National Performance Measures for Congestion, Reliability, and Freight, and CMAQ Traffic Congestion

General Guidance and Step-by-Step Metric Calculation Procedures

U.S. Department of Transportation
Federal Highway Administration

June 2018

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1.0 General PM3 Performance Measure Development Guidance

Q. How can hourly traffic volumes be estimated for the Peak Hour Excessive Delay measure?

A. The data requirements for Annual Hours of Peak Hour Excessive Delay (PHED) per Capita (23 CFR 490.709(c)) include hourly traffic volumes for each weekday of the calendar year. The regulations offer two possible approaches:[1] 1) use hourly traffic counts from continuous count stations and apply to multiple reporting segments; or 2) use a method to estimate hourly traffic volumes for each weekday using Annual Average daily traffic (AADT) values reported in the Highway Performance Monitoring System (HPMS).

The following guidance is applicable to the second approach. This guidance provides an example of one possible method to estimate hourly traffic volumes using AADT values from HPMS that have been included in the National Performance Management Research Data Set (NPMRDS) segment attributes file (TMC_Identification.csv). Other hourly traffic volume estimation methods may be used. Regardless of the method used, 23 CFR 490.709(c)(3)) requires State DOTs to report to FHWA the method used to develop hourly traffic volumes estimates.

For this example, the following data items will be needed to estimate hourly traffic volumes on each reporting segment:

- AADT value (included in the NPMRDS segment attributes file).
- Facility type (included in the NPMRDS segment attributes file).
- Functional class (included in the NPMRDS segment attributes file).
- Monthly and day-of-week traffic count adjustment factors (default values provided here, also can be calculated from State-specific continuous traffic count stations).
- Annual average time-of-day weekday speed values (calculated from NPMRDS speed data).

[1] 23 CFR 490.709(c)(1).

Under this example, the overall process for estimating hourly traffic volumes is as follows:

- **Directional split.** Apply a directional split adjustment factor to those AADT values that represent both travel directions to estimate directional AADT values.
- **Monthly adjustment.** Apply monthly adjustment factors to each directional AADT value to estimate directional month-by-month average daily traffic volumes.
- **Day-of-week adjustment.** Apply day-of-week adjustment factors to directional monthly average daily traffic volumes to estimate directional average daily traffic values for each month and each day of the week.
- **Hourly estimation.** Apply hourly adjustment factors to estimate directional hourly traffic volume for each day in each month.

These four steps are described in more detail in the following sections.

STEP 1: DIRECTIONAL SPLIT

In Step 1, a directional split adjustment factor is applied to each AADT value that represents two separate directions of travel. The AADT values included in the NPMRDS segment attributes file are obtained from HPMS, which currently reports many attributes for a roadway centerline, and not a specific direction of travel.

The *faciltype* attribute in the NPMRDS segment attributes file is from HPMS and indicates whether the reported AADT value is for a one-way or two-way roadway.[2] Specifically, if *faciltype*=1, then the reporting segment is a one-way roadway and the reported AADT value represents all traffic in that one direction. If *faciltype*=2 or 6, then the reporting segment is part of a two-way roadway and the reported AADT value in the NPMRDS segment attributes file represents both directions of travel. Therefore, when *faciltype*=2 or 6, a directional split adjustment factor must be applied to estimate the portion of AADT that occurs on the direction of the reporting segment. If a specific directional split adjustment factor is not available from other traffic counts, an even directional split (e.g., 50 percent/50 percent) should be assumed. That is, the two-way

[2] 23 CFR 490.101 defines "mainline highways" as the through travel lanes of any highway. Mainline highways specifically exclude ramps, shoulders, turn lanes, crossovers, rest areas, and other pavement surfaces that are not part of the roadway normally traveled by through traffic. Mainline highways in HPMS is identified by Facility Type data value equal to 1, 2, or 6. Please see Chapter 4 in the HPMS Field Manual (December 2016). https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/

AADT value should be multiplied by 50 percent to estimate the directional AADT value for that reporting segment.

STEP 2: MONTHLY ADJUSTMENT

In Step 2, monthly adjustment factors should be applied to each directional AADT value to estimate 12 monthly average daily traffic volume values. The preferred approach is to use continuous count stations within your specific State to calculate monthly adjustment factors for urban and rural functional classes.

