Weekday and Weekend Day Temporal Allocation of Activity In The NONROAD Model

Report No. NR-015

March 31, 1999

Greg Janssen
and
Penny Carey

Nonroad Engine Emission Modeling Team
Assessment and Modeling Division
EPA, Office of Mobile Sources

1. Introduction

The Nonroad Engine Emission Modeling Team (NEEMT) is developing a national nonroad air emissions inventory model called NONROAD. The model uses estimates of annual activity for each equipment type, generally expressed in terms of hours of operation or gallons of fuel used per year, to calculate yearly emission inventories. It will also calculate inventories on a seasonal (i.e., summer, fall, winter, spring), monthly, or daily (i.e., weekday or weekend day) basis by allocating annual activity to these smaller time periods. This memorandum documents the daily activity allocation fractions used in the current, draft version of NONROAD. The fractions are expressed as weekday and weekend day fractions of weekly activity and are provided for each equipment category/type. Seasonal and monthly activity allocation fractions are addressed in a separate technical memorandum (Report No. NR-004).

Section 2 provides a background and description of the basic sources of information used. Section 3 defines the fractions and how they are used in the model. Section 4 provides a list of the default fractions used in the model.

2. Background and Data Sources Used

The weekly temporal activity allocation feature of NONROAD allows the user to distribute nonroad equipment activity between weekdays and weekend days. This feature coincides with NONROAD's ability to allocate equipment activity to a specific month and season, thereby allowing the user to model a typical weekday or weekend day during a given month and season (e.g., a typical summer weekend day in June). State and local air agencies may want or need the ability to model weekly activity in order to analyze the effects of episodic controls or voluntary incentive programs involving specific categories or types of nonroad equipment.

At the weekly level, temporal activity allocation is largely dependent on people's recreational and work patterns as well as the purpose for which the equipment is used. For example, most commercial lawn and garden equipment activity occurs on weekdays when lawn care services tend to operate. In contrast, recreational marine equipment is used primarily on weekends.

The Nonroad Engine and Vehicle Emission Study (NEVES)[1] did not include a study of weekly activity patterns. Its main purpose was to assess the annual and seasonal contribution of nonroad equipment emissions to the total air pollution inventory for all sources, so it did not require that level of detail.

For the draft version of NONROAD, the fractions for residential lawn and garden equipment, commercial lawn and garden equipment, and recreational marine equipment were based on available survey data. For the remaining equipment types for which survey data were not available, fractions were based on NEEMT's assessment of typical usage patterns and, for similar equipment types, comparison with the off-highway model (OFFROAD, formerly known as MVOFF) developed by the California Air Resources Board.[2] The draft version of NONROAD and OFFROAD have similar weekday and weekend day activity fractions for common equipment types.

3. Methodology

The draft version of the NONROAD model has the capability to accept two fractions that represent the amount of activity allocated to each weekday and each weekend day. These fractions are contained in the seasonal/monthly allocation file (season.dat) following the seasonal/monthly allocation fractions. The weekday fraction represents equipment activity during each of the five weekdays and the weekend day fraction represents the activity during each of the two weekend days. For example, survey data indicate that 80 percent of commercial lawn and garden activity occurs Monday through Friday and 20 percent occurs during Saturday and Sunday. The resulting weekday and weekend day fractions are:

Weekday Fraction = 0.80/5 = 0.16, or 16% per weekday
Weekend Day Fraction = 0.20/2 = 0.10, or 10% per weekend day

Through the use of Source Category Codes (SCCs), weekday and weekend day fractions are assigned for each equipment category (e.g., construction equipment). All equipment types within a category (e.g., excavators within the construction equipment category) are assigned the weekday and weekend day fractions for that category. Users may substitute local activity data where available.

---

[1] Environmental Protection Agency, Office of Air and Radiation. Nonroad Engine and Vehicle Emission Study, 21A-2001, November 1991.

[2] Energy and Environmental Analysis. Documentation of Input Factors for the New Off-Road Mobile Source Emissions Inventory Model - Draft. Prepared for the California Air Resources Board, August 1995. OFFROAD was formerly known as MVOFF.

4. Default Weekday and Weekend Day Activity Allocation Fractions Used in Draft Version of NONROAD

The default weekly activity allocation fractions contained in the draft version of NONROAD are shown in Table 1.

Table 1
Default Weekday and Weekend Day Activity Allocation Fractions Used in Draft Version of NONROAD*

Equipment Category	Weekday	Weekend Day
Recreational	0.1111111	0.2222222
Construction	0.1666667	0.0833334
Industrial	0.1666667	0.0833334
Residential Lawn and Garden	0.1111111	0.2222222
Commercial Lawn and Garden	0.1600000	0.1000000
Agricultural	0.1666667	0.0833334
Light Commercial	0.1666667	0.0833334
Logging	0.1666667	0.0833334
Airport Service	0.1428571	0.1428571
Railway Maintenance	0.1800000	0.0500000
Recreational Marine	0.0600000	0.3500000
Transportation A/C Refrigeration	0.1428571	0.1428571
Underground Mining	0.1666667	0.0833334
Oil Field Equipment	0.1428571	0.1428571

* The values are the fractions of weekly activity allocated to each weekday and each weekend day. To get the fraction for all weekdays, multiply the weekday fraction by 5. Similarly, to get the weekend fraction, multiply the weekend day fraction by 2. All equipment types within a category (e.g., excavators within the construction equipment category) are assigned the weekday and weekend day fractions for that category.

As seen in Table 1, recreational equipment is assigned a pattern of twice as much use on the weekend days compared to the weekdays, based on an assessment of typical usage patterns. The fractions for recreational equipment are also in agreement with those used in California ARB's OFFROAD model (hereafter, simply referred to as OFFROAD).

