Southwest Washington Regional

Transportation Council

Clark County Freight Mobility Study

Technical Memorandum:

Task 3B1: Vehicle Classification Counts – Best Practices

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Prepared For:

RTC

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Vehicle Classification Counts – Best Practices

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Vehicle classification counts are the backbone of freight analysis. Knowing the number and mix of trucks on a given roadway improves the understanding of truck movements in the freight system, how trucks affect traffic operations, and what design standards should be applied. However, there are many different methods that can be used to gather truck data, each with various levels of accuracy depending on the circumstance in which they are used.

This memorandum provides guidance related to collecting truck count data, which will be applied to the Clark County Freight Mobility Study and for future truck volume data collection efforts by the Regional Transportation Council (RTC). The most commonly used methods now available to perform truck counts are described, and the benefits and disadvantages of the methods are listed in tables. Emerging technologies are also described. Finally, recommended practices that can be used to improve the accuracy of common machine (tube) counts are presented.

1. Truck Classifications

The Federal Highway Administration (FHWA) has established a vehicle classification system that uses 13 vehicle types distinguished by the number of axles. The classifications were originally established for use in pavement and bridge design. However, when describing trucks for the purpose of transportation planning or traffic operations analysis, the 13 classifications are often grouped into three primary categories: light (small), medium, and heavy (large). Some- times trucks are grouped as single, double, and triple. Table 1 shows the FHWA classifications, typical size groupings, and weight classifications.

Examples of different size trucks are shown on Figure 1. Light trucks are a single unit, have two axles and up to six tires. This size truck performs light commercial activity. On highways and arterials, the operating characteristics may be similar to a passenger car. This is the Class 5 example in Figure 1. It is noted that some goods are delivered in passenger vehicle classes such as vans and pick-up trucks. These types of vehicles are not included in the truck classifications. Medium sized trucks have three or four axles, but are a single unit. Today, single unit trucks with three or four axles are fire trucks, dump trucks, and large recreational vehicles. Some delivery trucks may have two rear axles although few are observed in the field. The medium trucks carry heavier loads, require a wider turning radius, and use more capacity on highways and arterials than a passenger car. Heavy trucks have four or more axles and a “tractor-trailer” configuration. The tractor is the vehicle, and the trailer is connected to the tractor to haul freight. The tractor-trailer trucks have operating characteristics that differ significantly from a passenger car, with slower acceleration speeds, longer stopping distances, different sight lines, and a large turning radius. Their operating characteristics consume approximately double the freeway capacity as compared to a passenger car. These are the Class 8, 9, 10, and 13 examples in Figure 1.

Table 1. Truck Type Nomenclature

Class Number [1]	Name	Truck Group [2]	Other Nomenclature [3]	Size and Typical Weight
1	Bikes			
2	Cars and Trailers			<16,000 lbs
3	2 Axle Long	Pass Veh/Light[4]		<16,000 lbs
4	Buses			
5	2 Axle 6 Tire	Light		<16,000 lbs
6	3 Axle Single	Medium	Single	Single Unit 16 – 52,000 lbs
7	4 Axle Single	Medium	Single	Single Unit 16 – 52,000 lbs
8	<5 Axle Double	Heavy	Double	Tractor Trailer – one trailer >52,000 lbs[5]
9	5 Axle Double	Heavy	Double	Tractor Trailer – one trailer >52,000 lbs
10	>6 Axle Double	Heavy	Double	Tractor Trailer – one trailer >52,000 lbs
11	<6 Axle Multi	Heavy	Triple	Tractor Trailer – two trailers >52,000 lbs
12	6 Axle Multi	Heavy	Triple	Tractor Trailer – two trailers >52,000 lbs
13	>6 Axle Multi	Heavy	Triple	

1. *Federal Highway Administration Classifications.*
2. *Groupings of truck categories for the purpose of a transportation planning study. These categories were originally defined in the Congestion Relief Analysis, PSRC Travel Model Documentation Final Report, Chapter 10.0*
   Truck Model, August 24, 2006, Cambridge Systematics, Inc.
3. *Trucks are sometimes grouped by into these categories.*
4. *Category 3 has often been classified as a "Light Truck." However, recent observations have found that this type of vehicle is most often a larger passenger vehicle such as a pick-up truck or a sports utility vehicle built on a large pick-up truck frame (e.g., Chevy Suburban). Category 3 has been excluded from most groupings of truck counts.*
5. *The weight of Class 8 and 9 may exceed the typical weight of 52,000 for extra heavy loads such as a cement truck.*

Figure 1. Example Truck Classifications

Class 5: Single Unit Delivery Truck Light Truck	
Class 7: Four-Axle Single Truck Medium Truck	
Class 8: Four Axle Tractor Trailer Heavy Truck	
Class 9: 5 Axle Tractor Trailer Heavy Truck	
Class 12: Six Axle Truck (two trailers) Heavy Truck	
Class 13: Eight Axle Tractor Trailer Heavy Truck	