However, if calculating monthly adjustment factors from continuous count data is not feasible, Table 1.1 provides national default values for monthly adjustment factors.

Table 1.1 National default values for monthly adjustment factors.

Month of Year	Adjustment Factor
January	94%
February	88%
March	101%
April	101%
May	105%
June	104%
July	105%
August	108%
September	99%
October	104%
November	95%
December	97%

(Source: Derived from Urban road locations in the Federal Highway Administration (FHWA) Traffic Volume Trends.[3])

STEP 3: DAY-OF-WEEK ADJUSTMENT

In Step 3, day-of-week adjustment factors should be applied to each directional monthly average daily traffic volume to estimate monthly average day-of-week daily traffic volume values. The preferred approach is to use continuous count stations within your specific State to calculate day-of-week adjustment factors for urban and rural functional classes for each month.

[3] Traffic Volume Trends (FHWA)—2011-2014 Data: https://www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm.

However, if calculating day-of-week adjustment factors from continuous count data is not feasible, Table 1.2 provides national default values for day-of-week adjustment factors.

Table 1.2 National default values for day-of-week adjustment factors.

Day of Week	Adjustment Factor
Monday to Thursday	105%
Friday	110%
Saturday	90%
Sunday	80%

(Source: Exhibit A-1 in Appendix A: Methodology for the *2015 Urban Mobility Scorecard*, https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-scorecard-2015-appx-a.pdf.)

STEP 4: HOURLY ESTIMATION

In Step 4, hourly adjustment factors are applied to the directional monthly average day-of-week traffic volumes from Step 3. The result from this step is hourly traffic volume estimates for each reporting segment for each month and day of week. These hourly traffic volume estimates are then used directly in the PHED calculations specified in 23 CFR 490.709(c), corresponding to each 15-minute time interval and day of the calendar year.

Like the monthly and day-of-week adjustment factors described in Steps 2 and 3, the hourly adjustment factors can be derived from continuous counters within your State. Alternatively, default national hourly adjustment factors have been developed, and the process for applying these to each reporting segment is described in the following paragraphs.

Previous analytical efforts have developed typical time-of-day traffic profiles at an hourly level.[4, 5] These traffic distribution profiles were developed for the following criteria (resulting in 16 unique time-of-day traffic profiles):

- **Functional Class.** Freeway and nonfreeway.
- **Day Type.** Weekday and weekend.
- **Traffic Congestion Level.** Percentage reduction in speed from free flow (varies for freeways and nonfreeways).

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[4] *Roadway Usage Patterns: Urban Case Studies,* prepared for Volpe National Transportation Systems Center and Federal Highway Administration, July 22, 1994.

[5] Development of Diurnal Traffic Distribution and Daily, Peak and Off-Peak Vehicle Speed Estimation Procedures for Air Quality Planning, Final Report, Work Order B-94-06, prepared for Federal Highway Administration, April 1996.

- **Directionality.** Peak traffic in the morning (AM), peak traffic in the evening (PM), approximately equal traffic in each peak.

The 16 traffic distribution profiles shown in Figure 1.1 through Figure 1.5 are comprehensive, as they were developed from 713 continuous traffic monitoring locations in urban areas of 37 States.