The construction, industrial, agricultural, light commercial, logging, and underground mining categories are commercial in nature, and should be used more on weekdays than on weekend days; therefore, it is estimated that these equipment categories are used twice as much on the weekdays compared to the weekend days. For the construction, industrial, agricultural, light commercial, and logging categories, this estimate is very similar to the weekday/weekend day activity fractions (0.164 weekday, 0.090 weekend day) specified in OFFROAD.[3] Weekday/weekend day activity fractions for the underground mining category are not specified in OFFROAD.

Airport service equipment, transportation A/C refrigeration equipment, and oil field equipment were thought to be used uniformly throughout the week. For the airport service equipment and transportation A/C refrigeration categories, this agrees with the estimates in OFFROAD. Weekday/weekend day activity fractions for the oil field equipment category are not specified in OFFROAD.

In contrast to the above equipment categories, survey data are available for the residential lawn and garden, commercial lawn and garden, and recreational marine categories. The surveys are described below, followed by a discussion of how they were used to develop weekday and weekend day activity fractions for these three categories.

Systems Applications International, Inc. (SAI) conducted a survey of recreational marine use in California for the California Air Resources Board.[4] The survey was part of a larger effort to develop an emissions inventory of pleasure craft in California. From June 1993 to May 1994, over 10,000 surveys were sent to randomly selected owners of motorized pleasure craft registered with the California Department of Motor Vehicles. Temporal (seasonal, weekly, and diurnal) profiles were obtained with the survey data. Profiles are provided of the percent of weekly activity for each day of the week, on both an annual basis and for the winter season. In both cases, usage during the week is fairly flat (less than or equal to 10% each weekday), with 60-70% of the total weekly activity occurring on the weekend. On an annual basis, the daily activity fractions are as follows: Monday (0.0527578), Tuesday (0.0621816), Wednesday (0.0702681), Thursday (0.0723208), Friday (0.1043395), Saturday (0.3039638), and Sunday (0.3341683). When combined, the fraction of activity on all weekdays is 0.36 and the fraction of activity on the weekend is 0.64.

SAI also conducted a telephone survey of weekly activity patterns for residential and commercial lawnmowers in the Houston/Galveston and Beaumont/Port Arthur areas for the

---

[3] OFFROAD has separate activity fractions for each day of the week. In order to compare the estimates with NONROAD, the fractions for each weekday were summed and divided by five to obtain the weekday fraction. The fractions for Saturday and Sunday were summed and divided by two to obtain the comparable weekend day fraction.

[4] Systems Applications International. Development of an Improved Inventory of Emissions from Pleasure Craft in California. Contract Number A132-184, Prepared for the California Air Resources Board, June 1995.

Texas Natural Resources Conservation Commission (TNRCC).[5] Again, this was part of a larger effort to develop an emissions inventory for selected area and nonroad sources. Profiles are provided of the percent of weekly activity for each day of the week for both residential and commercial lawnmowers. For residential lawnmowers, the daily activity fractions are as follows: Monday (0.11), Tuesday (0.10), Wednesday (0.11), Thursday (0.15), Friday (0.16), Saturday (0.24), and Sunday (0.14). When combined, the fraction of activity on all weekdays is 0.63 and the fraction of activity on the weekend is 0.38. For commercial lawnmowers, the daily activity fractions given in the SAI report are 0.16 for each weekday and 0.10 for each weekend day. This translates into a combined weekday fraction of 0.80 and a combined weekend fraction of 0.20.

There are also estimates of weekday vs. weekend use for residential lawnmowers and recreational marine equipment provided by the Texas Air Control Board.[6] During the first week in August 1993, the North Central Texas Council of Governments (NCTCOG) conducted an in-house survey to measure the level of consumer lawn mower usage and the degree of weekend usage in the Dallas-Fort Worth area. The results indicated a mean combined weekday activity fraction of 0.504 and a combined weekend fraction of 0.496. Based upon NCTCOG survey data of area lake authorities, the combined weekday and weekend fractions of summer boating activity are 0.25 and 0.75, respectively.

For residential lawn and garden equipment, the SAI and NCTCOG survey results were averaged to obtain a combined weekday fraction of 0.56 and a combined weekend fraction of 0.44. This translates into daily activity fractions of 0.11 for weekdays and 0.22 for weekend days.

For commercial lawn and garden equipment, the single source of survey data is the SAI telephone survey in the Houston/Galveston and Beaumont/Port Arthur areas. The daily activity fractions given in the SAI report (0.16 for each weekday and 0.10 for each weekend day) are used directly in NONROAD.

For the commercial marine category, SAI's annual estimates of pleasure craft activity in California were averaged with NCTCOG's estimates of summer recreational boating activity in the Dallas-Fort Worth area to obtain a combined weekday fraction of 0.30 and a combined weekend fraction of 0.70. This translates into daily activity fractions of 0.06 for weekdays and 0.35 for weekend days.

The NEEMT welcomes suggestions and comments about the approach and sources of information used, as well as information about other surveys of nonroad equipment that have been or are presently being conducted.

---

[5] Systems Applications International. Bottom-Up Emission Inventory Development for Selected Source Categories in the Houston-Galveston and Beaumont-Port Arthur Areas. Prepared for the Texas Natural Resource Conservation Commission, May 1995.

[6] Memorandum from Everett Bacon and Michael Burbank, North Central Texas Council of Governments to Bill Gill, Texas Air Control Board. Recreational Boating and Lawn and Garden Off-road Emission Inventories for the Dallas-Fort Worth Nonattainment Area. August 13, 1993.