and off-road motorcycles, shares the same challenge as the allocation of recreational boats, namely where the

equipment is registered, purchased, serviced, and stored is usually not the location where the equipment is actually used. Because of convenience, people tend to purchase recreational equipment, like other products, near where they live. Hence, most recreational equipment is purchased in urban and suburban areas, where the majority of the U. S. population lives, and this equipment also is registered, stored and serviced in these areas. However, there are relatively few places in urban and suburban areas where it is possible and legal to operate recreational equipment. Generally speaking, recreational equipment usage tends to be concentrated in rural and semi-rural areas near a metropolitan area; such areas are conveniently accessible to the owners of most of the recreational equipment, have more area that is attractive for recreational equipment use, and tend to impose fewer restrictions on recreational equipment use than more densely populated areas. Due to these complexities of allocating recreational equipment, the NONROAD model applies a composite approach to make use of the best available data at each level of allocation.

To allocate the national population of recreational equipment to the state level NONROAD2005 uses state equipment population estimates obtained from the Motorcycle Industry Council (MIC) for the combination of offroad motorcycles and ATVs. These estimates are based on sales data and assumptions of equipment life expectancy as well as equipment registration data where that is available.

To allocate recreational equipment population and activity from the state to county level NONROAD2005 uses the number of RV (Recreational Vehicle) Parks and Recreational Camps (NAICS code 72121) from the 2002 CBP database. This indicator includes sporting and recreational camps (other than sports instructional camps) as well as facilities providing short-term sites for recreational vehicles, trailers, campers, or tents, but not mobile home parks. The data subset containing the number of employees appears to be missing information for areas known to contain national and state parks, near which camps and recreational vehicle parks are likely to be located. EPA acknowledges that this approach may not adequately account for recreational equipment being used on private and public lands that are not associated with and/or adjacent to camps and recreational vehicle parks. In addition, using the number of camps and recreational vehicle parks as an allocation factor is only loosely correlated to the level of recreational equipment activity occurring in a county. At the present time, however, EPA is not aware of other allocation methods that are both practical and reasonably accurate to allocate from state to county population and activity. EPA welcomes suggestions of better alternative methods and data sources for allocation of recreational equipment.

The NEVES report used CBP data for SIC 557 (number of motorcycle establishments) to allocate recreational equipment to the county level. However, this data is not available for one or more counties in some States. The NEVES report also used SIC 55 (number of employees in auto dealerships and service stations), of which SIC 557 is a subset. Neither of these data sets provides a reasonable allocation factor for recreational equipment, because most motorcycle establishments, auto dealerships and service stations are located in urban and suburban areas instead of rural and semi-rural areas where most recreational equipment activity occurs. Registration data also exist for ATVs in most States, but there may be some cases where these data are not available or up to date. Sales data also are available from Power Systems Research or manufacturers. However, using registration or sales data alone as allocation factors presents the same drawback as using the CBP data: the location of population does not correlate

well with the location of recreational equipment activity outside of heavily urbanized or suburbanized areas.

Alternative approaches for the allocation of recreational equipment have also been considered by EPA. One option considered was allocating recreational equipment population and activity based on the inverse of population or population density (i.e., the higher the population or population density of a county, the less recreational equipment activity is allocated to that county). EPA has also considered allocating activity based on the amount of non-urbanized land area per county within a State. While these approaches would reduce the risk of overestimating urban activity, they would tend to overestimate activity in remote rural areas, such as the North Slope of Alaska, Michigan's Upper Peninsula, the Mojave Desert, or the Texas Panhandle. Yet another approach would have used employment or Gross Domestic Product (GDP) economic activity directly associated with recreational equipment usage to allocate recreational equipment. However, EPA has been unable to locate these data at the county level. The CBP database does not include recreational equipment GDP data, and the Bureau of Economic Analysis (BEA) only tracks GDP data down to the state level. Even if it were available at the county level, it would have the same drawback as the CBP data: the location where GDP is generated does not correspond to the location of recreational equipment activity.

GOLF CARTS

Golf carts have a different pattern of usage from other types of equipment in the recreational category. Unlike ATVs or snowmobiles, golf carts are predominantly used in a central location (golf courses), which is usually within or close to an urban/suburban area. In NONROAD2005 golf carts are allocated according to the number of golf courses and country clubs (CBP NAICS code 713910).

Using the number of golf courses to allocate golf carts and their emissions to the county level does not provide a precise reflection of golf cart population or activity. Like the allocation factor that is used to allocate the other types of recreational equipment (the number of RV parks and recreational camps), the relationship between the number of golf courses on the one hand and the population and activity level of golf carts and on the other is a loose one. The population and activity of golf carts at a given golf course depends on the size, popularity, and type of course. A large, popular, 36-hole championship golf course will have more golf carts that are used more intensively than a small, less intensively used 9 hole course. The location of a golf course also affects golf cart activity. A golf course adjacent to an urban area or in a suburban area will tend to have more players than one located in a rural area, resulting in higher golf cart activity at the urban or suburban course. An additional complication is that many golf courses use electrically powered carts instead of carts using gasoline-powered engines. However, EPA does not know of any nationally applicable allocation factors that account for these influences. Therefore, EPA plans to continue using the number of golf courses as an allocation factor in the NONROAD model, but is open to the use of other data that might better account for local nonelectric golf cart activity and population.