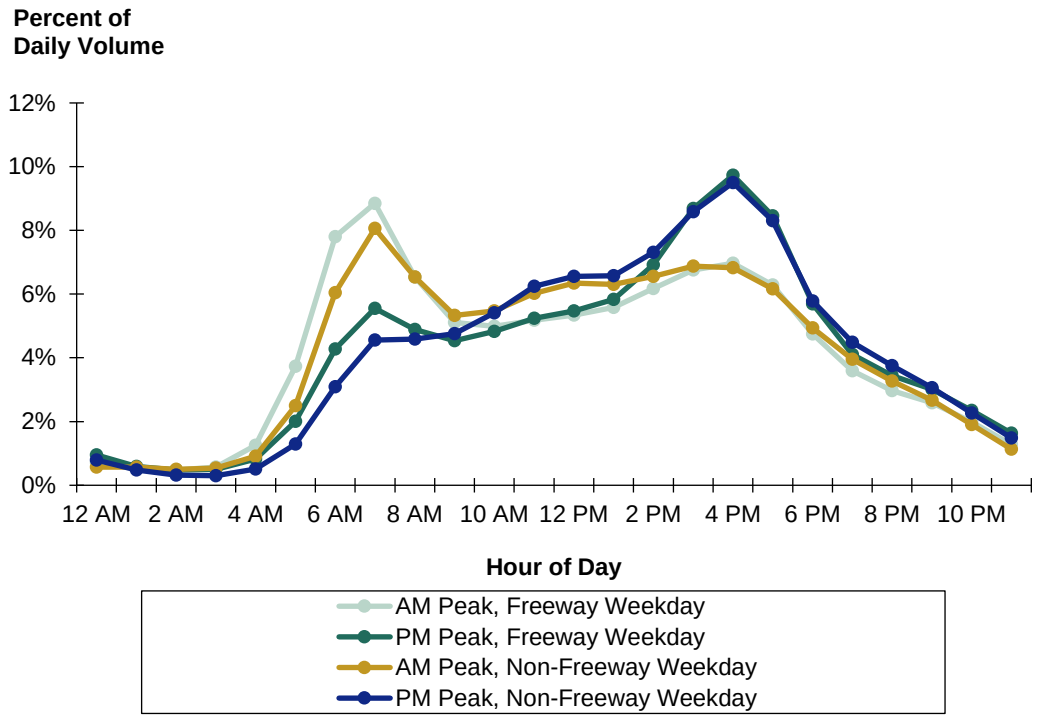

Figure 1.1 Chart. Weekday traffic distribution profile for no to low congestion.

(Source: Margiotta, Richard, Eisele, Bill, and Short, Jeffrey, *Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report,* FHWA-HOP-15-033, August, 2015, https://ops.fhwa.dot.gov/publications/fhwahop15033/index.htm.)

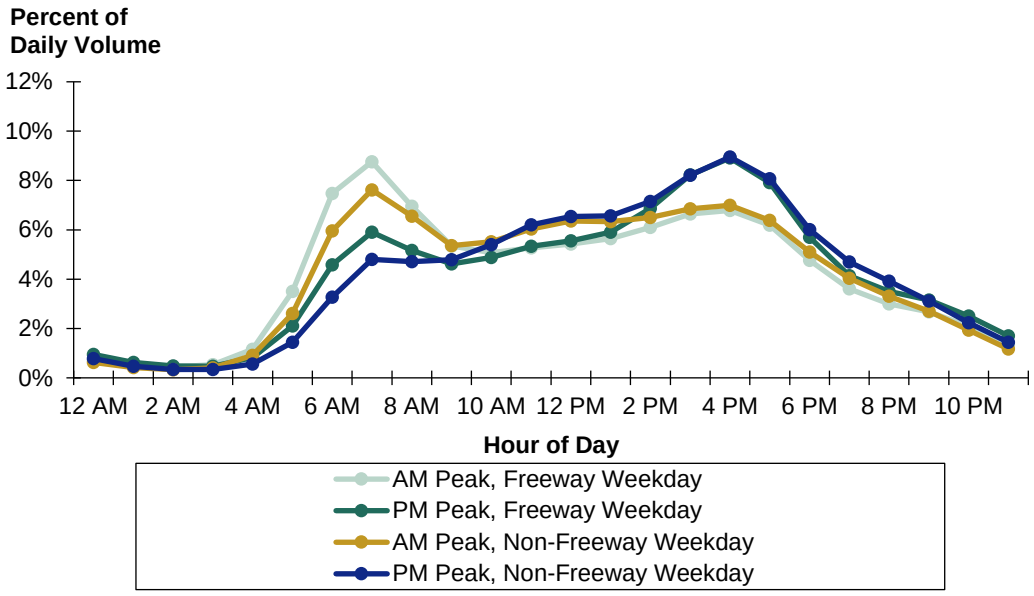

Figure 1.2 Chart. Weekday traffic distribution profile for moderate congestion.

(Source: Margiotta, Richard, Eisele, Bill, and Short, Jeffrey, *Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report,* FHWA-HOP-15-033, August, 2015, https://ops.fhwa.dot.gov/publications/fhwahop15033/index.htm.)

