



Standard Practice for Highway-Traffic Monitoring¹

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1. Scope

1.1 This practice describes highway-traffic monitoring, which is the activity of collecting, summarizing, and reporting traffic volume, vehicle classification, and vehicle weight data. This practice is foundational and is not intended to be all-inclusive. Users of this practice are allowed, indeed encouraged, to exceed the practice.

1.2 Traffic monitoring results in traffic-volume, classification, and weight-summary statistics which are used in highway geometric and pavement design, alternative highway route selection, roadway demand and service assessment, and accident-exposure estimation.

1.3 Traffic-monitoring practices are based on the principle of truth-in-data. This principle involves providing the supplementary information required for appropriate use of traffic data and summary statistics.

1.4 To measure traffic for summary-statistic calculation, traffic-monitoring practices are also based on the principle of unedited base-data integrity. Missing or inaccurate unedited base data shall not be completed, filled-in, or replaced for any type of traffic measurement.

1.5 A limitation of this practice is traffic-data summarization. Traffic-data summarization procedures are hypotheses, particularly in the use of adjustment factors. These hypotheses shall be consistently calculated, but may also be expected to be challenged and to change across time. These changes will be important in improving the precision of traffic-summary statistics.

1.6 The inherent limitation of traffic-monitoring practice results in strict adherence to the principle of unedited base-data retention. Only with adequate historical unedited base data can alternative hypotheses be tested, the impact of the alternative hypotheses assessed, and standard practice refined.

1.7 The values stated in inch-pound units are to be regarded as standard.

1.8 The following safety hazards caveat applies only to the traffic data collection portion, Section 6, of this practice. *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 determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

E 1318 Specification for Highway Weigh-in-Motion (WIM) Systems with User Requirements and Test Method²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *adjustment factors, n* —traffic summary statistic corrections for multiple-axle vehicles, weekday-traffic variation, seasonal-traffic variation, and regional-traffic characteristics; and, the estimate of annual growth or decline for traffic-summary statistics on road segments not recounted during a year.

3.1.2 *annual average daily traffic (AADT), n* —the estimate of typical traffic on a road segment for all days of the week, Sunday through Saturday, over the period of one year and calculated from permanent-counter data as the sum of Monthly Average Daily Traffic (MADTs) divided by the number of MADTs, and for short-term counts by using adjustment factors.

3.1.3 *annual average days of the week, (AADW), n* —a traffic volume mean statistic for each day of the week, over the period of one year, and calculated from included permanent-counter data as the sum of Monthly Average Days of the Week (MADWs) for a year divided by the number of MADWs.

3.1.4 *annual average weekday traffic, (AAWDT), n* —the estimate of typical traffic over the period of one year, for the days Monday through Thursday, calculated from permanent counter data as the sum of Monthly Average Weekday Traffic (MAWDTs) divided by the number of MAWDTs.

3.1.4.1 *Discussion*—Friday traffic may be included in AAWDT calculation at a permanent-counter site or for summary statistics from permanent counters by functional and operational classification if the inclusion of these data does not increase the AAWDT coefficient of variation.

3.1.5 *annual average weekend traffic, (AAWET), n* —the estimate of typical traffic over the period of one year, for the days Saturday through Sunday, calculated from included permanent-counter data as the sum of Monthly Average Weekend Traffic (MAWETs) divided by the number of MAWETs.

3.1.5.1 *Discussion*—Friday traffic may be included in

¹ This practice is under the jurisdiction of ASTM Committee E-17 on Vehicle Pavement Systems and is the direct responsibility of Subcommittee E17.52 on Traffic Monitoring Device Interconnect.

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² Annual Book of ASTM Standards, Vol 04.03.

AAWDT calculation at a permanent-counter site or for summary statistics from permanent counters by functional or operational classification if the inclusion of these data does not increase the AAWET coefficient of variation.

3.1.6 *annual summary statistics, n*—yearly estimates of the central tendency of traffic volume, vehicle classification, and Equivalent Single Axle Load (ESALs, see 3.1.17) by vehicle classification, based on traffic measurements during the week-day combinations of Sunday through Saturday, Monday through Thursday, and Friday through Sunday.

3.1.6.1 *Discussion*—Calendar year is the most common and recommended basis for the count year.

3.1.7 *annual vehicle miles traveled (AVMT), n*—average annual traffic on a road segment, expressed as AADT multiplied by the number of days in the year, multiplied by the length of the road segment.

3.1.8 *approach, n*—a set of lanes accommodating all left-turn, through, and right-turn movements arriving at an intersection from a given direction.

3.1.9 *axle correction factor, n*—an adjustment of vehicle axle sensor summarized base data for incidence of multiple axle vehicles.