SNOWMOBILES

The allocation of snowmobile activity presents the same challenges as other recreational equipment (except golf carts), but it is further complicated by the need to take snowfall into account. Thus, a more complex hybrid allocation methodology is used, which takes into account snowmobile state registrations, human population density, county urbanization, and snowfall. The allocation of the national snowmobile population to states is based on 1998 snowmobile registration data from the International Snowmobile Manufacturers Association (ISMA). This registration data was then modified on a state-by-state basis by ORNL in an attempt to account for unregistered snowmobiles, since anecdotal information suggests that these may account for a significant portion of total snowmobile emissions, and some states do not even have a registration program. Using this sort of registration data automatically avoids allocating snowmobiles to states without significant snowfall.

To allocate snowmobiles from the state to the county level in states other than Alaska, the model uses inverse human population as the basic allocation factor, placing more snowmobile activity in the more rural counties where snowmobile trails would be located. Additionally, to restrict snowmobile emissions to counties with sufficient snowfall the model applies a minimum average annual snowfall requirement of forty inches, such that allocation factors for counties receiving less than that much snow are set to zero, similar to the method used for snowblowers. The annual average snowfall data are available from NOAA. As a final filter on the county allocations, counties that are considered to be partially or fully urban are excluded completely from the snowmobile allocation, even if they receive over 40 inches of snow, and even if some portion of the county is rural enough to support snowmobile use.

An exception to the use of inverse human population and exclusion of urban counties has been made for Alaska, since using inverse human population would allocate snowmobiles to the numerous areas of Alaska that are uninhabited and largely inaccessible. Since most of the populated parts of Alaska are fairly rural to begin with, human population is used directly, rather than inversely. No counties are excluded, since all counties in Alaska average more than 40 inches of snow per year.

One alternative allocation methodology for snowmobiles was also considered. Snowmobile trail mileage by county presents an apparently logical method to allocate snowmobiles, since they are only located where the annual snowfall would support snowmobile use, and the amount of activity would be reflected by how many miles of trails a county would have. Most states where snowmobiles are used have trail maps, but these maps vary significantly in quality and may or may not be scaled accurately. In addition, EPA found that states with snowmobile trails do not keep track of the mileage of these trails by county. Trail mileage also does not necessarily provide an accurate reflection of activity, since it does not capture how intensively a given trail is used, and it does not account for off-trail snowmobiling.

AIRPORT GROUND SUPPORT EQUIPMENT

The population and use of ground support equipment (GSE), such as baggage tractors, fuel carts, aircraft tow tractors, etc., is a function of the number of aircraft operations (landings & take-offs), the sizes of the aircraft, and how full they are of passengers or cargo. For

NONROAD2005, EPA has allocated GSE in proportion to the estimated emissions of aircraft NO_x, as reported in the 2002 National Emissions Inventory (NEI). The use of aircraft NO_x provides a reasonable indication of the relative amounts of aircraft operations at different airports, with much greater weighting given to commercial aircraft, and especially larger commercial aircraft which would require most of the GSE. Additionally, by using the NEI data, any data submitted by state/local governments is included, which can be more accurate than the default data.

For all prior draft versions of NONROAD through 2004, EPA used the number of people employed in air transportation by county (CBP SIC 4500) to allocate ground support equipment. However, this indicator can include employees that are not directly connected to aircraft operations, such as airline reservation staff and ticket agents. Using this factor may lead to an overestimation of aircraft ground support equipment population and activity, especially in counties that either have airports with one or more airline "hubs" or that do not have a commercial airport but have branch ticket offices for various airlines.

INDUSTRIAL AND COMMERCIAL EQUIPMENT

Allocation of industrial and commercial equipment in NONROAD2005, and all prior versions of the model, is done using the same indicators as in the 1991 NEVES report. For industrial equipment, such as forklifts and sweepers/scrubbers, NONROAD uses the number of employees in manufacturing (NAICS codes 31xxxx, 32xxxx, 33xxxx, and 5111xx, formerly CBP SIC 20--, which included all SICs 2xxx and 3xxx). Commercial equipment, considered to include items such as generators, pumps, pressure washers and welders, is allocated according to the number of wholesale establishments (NAICS code 42, formerly CBP SIC 50--).