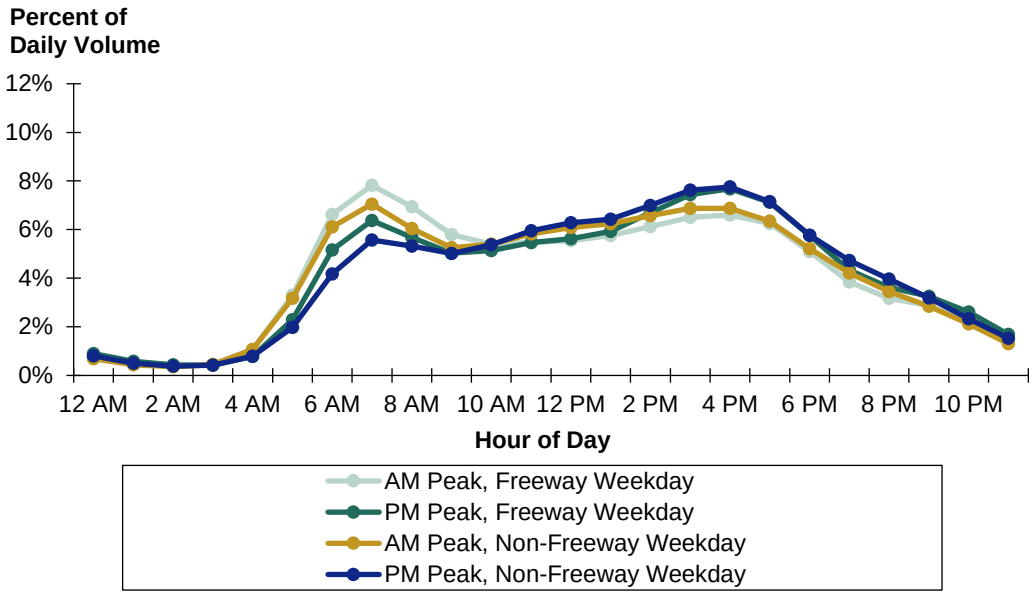

Figure 1.3 Chart. Weekday traffic distribution profile for severe congestion.

(Source: Margiotta, Richard, Eisele, Bill, and Short, Jeffrey, *Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report,* FHWA-HOP-15-033, August, 2015, https://ops.fhwa.dot.gov/publications/fhwahop15033/index.htm.)

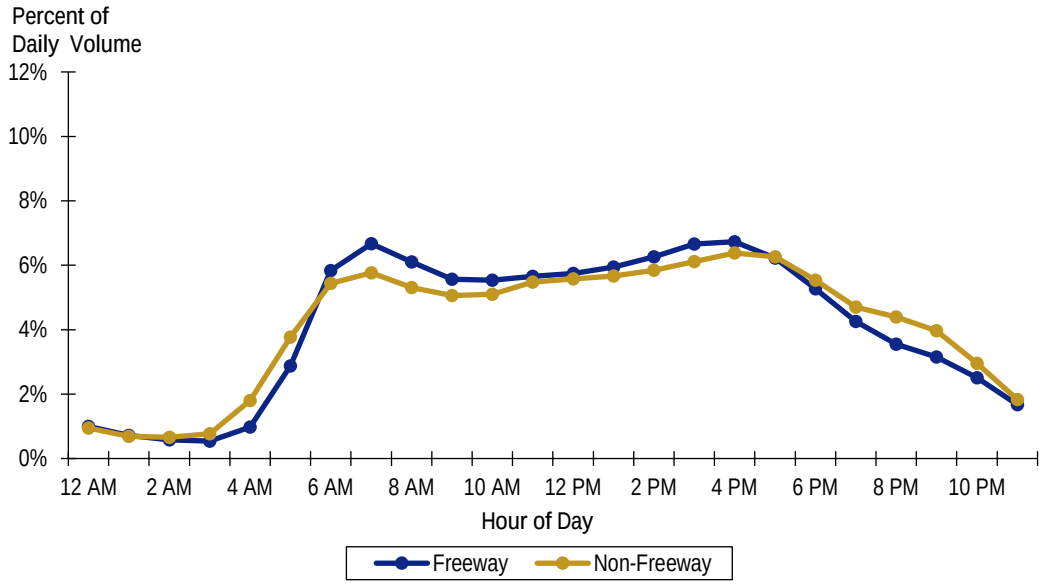

Figure 1.4 Chart. Weekday traffic distribution profile for severe congestion and similar speeds in each peak period.

(Source: Margiotta, Richard, Eisele, Bill, and Short, Jeffrey, *Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report,* FHWA-HOP-15-033, August, 2015, https://ops.fhwa.dot.gov/publications/fhwahop15033/index.htm.)