Source : Heffron Transportation, Inc., June 2009. Some of the photos are from WSDOT's training website at: http://training.ce.washington.edu/wsdot/Modules/04_design_parameters/trucks_buses.htm

2. Types of Counting Methods

Machine Counts

Machine counts are typically performed using pneumatic tubes laid across each lane of a street and a counting machine that detects the number of axles that cross the tubes. The data are then processed through an algorithm to define the 13 types of vehicles based on the spacing of axles. Most counting firms rely on the algorithms provided by their system's software and do not make adjustments for local vehicle conditions. The accuracy of machine counts is affected by the number of lanes (it is more difficult to count multi-lane roads), vehicle speeds below 10 mph, and higher volumes (which can cause closely-spaced vehicles to be counted as multi-axle trucks). The advantages and disadvantages of this counting method are listed in Table 2.

Table 2. Machine (Tube) Classification Counts

Advantages	Disadvantages
• Most common and least expensive method for classifying vehicles. • Best method to classify into FHWA 13 vehicle types. • Captures 24-hour data. • Good accuracy on single-lane arterials and highways where speeds are greater than 10 mph.	• Accuracy declines on multi-lane arterials and highway unless lanes can be isolated. • Accuracy declines when speeds drop below 10 mph. • Cannot distinguish between different types of trucks with the same axle configuration. • Some long wheel-base passenger vehicles may be classified as trucks.

Induction Loops

Many agencies have imbedded induction loops into the pavement for use in performing vehicle classification counts. This method allows lanes on multi-lane roadways (such as I-5) to be isolated, which improves the accuracy of the count. However, as with machine counts, speeds below 10 mph such as in stop-and-go traffic, reduce the accuracy of the counts. Although the capital cost of installation is high, once installed, the counters can be used to collect truck data during every hour of any day desired. These types of counters are useful for determining hourly, daily, and seasonal fluctuations in truck traffic.

Table 3. Induction Loop Classification Counts

Advantages	Disadvantages
• Can be used to determine fluctuations in hourly, daily, and seasonal truck volumes. • High level of accuracy when speeds are above 10 mph. • Good method to classify into the FHWA 13 vehicle types.	• Expensive up front capital cost to install loops. • Accuracy declines when speeds are below 10 mph. • Cannot distinguish between different types of trucks with the same axle configuration. • Some long wheel-base passenger vehicles may be classified as trucks.

Camera Counts

Video cameras can be used to record long periods of vehicle data that are then manually viewed to determine the number of vehicles by type. For these types of counts, it is difficult and expensive to determine axle classifications into the FHWA 13 vehicle types. Therefore, vehicles are usually classified as passenger vehicles, buses, and the three primary types of trucks (small, medium, and large). Camera counts are often the most accurate types of counts and the video footage can be viewed multiple times to classify different directions or turning movements. On the down side, camera counts are usually limited to daylight hours making 24-hour counts difficult. Newer infra-red technology is allowing camera counts to be taken during periods with little ambient light.

Table 4. Camera Classification Counts

Advantages	Disadvantages
• Most accurate, even at low speeds. • Can distinguish between different types of trucks that have the same axle configuration (for example a container truck versus a standard box truck). • Can capture vehicle classifications for intersection turning movements.	• Moderately expensive. • Usually limited to daylight hours. • Difficult to classify axle configurations per the FHWA classification system.

Manual Counts

Manual counts can be performed without the aid of a video camera. These types of counts are usually performed only for short periods of time, such as during the peak periods. Although WSDOT field crews are required to classify to FHWA 13 vehicle types when manually counting vehicles, it is very difficult to accurately distinguish between different axle configurations when trucks are traveling at speed. Therefore, vehicles are usually classified as passenger vehicles, buses, and the three primary types of trucks (small, medium, and large).

Table 5. Manual Classification Counts

Advantages	Disadvantages
• High level of accuracy when classifying for three to five types of trucks. • Not affected by congested conditions (although more personnel may be needed). • Can distinguish between different types of trucks that have the same axle configuration (for example a container truck versus a standard box truck). • Can capture vehicle classifications for intersection turning movements.	• Moderately expensive. • Usually limited to short periods of time during daylight hours. • Difficult to observe axles and classify into the FHWA system.

Radar Counts

A relatively new technology for classification counts is a radar that detects vehicle length. Current technology allows up the three different lengths to be set (e.g., less than 20 feet, 20 to 40 feet, and more than 40 feet). These lengths can be set by the user. Newer models will also detect up to 10 different vehicle lengths. However, it is not possible to classify vehicles into the FHWA 13 vehicle types. There are multiple radar technologies (microwave, doplar, and laser). The accuracy of radar technologies and the factors that affect classification accuracy has not yet been thoroughly investigated.