3.1.9.1 *Discussion*—The purpose of the axle correction factor is to account for the incidence of multiple-axle vehicles in the traffic stream.

3.1.10 *base data, n*—the unedited and unadjusted measurements of traffic volume, vehicle classification, and vehicle or axle weight.

3.1.11 *count, n*—the activity of measuring and recording traffic characteristics such as vehicle volume, classification, speed, weight, or a combination of these characteristics.

3.1.12 *count period, n*—the beginning and ending time of traffic characteristic measurement.

3.1.13 *count type, n*—the traffic characteristic being measured, the measurement device, and period.

3.1.14 *daily vehicle miles traveled, (DVMT), n*—average daily traffic on a road segment, expressed as AADT, multiplied by the length of the road segment.

3.1.15 *edit-accepted, adj*—having the unadjusted base data compliant with standards of practice.

3.1.15.1 *Discussion*—The standards of practice are those described in this document combined with edit routines related to specific types and models of traffic-measurement devices and data-retrieval procedures.

3.1.16 *edit-rejected, adj*—having the unedited base data non-compliant with standards of practice.

3.1.16.1 *Discussion*—The standards of practice are those described in this document combined with edit routines related to specific types and models of traffic-measurement devices and data-retrieval procedures.

3.1.17 *equivalent single axle load, (ESAL), n*—a numerical factor that expresses the relationship of a given axle load to another axle load in terms of their effect on the serviceability of a pavement structure.

3.1.17.1 *Discussion*—In common usage, all axle loads are equated in terms of the equivalent number of repetitions of an 18 000 lb single axle.

3.1.18 *excluded counters, n*—permanent traffic counters for

which monthly traffic adjustment factors may not be calculated for a given year.

3.1.19 *functional classification, n*—the grouping of streets and highways into classes, or systems, according to the character of service they are intended to provide.

3.1.19.1 *Discussion*—Basic to functional classification is the recognition that individual roads do not serve travel independently in any major way. Most travel involves movement through a network of roads. It is helpful and necessary to determine how travel can be channelized within the road network in a logical and efficient manner. Functional classification is a way of describing how travel is channelized and the part that a particular road or street plays in serving the flow of trips through the road network.³

3.1.20 *included counters, n*—permanent-traffic counters for which monthly traffic adjustment factors may be calculated for a given year, based on the quantity of edit-accepted data.

3.1.21 *isolated ramps, n*—an interstate interchange ramp at which the traffic flow is not influenced by upstream or downstream ramps.

3.1.22 *MADT*—see *monthly average daily traffic*.

3.1.23 *manual count, n*—measurement of traffic characteristics based on human observation, which may or may not be electronically recorded.

3.1.24 *mechanical count, n*—measurement of traffic characteristics by sensors and electronic recording of the measurements, independent of human observations.

3.1.25 *monthly average daily traffic, (MADT), n*—the mean traffic volume for a month, calculated by the sum of Monthly Average Days of the Week (MADWs) divided by seven; or, in the absence of a MADW for each day of the week, divided by the number of MADWs during the month.

3.1.26 *monthly average days of the week, (MADWs), n*—a traffic volume mean statistic for each day of the week, over the period of one month, calculated from included permanent counter data as the sum of all traffic for each day of the week (Sunday, Monday, and so forth through the week), during a month, divided by the occurrences of that day during the month.

3.1.27 *monthly average weekday traffic, (MAWDT), n*—the four-day average of traffic for the period Monday through Thursday in each month, calculated as the sum of MADWs for Monday through Thursday, divided by four.

3.1.27.1 *Discussion*—Friday traffic may be included in MAWDT calculation if the inclusion of these data does not increase the coefficient of variation. If Friday traffic is included, MAWDT is the five-day average of traffic for the period Monday through Friday in each month, calculated as the sum of MADWs for Monday through Friday, divided by five.

3.1.28 *monthly average weekend traffic, (MAWET), n*—the two-day average of traffic for the period Saturday through Sunday in each month, calculated by the sum of MADWs for Saturday through Sunday divided by the number of MADWs for Saturday through Sunday during the month.

3.1.28.1 *Discussion*—Friday traffic may be included in

³ *Highway Functional Classification Concepts, Criteria and Procedures*, March 1989, U.S. Department of Transportation, Federal Highway Administration, Washington, DC 20590.

MAWET calculation if the inclusion of these data does not increase the coefficient of variation. If Friday traffic is included, MAWET is the three-day average of traffic for the period Friday through Sunday in each month, calculated as the sum of MADWs for Friday through Sunday, divided by three.

3.1.29 *monthly classification ratio*, (MCR), n —the monthly average volume by vehicle classification divided by the annual average volume by vehicle classification, calculated for vehicle classification annual summary statistics.

3.1.30 *monthly traffic ratio*, (MTR), n —the monthly average traffic volume divided by the annual average traffic volume, calculated for traffic volume annual summary statistics.