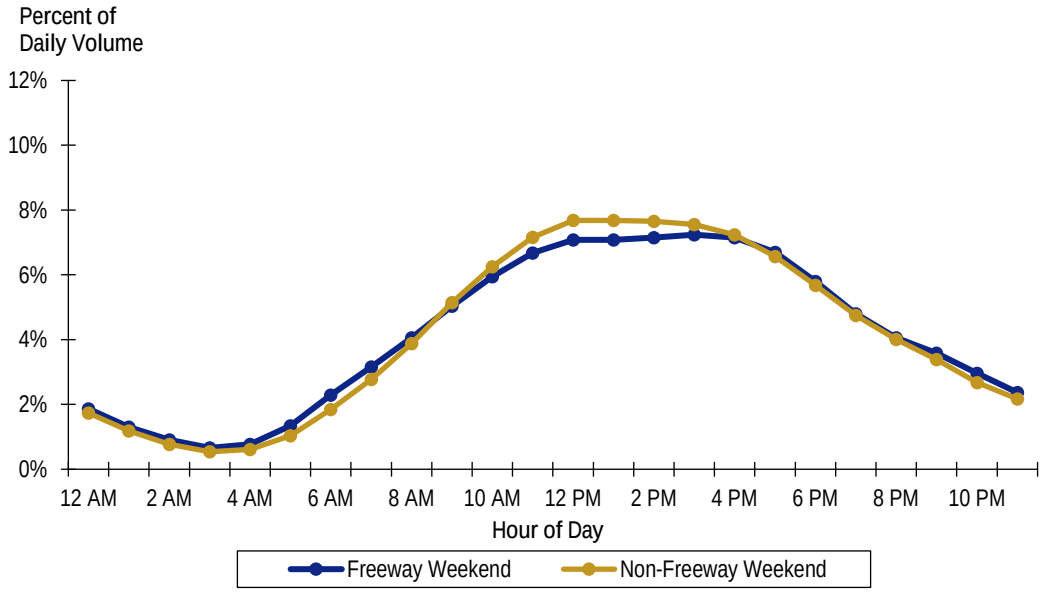

Figure 1.5 Chart. Weekend traffic distribution.

(Source: Margiotta, Richard, Eisele, Bill, and Short, Jeffrey, *Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report,* FHWA-HOP-15-033, August, 2015, https://ops.fhwa.dot.gov/publications/fhwahop15033/index.htm.)

To determine which of the 16 traffic distribution profiles should be assigned to each reporting segment, the following guidance is provided:

- **Functional Class.** Assign based on *f_system* in NPMRDS segment attributes file):
  - Freeway. *f_system*=1 or 2.
  - Nonfreeway. *f_system*=3, 4, 5, 6, or 7.
- **Day Type.** Assign volume based on each day of week:
  - **Weekday** (Monday through Friday): Use Figure 1.1 to Figure 1.4.
  - **Weekend** (Saturday and Sunday): Use Figure 1.5.
- **Traffic Congestion Level.** Assign based on the peak-period speed reduction percentage calculated from NPMRDS in the calendar year on each reporting segment. Note that congestion level is used only to determine weekday traffic profile assignments, and is not used for weekend traffic profile assignment.
  - Calculate a simple average peak-period speed (add up all the morning and evening peak-period speeds, and divide the total by the eight periods in the eight peak hours) for each reporting segment using speed data from 6:00 a.m. to 10:00 a.m. (morning peak period) and 3:00 p.m. to 7:00 p.m. (evening peak period). Alternatively, one could use speeds from 4:00 p.m. to 8:00 p.m. if those hours are used to represent the evening peak period in calculating the PHED metric.
  - Calculate a free-flow speed during light traffic hours (e.g., simple average speed for all hours between 10:00 p.m. to 5:00 a.m. on all days).
  - Calculate the peak-period speed reduction percentage for each reporting segment by dividing the average combined peak-period speed by the free-flow speed.

$$\underset{Reduction\ Factor}{Speed} = \frac{\underset{Period\ Speed}{Average\ Peak}}{\underset{(10\ pm\ to\ 5\ am)}{Free - Flow\ Speed}}$$

Figure 1.6 Equation.

