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# Standard Practice for Highway Traffic Monitoring Truth-in-Data[1]

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## 1. Scope

1.1 Traffic monitoring truth-in-data is the disclosure of how data are managed from field data collection through evaluation, acceptance, summarization and reporting. Through this disclosure, truth-in-data permits traffic monitoring summary statistics to be recalculated from the base data.

1.1.1 Truth-in-data can be applied in all traffic monitoring programs at all levels of investment and development. Temporary manual field activities and permanent data gathering installations share a common interest in and need for the ability to check and confirm reported traffic statistics. This is the irreducible minimum for both sharing traffic data over time within an agency, and at a point of time and over time among agencies.

1.1.2 Truth-in-data also permits alternative assessment of the base data. The ability to recalculate traffic statistics from base data provides the opportunity to use different assumptions or to apply different adjustment factors. As understanding of traffic data proceeds, truth-in-data permits equivalent longitudinal assessment of traffic summary statistics through consistent adjustment and treatment of base data over a study period.

1.1.3 Truth-in-data is the foundation for all traffic monitoring programs because of its applicability to all traffic monitoring programs, its support of meaningful sharing of data among diverse programs, and its contribution to understanding and applying data for the improvement of traffic management.

1.2 *Units*—The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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:*[2]

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E2259 Guide for Archiving and Retrieving Intelligent Transportation Systems-Generated Data

E2300 Specification for Highway Traffic Monitoring Devices

E2468 Practice for Metadata to Support Archived Data Management Systems

E2532 Test Methods for Evaluating Performance of Highway Traffic Monitoring Devices

E2665 Specification for Archiving ITS-Generated Traffic Monitoring Data

E2667 Practice for Acquiring Intersection Turning Movement Traffic Data

## 3. Terminology

3.1 *Definitions:*

3.1.1 *accepted reference value, n*—a particular quantity (for example, number of vehicles in a particular class defined by number of axles and interaxle spacing, vehicle count, lane occupancy, or vehicle speed) that is agreed upon in advance of testing of a Traffic Monitoring Device (TMD), which has an uncertainty appropriate for the given purpose. **E2300**

3.1.2 *accuracy, n*—closeness of agreement between a test result, such as a value indicated by a TMD, and an accepted reference value. **E177**

3.1.3 *base data, n*—traffic field measurements that have not been adjusted. **E2667**

3.1.4 *base data integrity, n*—retention of traffic monitoring field measurements without modification. Base Data Integrity is a component of ruth in Data. **E2667**

3.1.5 *bias, n*—the difference between the expectation of the test results, such as values indicated by a TMD, and a related reference value.

3.1.5.1 *Discussion*—Bias is the total systematic error as contrasted to random error. There may be one or more

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

systematic error components contributing to the bias. A larger systematic difference from the accepted reference value is reflected by a larger bias value. **E177**

3.1.6 *metadata, n*—definitional and descriptive data that provide information about or documentation of other data managed within an application or environment. **E2665**

3.1.7 *percent difference, n*—percent difference is defined as an absolute value given by:

$$\text{Percent Difference} = \frac{\left|\text{TMD Output Value} - \text{Accepted Reference Value}\right|}{\text{Accepted Reference Value}} \times 100 \quad (1)$$

where:

TMD = Traffic Monitoring Device

**E2300**

3.1.8 *precision, n*—the closeness of agreement between independent test results obtained under stipulated conditions

3.1.8.1 *Discussion*—Precision depends on random errors and is not related to the accepted reference value or set of accepted reference values. **E177**

3.1.9 *sensor, n*—a device for acquiring a signal that provides data to indicate the presence or passage of a vehicle or of a vehicle component over a detection area with respect to time (for example, vehicle flow, number of axles and their spacing); or, one or more distinctive features of the vehicle such as height or mass. **E2300**

3.1.10 *traffic monitoring device, n*—equipment that counts and classifies vehicles and measures vehicle flow characteristics such as vehicle speed, lane occupancy, turning movements, and other items typically used to portray traffic movement. TMD components include sensor input, electronics that convert an impulse into an electrical signal, then amplify, filter, and otherwise condition the signal. The signal may be translated into vehicle data within the device, downloaded or electronically transmitted and separately processed. **E2300**

3.1.11 *variability, n*—sources that affect the precision and bias of the results of a repeated application. The sources of variability include personnel training and operation; technology; environment; sample; and time-span over which measurements are made. **E177**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *adjustment factor, n*—a multiplicative factor that adjusts a parameter for a base condition to represent a prevailing condition.