Table 6. Radar Counts

Advantages	Disadvantages
• Relatively easy to perform. • Can classify trucks by length. • Can detect by lane on multiple lane facilities.	• Cannot classify by axle. • Cannot distinguish between different types of trucks with the same length. • Accuracy is unknown.

3. Improving the Accuracy of Machine Counts

Machine counts are the most common type of vehicle classification counts. Accuracy of these counts can be improved through proper placement. Recommended practices are listed below.

- When locating counting machines in an urban environment, place the tubes downstream from a traffic signal to lessen the chance that the tubes would be blocked by a standing queue or speeds less than 10 mph.

- On multi-lane arterials or highways, each lane should have its own set of isolated tubes. On four lane arterials, this is easiest if there is a median where separate machines with tubes on the inside lanes can be located.

- Avoid counting locations where vehicles could park or be queued on the tubes.

- Avoid using machines to count arterials that have more than two lanes in each direction. Another method such as camera counts should be used.

- Collect data on Tuesdays, Wednesdays, and Thursdays to avoid end of week variations. Avoid collecting data on days adjacent to work-week holidays. And finally, avoid collecting data during adverse weather conditions, near construction zones or any other situation that affects traffic patterns.

4. Application of Vehicle Classification Data

Truck volumes and characteristics can vary greatly from one geographic area or facility to another. Using estimates may result in incorrect planning for needs and impacts, and project design that will not function as effectively as intended. Given the cost of transportation projects, high level of need and limited funds, it is often well worth the nominal cost to obtain accurate counts.

Estimating truck volumes and classifications based on an applied percent to total traffic volume can result in an inaccurate view of actual volumes. However, collecting accurate and complete classification counts is expensive and may be cost prohibitive in all locations. A statistically reliable method of estimating vehicle classification percentages on roadways may sometimes need to be developed. Jurisdictions should use FHWA's guidelines for prioritizing locations to collect full counts and developing accurate estimation methodology.

If short duration counts are used, it is important that they cover at least a 24-hour period, but 48-hour counts are preferred. Truck traffic operates in a very different manner than general-purpose traffic. The highest volume time periods for general-purpose traffic will not be the same for trucks. A count during peak periods only may not provide accurate information on truck volumes as a percent of total traffic during a full day. Seasonal variations may also greatly affect volume and size of trucks on a roadway, particularly on corridors carrying agricultural commodities. Control locations where counts are taken at different times of the year can be used to determine a seasonal adjustment factor.

The following excerpts from FHWA's *Traffic Monitoring Guide*, a set of best practices for traffic monitoring, are particularly relevant to obtaining and designing a good vehicle classification system.[1] The full guidebook should be consulted by those managing a jurisdiction's count program.

- Large numbers of transportation analyses are starting to require more and better truck volume information. Truck volume information has become particularly important for pavement design, freight mobility, planning, safety, and project programming decisions.

- Short duration counts by themselves, however, are only part of the data collection process. Research has shown that truck volumes vary dramatically during the day, often differ significantly between weekdays and weekends, and can change as well from one season to the next season. If adjustments are not made for day-of-week and seasonal variation, the result is likely to be erroneous analytical conclusions.

- The classification counting program should include both extensive, geographically distributed, short duration counts and a smaller set of permanent, continuous counters.

- A fairly large number of short duration classification counts should be performed to monitor and capture truck movements taking place on individual roads. These counts should be collected by equipment capable of providing hourly volume summaries. They should normally include data for all lanes and directions for a given location, since truck traffic varies considerably from lane to lane and often by direction. This data collection effort yields the basic truck traffic statistics needed on any given road including the geographic variability of truck movements, and the time-of-day distribution at a variety of locations.

- Without adjustment, short duration classification counts can yield biased estimates. Thus, as with traditional traffic volume counting, classification coverage counts must be supplemented by the use of permanent, continuously operating, vehicle classification counters (CVC). The permanent counters provide an understanding of how truck travel varies by day of the week and season of the year.

[1] U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information. *Traffic Monitoring Guide.* Retrieved as of June 30, 2008: http://www.fhwa.dot.gov/ohim/tmguide/.

5. Next Steps

Obtaining accurate truck counts is critical for making good decisions about transportation system priorities, needs, and impacts for the movement of freight. These counts are also necessary for accurate corridor planning, project identification and design. For the Clark County Freight Study, truck data will be used to understand the relationship between land use and truck trips, the importance of freight movement to Clark County's economy, and ultimately to prepare a solid message regarding the economic benefits of transportation improvement projects. This information will enhance project applications for grant funding, as well as assist elected officials with decision-making and advocacy for projects. A truck counting program should continue beyond the near term freight study in order to continue evaluating changes in truck trip patterns and assess freight infrastructure needs.