(Source: Margiotta, Richard, Eisele, Bill, and Short, Jeffrey, Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report, FHWA-HOP-15-033, August, 2015, https://ops.fhwa.dot.gov/publications/fhwahop15033/index.htm.)

For Freeways:

- No to Low Congestion. Speed reduction factor ranging from 90 percent to 100 percent.

  - Moderate Congestion. Speed reduction factor ranging from 75 percent to 90 percent.
  - Severe Congestion. Speed reduction factor less than 75 percent.
- **For Nonfreeways:**
  - No to Low Congestion. Speed reduction factor ranging from 80 percent to 100 percent.
  - Moderate Congestion. Speed reduction factor ranging from 65 percent to 80 percent.
  - Severe Congestion. Speed reduction factor less than 65 percent.
- **Time Period Peaking.** Assign based on difference between average morning and evening peak-period speeds, as calculated from NPMRDS in the calendar year on each reporting segment. Note that time period peaking is used only to determine weekday traffic profile assignments, and is not used for weekend traffic profile assignment.
  - Calculate the average morning peak-period speed (6:00 a.m. to 10:00 a.m.) and the average evening peak-period speed (3:00 p.m. to 7:00 p.m.) from NPMRDS for each reporting segment in the calendar year. Note that the average morning peak-period speed should be calculated separately from the average evening peak-period speed.
  - Compare the morning peak-period speed to the evening peak period speed.
- **For Freeways and Nonfreeways:**
  - AM Peak. Morning peak-period speed is slower than evening peak period speed by 6 mph or more. Use Figure 1.1, Figure 1.2, or Figure 1.3, corresponding to the congestion level computed in an earlier step.
  - PM Peak. Evening peak-period speed is slower than morning peak-period speed by 6 mph or more. Use Figure 1.1, Figure 1.2, or Figure 1.3, corresponding to the congestion level computed in an earlier step.
  - Similar Speeds in each Peak (Figure 1.4). Difference between morning and evening peak-period speed is less than 6 mph.

In summary, to use these figures, the following steps should be followed:

1. Determine Day Type
    a. For weekdays, use Figure 1.1, Figure 1.2, Figure 1.3, or Figure 1.4
    b. For weekend days, use Figure 1.5
2. Select Chart to use based on Congestion Level (definition in step description)
    a. For no to low congestion, use Figure 1.1

b. For moderate congestion, use Figure 1.2

c. For severe congestion, use either Figure 1.3 or Figure 1.4

3. Select Profile Line to use based on Time Period Peaking

   a. For Figure 1.1 and Figure 1.2, select the profile corresponding to the time peaking and functional class

   b. For severe congestion, select Figure 1.3 if there is a distinct time period peak in AM or PM (one period is 6 mph slower than other)

   c. For severe congestion, select Figure 1.4 if difference between AM and PM peak speeds is less than 6 mph

Q. IF DESIRED, HOW ARE ROAD CLOSURES EXCLUDED FROM METRIC CALCULATION?

A. The final rule describing the National Performance Management Measures that assess the performance of the national highway system, freight movement on the Interstate system, and congestion and mitigation and air quality improvement programs[6] allows for the omission of roads that are closed when calculating metrics and measures for Travel Time Reliability (23 CFR 490.507(a)), the Truck Travel Time Reliability Index (23 CFR 490.607), and Peak Hours of Excessive Delay (23 CFR 490.707).

- *If an NHS roadway is closed, the State DOT is not required to include those time periods for those segments of road in the calculations required for the* ***Level of Travel Time Reliability*** *(LOTTR) metric. 23 CFR 490.509(e)*
- *If an NHS roadway is closed, the State DOT is not required to include those time periods for those segments of road in the calculations required for the* ***Freight Reliability metric/measure****. 23 CFR 490.609(d)*
- *If an NHS roadway is closed, the State DOT is not required to include those time periods for the segment of road in the calculations required for this metric and measure* ***[Peak Hour Excessive Delay]****. 23 CFR490.709(c)(5)*

If an agency does not want to consider portions of the NHS that are closed when calculating annual performance measures, they may remove those segments and associated travel time data (if present) for the time periods that are applicable

[6] Final Rule on "National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program": Docket No. FHWA–2013–0054, RIN 2125–AF54, Federal Register - Vol. 82, No. 11, Pg. 5970 - January 18, 2017: https://www.gpo.gov/fdsys/pkg/FR-2017-01-18/pdf/2017-00681.pdf.

and then calculate travel time measures as described in Section 2 of this document.