3.2.2 *cluster analysis, n*—a class of statistical techniques that can be applied to data to identify natural groupings. Cluster analysis sorts through raw data and groups them into clusters. Objects in a cluster are similar to each other. They are also dissimilar to objects outside the cluster, particularly objects in other clusters. Cluster analysis may be used to group data from continuous traffic recorders. Similarly grouped data may be used to calculate adjustment factors.

3.2.3 *grade, n*—the slope (ratio of change in elevation to change in distance) of a roadway typically given in percent. Grade is considered in traffic monitoring to ensure that vehicle speeds are operating in free flow condition.

3.2.4 *manual traffic count, n*—traffic data collected from the field observations by one or more persons.

3.2.5 *traffic monitoring data, n*—data collected, summarized and reported to estimate travel characteristics for one or more traffic monitoring infrastructure segments or points.

3.2.6 *traffic monitoring infrastructure, n*—for motorized transportation, traffic monitoring infrastructure may be a road network segment or point. For non-motorized transportation, traffic monitoring infrastructure may be a road lane, sidewalk, path or trail segment or point.

3.2.7 *traffic monitoring stages, n*—the steps of traffic monitoring field data collection, evaluation, acceptance, summarization and reporting.

## 4. Significance and Use

4.1 There are general references to the principle of truth-in-data as found in Guide E2259 and Practice E2667. While these references are helpful, without clarification differences occur within agencies over time as well as among agencies in how truth-in-data is implemented. In the absence of a standard practice for truth-in-data, documentation in some governmental agencies is neither comprehensive nor consistent. For some organizations, truth-in-data is an exception to common practice and occurs only in response to a specific request to understand a specific traffic data set or summary statistic from a traffic data set. This practice provides a consistent approach to truth-in-data implementation.

4.1.1 *Traffic Monitoring Stages*—Traffic monitoring truth-in-data describes how base data are treated at each traffic monitoring stage from field data collection through evaluation, acceptance, summarization and reporting.

4.1.2 *Benefits*—Truth in data provides a means of addressing if and how missing or questionable data are modified as part of data acceptance and use. The benefit arises from understanding what data assumptions or adjustment factors, if any, were applied to reported traffic summary statistics. If an adjustment factor or factors were applied, consistent with truth-in-data the source and adjustment factor source characteristics are disclosed. With this type of information, the data user is in a better position to understand the data set and summary statistics, ask questions, and appropriately apply the data. Truth-in-data ensures that traffic data can be correctly interpreted and appropriately used to improve highway operations safety and efficiency.

4.1.3 *Exceptions*—Traffic monitoring truth-in-data does not address subsequent use of the data and summary statistics as in longitudinal studies. Traffic monitoring truth-in-data establishes the basis for appropriate current and longer-term use of base data and summary statistics. Critical use of traffic monitoring data such as in safety analysis depends on the data clarity and integrity identified by implementing truth-in-data. Traffic monitoring truth-in-data does not address data storage. Traffic monitoring truth-in-data describes the conditions leading to acceptance of data for storage and the reporting of data retrieved from storage. The metadata structure for archived

data management systems (ADMS) recommended for traffic monitoring data is presented in Practice E2665. An ADMS is the information management system used to store traffic data with integrity over time.

## 5. Procedure

5.1 The procedure documents traffic monitoring activities by identifying data elements for each traffic monitoring stage and is incorporated into reported traffic summary statistics. If information sought is not applicable, "NA" should be entered. If information sought was not collected, "NC" should be entered.