Because these types of equipment are expected to remain close to a fixed central base of operations, unlike construction equipment that often crosses county or state boundaries, one would expect that the number of establishments or employees could be reasonable factors for allocation of commercial and industrial equipment. Analyses done for the NEVES report showed that these indicators were indeed reasonable predictors of commercial and industrial equipment populations. EPA acknowledges that the number of establishments may not be the best possible indicator of activity, since equipment activity would depend on the average size of establishment and the mix of establishment types, in addition to the absolute number of establishments.

LOGGING EQUIPMENT

In NONROAD2005, logging equipment activity is allocated by county according to 2002 Total Product estimates (cubic feet, without residues) in the Timber Product Output (TPO) database from the U.S. Forest Service (www.fia.fs.fed.us/program-features/tpo/). This is a change from the 2002 and 2004 versions of NONROAD, in which allocation of logging equipment was based on the number of employees in logging operations (1996 CBP SIC 2410). Although the number of logging employees would be expected to provide a reasonable reflection of logging equipment activity, peer review comments provided information on the TPO database, which is expected to correlate even better with equipment activity.

In earlier versions of NONROAD, EPA used the number of employees in logging (CBP SIC 2410) combined with the number of employees in saw and planing mills (CBP SIC 2420). However, inclusion of saw and planing mill employees caused logging equipment populations to be allocated to unlikely places such as Southern California and various urban areas in Texas, where actual mobile logging equipment would not be found.

OIL FIELD EQUIPMENT

To allocate oil field equipment population and activity, NONROAD2005 uses the number of employees in Oil & Gas Extraction (2002 CBP NAICS code 211xxx) plus the number of employees in Drilling Oil & Gas Wells (2002 CBP NAICS code 213111).

All prior versions of NONROAD used the total number of employees in oil and gas extraction operations (CBP SIC 1300). That SIC category included employees in support activities for oil and gas operations, but under the newer NAICS system it became possible to exclude this particular subcategory since it would tend to involve more office activities rather than equipment-oriented field activities.

Employment data provide reasonable allocation factors for oil field equipment activity because a proportional relationship is believed to exist between the number of employees and the amount of equipment they use. Furthermore, economic incentives to avoid leaving expensive equipment idle suggests that activity and equipment populations will be closely correlated. Finally, these types of equipment tend to remain within a given state and county (unlike construction equipment, for example), so the location of activity for oil field equipment usually coincides with the location where the employees are based. A production-based indicator, such as gallons of oil pumped, might be a better allocation factor, but EPA has been unable to find this type of activity-related data at the county level.

UNDERGROUND MINING EQUIPMENT

To allocate underground mining equipment population and activity, NONROAD2005 uses tons of underground coal production, as reported in the Energy Information Administration's Annual Coal Report. EPA considers this production-based indicator to be a better allocation factor for equipment use than the employment data used in prior versions of the model.

In earlier versions of NONROAD, before finding the underground coal production data by county, mining employment data were used based on the same rationale described above for oil field equipment. In earlier versions of the model, EPA used the number of employees in all types of coal mining (CBP SIC 1200) as the indicator for underground mining equipment. This was not limited specifically to underground coal mining because there was no separation of SICs for underground versus surface mining of anthracite coal.

RAILROAD MAINTENANCE EQUIPMENT

Rail maintenance equipment includes any type of nonroad equipment specific to railroad operation other than the locomotives themselves. This usually refers to rail maintenance

machinery, whether designed to travel directly on the rails or be hauled to the job site. The population and activity of rail maintenance equipment in each county depend upon factors such as the number of miles of track in a county, the number of cargo and passenger rail trips within the county, the size of the trains used and how fully loaded they are, the age and condition of the track, and the resources available for maintenance.

For NONROAD2005, EPA has chosen to allocate rail maintenance equipment in proportion to the estimated locomotive NO_x emissions, as reported in the 2002 National Emissions Inventory (NEI). The use of locomotive NO_x provides a reasonable indication of the relative amounts of train operation in different counties, with greater weighting given to operation of larger cargo trains and those operated in areas with greater grades. Additionally, by using the NEI data, data submitted by state/local governments is included, which can be more accurate than the default data.

For all prior draft versions of NONROAD through 2004 the model simply used human population as the allocation factor for rail maintenance equipment. EPA acknowledged that human population is unlikely to correspond well to the location and usage of railroad maintenance equipment, but no applicable CBP business/employment category was found, nor any other reasonable alternative indicators, until the recent update to the NEI locomotive data.

AIR CONDITIONING AND REFRIGERATION EQUIPMENT

Air conditioning and refrigeration equipment covered by the NONROAD model typically are units used on trucking trailers and refrigerated rail cars to keep food cold and fresh while it is transported to restaurants and markets. NONROAD2005 and all prior versions of the model use human population by county as the allocation factor for this equipment. The rationale for using human population as the indicator is that the number of units being used to transport food into or within a given county is likely to be directly related to the size of the human population in that county. However, EPA acknowledges that there may be better allocation factors that might, for example, account for refrigerated transport over longer distances outside of population centers.