To accomplish this, agencies must have a record of the road closure location(s) and time and duration, so that applicable reporting segments and travel time data can be identified in the travel time data set and then removed for the duration of the road closure.

2.0 Step-by-Step Calculation Procedures for PM3 Metrics

DEFINITIONS[7]

- *Highway Performance Monitoring System (HPMS)* is a national-level highway information system that includes data on the extent, condition, performance, use, and operating characteristics of the Nation's highways.
- *Measure* means an expression based on a metric that is used to establish targets and to assess progress toward achieving the established targets.
- *Metric* means a quantifiable indicator of performance or condition. Metrics are used to calculate measures.
- *National Performance Management Research Data Set (NPMRDS)* means a data set derived from vehicle/passenger probe data (sourced from Global Positioning Station (GPS), navigation units, cell phones) that includes average travel times representative of all traffic on each mainline highway segment of the National Highway System (NHS), and additional travel times representative of freight trucks for those segments that are on the Interstate System. The data set includes records that contain average travel times for every 15 minutes of every day (24 hours) of the year recorded and calculated for every travel time segment where probe data are available. The NPMRDS does not include any imputed travel time data.
- *Reporting segment* means the length of roadway that the DOT and MPOs define for metric calculation and reporting and is comprised of one or more travel time segments.
- *Target* is a quantifiable level of performance or condition, as a value for the measure, to be achieved within a time period required by FHWA.
- *Travel time reliability* means the consistency or dependability of travel times from day to day or across different times of the day.
- *Travel time segment* means a contiguous stretch of the NHS for which average travel time data are summarized in the travel time data set.
- *Urbanized area boundary* is identified based on the most recent U.S. Decennial Census, unless FHWA approves adjustments to the urbanized area as

[7] 23 CFR 490.101 and 490.103 and 23 CFR 450.104.

provided by 23 U.S.C. 101(a)(34) and these adjustments are submitted to HPMS.

- *Metropolitan Planning Area* is means the geographic area determined by agreement between the MPO for the area and the Governor, in which the metropolitan transportation planning process is carried out.

DATA PREPARATION

DATASET COMPOSITION

The step-by-step procedures that follow use the travel time dataset in the NPMRDS Version 2 as a starting point. If users are using an alternate travel time dataset, they must use a dataset satisfies the requirement specified in 23 CFR 490.103(e) and (f). Two types of travel times need to be present: all vehicles and trucks only. The travel time dataset also must cover all mainline highways[8] on the NHS.[9] In addition, at a minimum, the following data elements for each reporting segment also should be present in the final travel time data set that is used; these come from the Traffic Message Channel (TMC) Identification file in NPMRDS Version 2:

- Reporting segment length ("miles").
- Percent of reporting segment length that is designated as being on the NHS ("nhs_pct").
- State code ("state").
- Urbanized area code ("urban_code," see HPMS Field Manual).[10]
- Functional system ("f_system," see HPMS Field Manual).[11]

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[8] 23 CFR 490.101 defines "mainline highways" as the through travel lanes of any highway. Mainline highways specifically exclude ramps, shoulders, turn lanes, crossovers, rest areas, and other pavement surfaces that are not part of the roadway normally traveled by through traffic. Mainline highways in HPMS is identified by Facility Type data value equal to 1, 2, or 6. Please see Chapter 4 in the HPMS Field Manual (December 2016). https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/.

[9] 23 CFR 490.509(a)(1), 490.609(b), and 490.709(b)

[10] HPMS Field Manual (December 2016): https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/. The Field Manual is incorporated by reference in 23 CFR 490.111.

[11] HPMS Field Manual (December 2016): https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/.

- NHS designation ("nhs," see HPMS Field Manual).[12]
- Direction of traffic ("direction"; eastbound, westbound, northbound, southbound).
- One-way or two-way operation in inventory and non-inventory directions ("faciltype," see HPMS Field Manual).
- Annual Average Daily Traffic[13] ("aadt," see HPMS Field Manual)[14].