5.2 *Field Data Collection:*
5.2.1 *Resources:*
5.2.1.1 *People:*
*(1)* Training of person(s) collecting traffic monitoring data.
*(2)* Years experience of person(s) collecting traffic monitoring data.
5.2.1.2 *Technology:*
*(1)* Traffic monitoring device manufacturer and type, model, and software version.
*(2)* Device(s) purchase or installation date and repair history.
*(3)* Device(s) calibration.
5.2.1.3 *Standards or Guidelines Implemented for Field Data Collection:*
*(1)* Device manufacturer recommended practice.
*(2)* National standard or guideline (specify).
5.2.2 *Types of Traffic Monitoring:*
5.2.2.1 *Manual:*
*(1) Type(s) of Facilities:*
*(a)* Road segments:
*(i)* Functional Classification.
*(ii)* Access control.
*(b)* Road intersections or other points.
*(c)* Sidewalks.
*(d)* Trails.
*(e)* Paths.
*(2) Types of Data Collected:*
*(a)* Motorized traffic.
*(b)* Non-motorized traffic.
*(3) Period of Data Collection:*
*(a)* Month and year.
*(b)* Day(s) of week.
*(c)* Time(s) of day.
5.2.2.2 *Technology-Based* (consistent with the technologies listed in 5.2.1.2, and with automated data collection, Practice E2532, Appendix X2):
*(1) Type(s) of Facilities:*
*(a)* Road segments:
*(i)* Functional Classification.
*(ii)* Access control.
*(b)* Road intersections or other points.
*(c)* Sidewalks.
*(d)* Trails.
*(e)* Paths.
*(2) Types of Data Collected:*
*(a)* Motorized traffic.
*(b)* Non-motorized traffic.
*(3) Period of Data Collection:*
*(a)* Month and year.
*(b)* Day(s) of week.
*(c)* Time(s) of day.
*(d)* Break or interruption in the count:
*(i)* Time.
*(ii)* Duration.
*(iii)* Cause.
5.2.3 *Traffic Monitoring Location identification:*
5.2.3.1 *Global Positioning System (GPS) Location:*
*(1)* Device type.
*(2)* Measurement error.
*(3)* Datum.[3]
5.2.3.2 *Other Location Identification:*
*(1)* Methodology.
*(2)* Measurement error.
5.2.4 *Traffic Monitoring Site Conditions:*
5.2.4.1 *Physical Characteristics:*
*(1)* Grade.
*(2)* Lanes.
*(3)* Other.
5.2.4.2 *Operational Characteristics:*
*(1) Monitoring Location or Locations:*
*(a)* Manual count staff.
*(b)* Technology.
*(2) Potential Sources of Traffic Disruption that May Affect the Traffic Data Collected:*
*(a)* Infrastructure construction or maintenance.
*(b)* Other (specify).
5.2.4.3 *Weather.*

5.3 *Evaluation—Identification of Missing, Incomplete or Erroneous Traffic Monitoring Data:*
5.3.1 *Resources:*
5.3.1.1 *People:*
*(1) Training:*
*(a)* Training of person(s) evaluating traffic monitoring data.
*(b)* Years experience of person(s) evaluating traffic monitoring data.
*(2) Traffic Monitoring Staff Evaluation of Base Data:*
*(a)* Documentation:
*(i)* Documented formally adopted procedure.
*(ii)* Documented, informal procedure.
*(iii)* Undocumented procedure.
*(b)* Methodology:
*(i)* Percent difference between traffic monitoring count and reference dataset:
· Acceptance tests.
· Indicator of accuracy and bias.
*(ii)* Repeatability (side-by-side counts).
*(iii)* Other (specify).
5.3.1.2 *Technology:*
*(1) Traffic Monitoring Device Internal Software Data Evaluation:*

[3] Federal Geographic Data Committee (FGDC) *Content Standards for Digital Geospatial Metadata* (FGDC-STD-001-1998).

*(a)* Documentation:

*(i)* Evaluation rules are provided for review without ability to modify the rules.

*(ii)* Evaluation rules are provided for review with the ability to modify the rules.

*(iii)* Evaluation rules are internal to the device and are not provided for review.

*(b)* Results of applying the methodology:

*(i)* Data results of applying the rules are provided for review.

*(ii)* Data results of applying the rules are internal to the device and are not provided for review.