3.1.31 *monthly weight ratio*, (MWR), n —the monthly average ESALs by vehicle classification divided by the annual average ESALs by vehicle classification, calculated for the vehicle weight annual summary statistics.

3.1.32 *operational classification*, n —the grouping of permanent-counter sites, and roadways, on the basis of observed variation in traffic measurements, rather than designed purpose of the roadways.

3.1.33 *permanent counter*, n —a device intended to continuously measure and periodically record traffic volume, vehicle classification, or weight, or combination thereof.

3.1.34 *polling*, n —automated transfer of traffic measurements from permanent counters to a computer for editing and summarization.

3.1.35 *portable counter*, n —a device which may be moved to various locations and periodically measures and records traffic volume, vehicle classification, or weight, or combination thereof.

3.1.36 *rural area*, n —individual agencies may have a political boundary definition of rural, which would be the definition for traffic-monitoring purposes; in the absence of such an individual agency definition, a rural area is defined as an area outside of a community with a population of 5000 persons or more.

3.1.36.1 *Discussion*—If an agency's political definition differs from this definition of rural, the exception must be documented.

3.1.37 *seasonal factor*, n —a summarized short-term count adjustment for variability by period of year, which can be based on monthly, weekly or daily factors when estimating typical annual traffic characteristics.

3.1.37.1 *Discussion*—An alternative to defining seasonal factors as months or weeks is to use edit-accepted data variability during the year. This alternative may result in separate seasons for traffic volume, vehicle classification, and weight.

3.1.38 *thirtieth highest hour*, n —for all edit-accepted hours of data during a one-year period, the thirtieth highest hourly traffic volume; this volume is commonly used as a representative hour of traffic volume in roadway design.

3.1.39 *traffic volume*, n —the number of motorized highway vehicles with two or more axles passing a point on a roadway in a unit of time.

3.1.40 *urban area*, n —individual agencies may have a political boundary definition of urban, which would be the

definition for traffic-monitoring purposes; in the absence of such an individual agency definition, an urban area is defined as a community with a population of 5000 persons or more.

3.1.41 *validation count*, n —measurement of traffic characteristics for acceptance testing of a separate traffic measurement on the same road segment.

3.1.42 *vehicle classification*, n —the identification, summarization and reporting of traffic volume by vehicle configuration.

3.1.43 *vehicle miles traveled*, (VMT), n —average Sunday through Saturday vehicle movement on a specific road segment multiplied by the length of the road segment, reported in the form of daily and annual VMT; this statistic is also referred to as “vehicle miles of travel.”

3.1.44 *weekday traffic factor*, n —the relationship of MAWDT to MADT and MAWET, from permanent counters, used to adjust short-term weekday counts to MADT and MAWET.

3.1.44.1 *Discussion*—In operational classification this short-term count adjustment factor may be based on the relationship of periods of time other than day, week, and month.

3.1.45 *weigh in-motion*, (WIM), n —the process of estimating a moving vehicle's gross weight and the portion of that weight that is carried by each wheel, axle, or axle group, or combination thereof, by measurement and analysis of dynamic vehicle tire forces. (See Specification E 1318.)

4. Summary of Practices

4.1 Traffic-monitoring practice constitutes the collection, summarization, and reporting of traffic volume, vehicle classification, and vehicle weight.

5. Significance and Use

5.1 This practice addresses both short-term and long-term measurement of traffic characteristics, using either portable or permanent measurement and recording devices. Where mechanical or electronic devices cannot be used for traffic volume and classification, manual procedures are described. It provides a reference for improving traffic-monitoring practice by governmental agencies and private firms.

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

6. Measurement and Summarization Procedures

6.1 General measurement and summarization procedures in traffic monitoring are related to traffic volume, vehicle classification, and weight.

6.1.1 *Traffic volume*—Traffic monitoring includes measuring and recording traffic volume.

6.1.1.1 Traffic volume is in part monitored by permanent traffic recording devices operated on a continuous basis.

6.1.1.2 Traffic volume is also in part monitored by portable counters operated on a short-term basis on a given road segment. Traffic counts are for all traffic on a road segment and may include traffic direction and lane use. Short-term mechanical volume measurement on non-interstate rural roads will

have a planned duration of 48 consecutive hours of data reported from each short-term count site. Short-term mechanical volume measurement on non-interstate urban roads will have a planned duration of 24 consecutive hours of data reported from each short-term count site. On both rural and urban roads, if portable equipment fails with less than 24 complete and edit-accepted hours of data collection, retake the count. This count duration includes screenline or cordon counts, and project or research site specific applications. The date associated with the traffic count is the first calendar day during which there are 24 hourly edit-accepted traffic measurements; or, in the absence of 24 hourly traffic measurements during one calendar day, the calendar day with the most consecutive edit-accepted hours of data. If there are 48 consecutive hours of data, divide the sum of hourly measurements by two to provide the unadjusted 24-h volume. If there is a minimum of 24 consecutive hours of data, but less than 48 h, use the first 24 consecutive hours of edited-accepted data as the unadjusted 24-h volume.

