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Standard Practice for Developing Axle Count Adjustment Factors[1]

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1. Scope

1.1 This standard practice describes techniques for adjusting observed or assumed axle counts so that they will represent corresponding estimated vehicle counts as part of roadway traffic monitoring.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *Other:*

Traffic Monitoring Guide, U.S. Department of Transportation, Federal Highway Administration, Washington, DC 20590

3. Terminology

3.1 *Definitions:*

3.1.1 *axle, n*—axis oriented transversely to the nominal direction of vehicle motion, and extending the full width of the vehicle, about which the axle wheels at both ends rotate.

3.1.2 *axle count, n*—total number of vehicle axles that are enumerated at a point on a lane or roadway during a specified time interval.

3.1.3 *axle counter, n*—device that receives signals from an axle sensor and indicates the cumulative number of axles that were detected by the sensor during a specified time interval.

3.1.4 *functional classification, n*—a stratification of highways based on their common usage or function.

3.1.5 *machine count, n*—the cumulative number of axles, vehicles, or vehicles within specified classes, or all of these, indicated or recorded by a traffic recording device for a specified time interval.

3.1.6 *traffic counter, n*—a device that indicates, and usually records, the number of vehicles or vehicle axles, or both, that pass a point on a lane or roadway during a specified time interval.

3.1.7 *traffic recording device, n*—a device that receives signals from a sensor(s) and registers axle count, vehicle count, vehicle classification count, speed, gap, or headway (any or all of these) for defined time intervals.

3.1.8 *vehicle, n*—an assembly of one or more mobile units coupled together for travel on a highway; a vehicle comprises one powered unit and may include one or more unpowered full-trailer or semi-trailer unit(s).

3.1.9 *vehicle classification, n*—the process of categorizing vehicles into various classes, usually according to their respective axle or mobile-unit(s) configuration.

3.1.10 *vehicle classification count, n*—the cumulative number of vehicles of each defined class indicated or recorded for a specified time interval.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *axle count adjustment factor, n*—the number that when multiplied by an axle count (3.1.2) will adjust the axle count to an estimate of the total number of vehicles that produced the axle count.

3.2.1.1 *Discussion*—The adjustment factor is sometimes based upon the premise that (1) the portion of all vehicles included in each of various vehicle classes, and (2) the respective average number of axles per vehicle class for the vehicles that produced the axle count being adjusted are known or are assumed to be the same as the two corresponding values used to characterize the vehicles in a chosen, representative, or similar traffic stream.

4. Summary of Practice

4.1 *Basic Steps*—Development of an axle count adjustment factor involves two basic steps: (1) defining a time interval along with the characteristics of the vehicles that comprised the traffic stream during the time interval, and (2) obtaining the data needed to characterize the vehicles in the traffic stream. Depending upon the type of data available, one of the following methods may be used to calculate the factor.

4.1.1 *Direct Method*—If, for a chosen time interval, recorded data are available (e.g., from an ASTM Type I and Type II WIM system or from certain types of traffic counters or

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traffic recordings devices) concerning the total number of vehicles in the traffic stream concurrently with the total axle count (3.1.2), the axle count adjustment factor can be calculated directly as the ratio of the two numbers. The total number of vehicles in the traffic stream may be determined from a recorded machine count (3.1.5) or by summating the number of vehicles in each applicable vehicle class as recorded in a vehicle classification count (3.1.10). This method of deriving an axle count adjustment factor is illustrated in Appendix A as Appendix X2.

4.1.2 *Alternative Method*—If specific data such as that described in 4.1.1 are not available for the chosen time interval, in order to develop an axle count adjustment factor it might be expeditious to characterize the vehicles in a representative – presumed to be similar – traffic stream by obtaining for a time interval of the same duration as that for the axle count to be adjusted, concurrent data samples of: vehicle classification count, average number of axles per vehicle class, and total axle count. The average number of axles per vehicle class may be either calculated from observed data or estimated from previous experience. An example is shown in Table 1 for the average number of axles per vehicle class (suggested by descriptions of vehicles in each of the 13 vehicle classes defined in the *Traffic Monitoring Guide*. To derive the axle count adjustment factor, divide the sum of the vehicles in all classes (total number of vehicles) by the sum of the products of the number of vehicles in each class times the respective average number of axles per vehicle class (total number of axles). This alternative method of deriving an axle count adjustment factor is illustrated in Appendix A as Appendix X1. The axle count adjustment factor developed from this method may be applied to an axle count when it is assumed that the traffic stream which produced the axle count being adjusted had essentially the same portion of vehicles in each designated vehicle class and average number of axles per vehicle class as the traffic stream that was chosen to be representative.