*(2) Post-processing Evaluation of Traffic Data Using Computer Software:*

*(a)* Software source, name, and version.

*(b)* Evaluation of data:

*(i)* Data evaluated are reported for review:

· Attribute Accuracy Report (from Practice E2468).

· Other (specify).

*(ii)* Data evaluated are not reported for review.

5.4 *Acceptance—Modification of Traffic Data Prior to Their Inclusion in the Calculation of Summary Statistics:*

5.4.1 *Resources Used to Modify Traffic Data as a Condition of Acceptance:*

5.4.1.1 *People:*

*(1) Training:*

*(a)* Training of person(s) in modifying traffic data.

*(b)* Years experience of person(s) modifying traffic data.

*(2) Documentation:*

*(a)* Documented formally adopted procedure (specify source).

*(b)* Documented, informal procedure (specify source).

*(c)* Undocumented procedure.

5.4.1.2 *Computer Software Used to Modify Traffic Data:*

*(1)* Software source, name, and version.

*(2)* Modified data reported for review.

*(3)* Modified data not reported for review.

5.4.2 *Modification of Traffic Data as a Condition of Acceptance:*

5.4.2.1 *Imputation or Estimation of Missing Data:*

*(1)* Methodology.

*(2)* Source of methodology.

5.4.2.2 *Data Adjustment Factors* (factors may include but are not limited to annual growth factors; axle correction factors; design hour factors; monthly adjustment factors; peak hour factors; and, seasonal adjustment factors):

*(1) Methodology:*

*(a)* Cluster analysis.

*(b)* Roadway functional classification.

*(c)* Other.

*(2) Base Data for the Adjustment Factors:*

*(a)* Adjustment factor base data practices have implemented truth-in-data.

*(b)* Adjustment factor base data practices have not implemented truth-in-data (specify).

5.4.2.3 *Other Data Modification Procedures as a Condition for Acceptance:*

*(1) Procedure:*

*(a)* Methodology (specify).

*(b)* Source (specify).

*(2) Base Data for Other Data Modification Procedures:*

*(a)* Data for other modification procedures have implemented truth-in-data.

*(b)* Data for other modification procedures have not implemented truth-in-data (specify).

5.5 *Summarization:*

5.5.1 *Resources:*

5.5.1.1 *People:*

*(1) Training:*

*(a)* Training of person(s) summarizing traffic monitoring data.

*(b)* Years experience of person(s) summarizing traffic monitoring data.

*(2) Traffic Monitoring Staff Summarization of Base Data:*

*(a) Methodology for Motorized Traffic Monitoring Summary Statistics:*

*(i)* Summarization of motorized traffic monitoring data based on nationally approved methodologies:[4]

· *Traffic Monitoring Guide*, Federal Highway Administration.

· *Traffic Monitoring Procedures for the Highway Performance Monitoring System*, Federal Highway Administration.

· *Guidelines for Traffic Data*, American Association of State Highway and Transportation Officials.

*(ii)* Other (specify).

*(b) Methodology for Non-Motorized Traffic Monitoring Summary Statistics:*

*(i)* Documented formally adopted procedure (specify).

*(ii)* Documented, informal procedure (specify).

*(iii)* Undocumented procedure.

5.5.1.2 *Computer Software Data Evaluation:*

*(1)* Software source, name, and version.

*(2)* Data summarization:

*(a)* Data are summarized based on the nationally approved methodologies.

*(b)* Data are summarized based on other methodologies (specify).

5.6 *Reporting:*

5.6.1 *Summary Statistic(s):*

5.6.1.1 Base data available for review.

5.6.1.2 Evaluation of base data available for review.

5.6.1.3 Acceptance of base data available for review.

5.6.2 *Variability:*

5.6.2.1 Reported.

5.6.2.2 Available.

5.6.2.3 Not available.

5.6.3 *History*—Other summary statistics in the same location for previous periods of time.

5.6.3.1 Reported.

5.6.3.2 Available.

5.6.3.3 Not available.

[4] 23 CFR Ch. I [4-1-04 Edition] Para. 500.203[b] specifies the three listed resources.

## 6. Keywords

6.1 base data integrity; traffic monitoring; truth-in-data