6.1.1.3 Count traffic volume on urban and rural interstate roads and interchange ramps for a minimum of 48 consecutive hours. Interchange ramps which are considered as influenced by upstream or downstream ramps, as opposed to isolated ramps, should be counted in the same 48 h period, and minimally shall be counted within the same seasonal adjustment period. Interstate interchange traffic volume monitoring may include analysis of traffic on the contiguous upstream and downstream interstate road segments. If traffic counts were taken on the contiguous interstate segments in the same or prior year, no additional measurement activity is required. If no traffic counts were taken on the contiguous upstream and downstream interstate segments, it is recommended that interchange traffic monitoring include counts on the interstate road segments. If traffic volume counts are taken on the interstate road segments, the counts shall be a minimum of 48 h, with notation of days of week counted, conducted in the same seasonal adjustment period as the interchange ramp monitoring.

6.1.2 *Vehicle Classification* is another type of traffic monitoring. Vehicle classification mechanical measurement shall be based on, or capable of direct translation to, the Federal Highway Administration thirteen vehicle classifications.⁴

6.1.2.1 Measure continuous vehicle classification by permanent counters which collect vehicle classification data at a specific point on a road segment. The devices record the number of axles per vehicle, and store individual records or records aggregated by classification within a discrete time period. Maintain all records by lane. Permanent traffic recorder installations may combine periodic measurement of total volume, with periodic measurement of vehicle classification. This reduces the quantity of data collected by primary measurement of traffic volume, while sampling the classification of vehicles comprising the traffic stream. The period of classification sampling should be based on an estimate of seasonality of vehicle composition in the traffic stream. In the absence of

site-specific measurement of seasonality, it is recommended that a minimum of one week of vehicle classification data be collected during each quarter over the period of one year.

6.1.2.2 Short-term mechanical classification measurement on non-interstate rural roads shall have a planned duration of 48 consecutive hours of data reported from each short-term monitoring site. Short-term mechanical classification measurement on non-interstate urban roads shall have a planned duration of 24 consecutive hours of data reported from each short-term count site. In both rural and urban areas, if portable equipment fails with less than 24 complete, consecutive hours of data collection, retake the count. This standard includes screenline or cordon counts, and project or research site specific applications.

6.1.2.3 Count vehicle classification on urban and rural interstate roads and interchange ramps for a minimum of 48 consecutive hours. If interchange ramps are considered influenced by upstream or downstream ramps, as opposed to isolated ramps, the ramps should be counted in the same 48 h period, and minimally shall be counted within the same seasonal adjustment period. Interstate interchange vehicle classification traffic monitoring may include analysis of traffic on the contiguous upstream and downstream interstate road segments. If traffic counts were taken on the contiguous interstate segments in the same or prior year, no additional measurement activity is required. If no traffic counts were taken on the contiguous upstream and downstream interstate segments, it is recommended that interchange traffic monitoring include counts on the interstate road segments. If vehicle classification counts are taken on the interstate road segments, the counts shall be a minimum of 48 h, weekday counts, conducted in the same seasonal adjustment period as the interchange ramp monitoring.

6.1.2.4 Manual vehicle classification may be taken at intersections where manual classification is not practical. In manual counts of turning movements at urban intersections, Federal Highway Administration classifications are preferred, but the measurement may be aggregated by passenger cars and trucks, in which trucks are commercial vehicles with Gross Vehicle Weights typically 1.5 tons and heavier. Monitor interstate interchange ramp/street junctions by the same traffic-monitoring procedures identified for intersections. Short-term manual measurements at intersections shall include turning movements. Conduct the counts within a given day, or between two consecutive weekdays, Monday through Thursday. The minimum fixed measurement periods will be from 0700 to 1000 and 1500 to 1800. This provides two traffic monitoring periods during the day, each of a 3-h duration, for a total of 6 h of data collection. A flexible intersection count period may be defined based on observed peak traffic observations. The typical morning and evening peak hours may each be defined, using 15-min intervals rather than the clock hour. One hour before and one hour after the anticipated peak hour may be defined. This results in two traffic-monitoring periods during the day, each of a 3-h duration, for a total of 6 h of data collection. At urban intersections an additional third peak period around the noon hour may be monitored. The third fixed time period shall be from 1100 to 1400; and, if selected, the

⁴ *Traffic Monitoring Guide*, June 1985, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Planning, Washington, DC 20590.