TABLE 1 Average Number of Axles per Vehicle Class

Vehicle Class	Description	Average Number of Axles per Vehicle
1	Motorcycles	2
2	Passenger Cars	2
3	4-Tire Single Unit Trucks	2
4	Buses	2
5	2-Axle, 6-Tire Single Unit Trucks	2
6	3-Axle Single Unit Trucks	3
7	4 or More Axle Single Unit Trucks	4
8	4 or Fewer Axle Single Trailer Trucks	4
9	5-Axle Single Trailer Trucks	5
10	6 or More Axle Single Trailer Trucks	6
11	5 or Fewer Axle Multi-Trailer Trucks	5
12	6 Axle Multi-Trailer Trucks	6
13	7 or More Axle Multi-Axle Trucks	7

4.2 *Time Interval*—It is recommended that a series of axle count adjustment factors be developed for application to axle counts taken during weekdays (Monday – Friday), weekends (Saturday and Sunday), months, quarters (either calendar quarters or seasonal quarters), and calendar year. Special events that produce significant traffic volumes and recur periodically – such as festivals, fairs, and sporting events – might justify the development of a separate axle count adjustment factor for the specific time interval and locality.

4.3 *Vehicle Characteristics*—The critical vehicle characteristic required for developing an axle count adjustment factor is the number of axles on each individual vehicle that produced the axle count to be adjusted, or a credible estimate thereof. Various sensor types – vehicle-presence, axle-passage, tire-presence, and others – are employed in various arrays and teamed with various signal-processing algorithms and traffic recording devices to count vehicles, and sometimes count and classify them according to their axle number and spacing, or to only count axles with respect to time. Application of appropriate and capable traffic recording devices is required for acquiring data – with proper analysis – needed to develop an axle count adjustment factor.

4.4 *Application*—The derived axle count adjustment factor – always less that 0.5 – may be correlated with other parameters such as volume, density, speed, highway functional class, designated truck routes, parkways, and geographic locale to further describe the characteristics of the observed traffic stream and suggest potential future applications of the factor when only axle count for a similar traffic stream is known.

5. Significance and Use

5.1 This practice addresses the development of axle count adjustment factors, using axle counts and vehicle classification counts. This practice provides information for use with professional judgment by governmental agencies and private firms in the management of roads and roadway traffic.

5.2 Traffic monitoring is important to the safe and efficient movement of people and goods. The purpose of this practice is to ensure that traffic monitoring procedures produce traffic data and summary statistics that are adequate to satisfy diverse and critical traffic information needs.

6. Keywords

6.1 axle; axle count; traffic counter; vehicle; vehicle axles; vehicle classification

APPENDIXES

(Nonmandatory Information)

X1. Sample Calculation of Axle Count Adjustment Factor by Alternative Method

X1.1 For a specified time interval, obtain a previous classification count from the same section of roadway or a section of roadway with similar traffic characteristics.

X1.2 Using data such as that illustrated in Table 1 as a guide, multiply the estimated average axles per vehicle class (e.g., Table X1.1, Col 2) by the vehicle count by class (Col 3) to determine the calculated axle count (Col 4) for each vehicle class.

X1.3 Determine the total axle count by summating the calculated axle counts for each vehicle class (total Col 4).

X1.4 Summate all vehicle-count-by-class (Col 3) to determine the total vehicle count, and divide this total vehicle count by the total axle count (total Col 4) to determine the axle count adjustment factor.

X1.4.1 As shown is Table X1.1, the total vehicle count was 10 507. Using the suggested average number of axles per vehicle, the total axle count was 33 086. By dividing the former number by the latter number, the axle count adjustment factor of 0.3176 is determined.

X1.5 If at some future time, only an axle count is taken at this location on a weekday, e.g. 33 086, (or at another location with a similar mix of vehicle types and percentage of each type) the estimated number of vehicles that produced the axle count would be calculated by multiplying the axle count adjustment factor of 0.3176 by the axle count of 33 086 to give an estimated 10 508 vehicles.

TABLE X1.1 Example Weekday Traffic Count (Rural Interstate)

1 VEHICLE CLASS	2 AVERAGE AXLES PER VEHICLE CLASS	3 VEHICLE COUNT BY CLASS	4 CALCULATED AXLE COUNT
1	2	0	0
2	2	3 929	7 858
3	2	2 049	4 098
4	2	68	136
5	2	331	662
6	3	139	417
7	4	3	12
8	4	355	1 420
9	5	3 122	15 610
10	6	154	924
11	5	249	1 245
12	6	52	312
13	7	56	392
TOTALS		10 507	33 086

X2. Sample Calculation of Axle Count Adjustment Factor by Direct Method

X2.1 In the situation where a traffic counter capable of recording vehicle counts is available at a site, an axle counter may be installed adjacent to it.

X2.2 While one device is enumerating the total number of vehicles, the other is enumerating the total number of axles.

X2.3 At the end of the specified time period, the recorded values from the two devices should be recorded.

X2.4 By dividing the total number of vehicles by the total number of axles, the axle count adjustment factor is determined.

X2.5 Using Table X1.1 as an example, only the Totals line would be utilized

X2.5.1 The total vehicle count was determined to be 10 507 and the total axle count was determined to be 33 086.

X2.5.2 By dividing the former by the latter, an axle count adjustment factor of 0.3176 is calculated.