OVERVIEW OF DATA PROCESSING

Several other data elements beyond those in the NPMRDS Version 2 must be created in order to calculate the metrics for Travel Time Reliability (23 CFR 490.507(a)), the Truck Travel Time Reliability Index (23 CFR 490.607) and Peak Hours of Excessive Delay (23 CFR 490.707). The approach taken in defining the step-by-step procedures is to add all of these newly created data elements to the NPMRDS. Users may find this structure is inefficient especially when the new data element does not change value much across the data set. In these cases, users may wish to wait to the appropriate place in the processing to introduce these new data elements. Table 2.1 summarizes the additional data elements that are required for calculating the metrics. Details on the new data elements follow Table 2.1.

Table 2.1 Data elements that must be created for metric calculation.

Data Element	Derived From	Used in Metric Calculation for
Hour	measurement_tstamp in NPMRDS.	Defines periods for National Highway Performance Program reliability, freight reliability, and peak hour excessive delay (PHED) metrics.
Day_of_Week	measurement_tstamp in NPMRDS.	Defines periods for National Highway Performance Program reliability, freight reliability, and peak hour excessive delay metrics.

[12] HPMS Field Manual (December 2016): https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/. The Field Manual is incorporated by reference in 23 CFR 490.111.

[13] 23 CFR 490.509(c) and 23 CFR 490.709(d)(1)(ii)

[14] HPMS Field Manual (December 2016): https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/.

Data Element	Derived From	Used in Metric Calculation for
Month	measurement_tstamp in NPMRDS.	May be used in the calculation of 15-minute traffic volumes for the PHED metric.
NHPP_Period	Hour and Day_of_Week. (23 CFR 490.511(b))	NHPP reliability
Freight_Period	Hour and Day_of_Week. (23 CFR 490.611(a))	Freight reliability
Dir_AADT	AADT and faciltype[15] in NPMRDS. (23 CFR 490.509(c) and 23 CFR 490.511(e)(2))	NHPP reliability

[15] Please see the section on "National Highway Performance Program Reliability Metrics" for using facility type value for splitting AADT by direction.

Table 2.1 Data elements that must be created for metric calculation. (continuation)

Average vehicle occupancies of cars, buses, and trucks: AVO_c, AVO_b, and AVO_t	Must be created by users; In accordance with 490.709(e), the average occupancy factors for the State and/or metropolitan area (as applicable) needed to calculate Travel Time Reliability measures must come from the most recently available data tables published by FHWA unless State DOT and MPOs have more specific data for a specific reporting segment(s).	PHED
Traffic proportions of cars, buses, and trucks: P_c, P_b, and P_t	Must be created by users. (23 CFR 490.711(e))	PHED
Posted_Speed_Limit	Must be created by users; many roadway characteristics inventories have speed limit. (23 CFR 490.705)	PHED
Hourly_Percent_Traffic (percent of AADT for the reporting segment and hour)	Must be created by users; continuous count locations can be used to create this data element (see Section 1 of this report). (23 CFR 490.711 (e))	PHED
Volume15—15-minute directional volume	(AADT x Hourly_Percent_Traffic)/4 (23 CFR 490.711 (e))	PHED

IMPORTING/READING THE DATA

1. The travel time data must be summarized to the **15-minute level**.[16] The NPMRDS can be downloaded in this format.
2. Import the travel time file(s). If there are multiple files, create a single file that has travel times in seconds for 1) trucks and 2) passenger cars/trucks combined.
3. If using the NPMRDS, import the TMC Identification file. This file has locational information on the TMCs as well as selected data elements from HPMS that have been conflated to the TMC network. If using an alternative travel time data set, obtain locational data similar to the TMC Identification file.
4. Join the travel time file with the TMC Identification file using TMC as the key.

[16] 23 CFR 490.511(b)(1), 23 CFR 490.611(a)(1), and 23 CFR 711(b)(1).

DATA PREPARATION: JOINED TRAVEL TIME AND LOCATIONAL DATASET

1. Select only those TMC segments where facility type ("faciltype") is equal to 1, 2, or 6.[17]
2. If truck travel times are not available in NPMRDS or are equal to 0, set them equal to the travel time for combined passenger cars and trucks for the corresponding "tmc_segment" and "measurement_tstamp."[18]
3. Parse the NPMRDS field "measurement_tstamp" into date and time; create new data elements:
   a. "Hour" from the time data element.
   b. "Month" from the date data element.
   c. "Day_of_Week" from the date data element, with two values.
      i. Weekdays.
      ii. Weekends.
4. Create a new data element for time periods for the NHPP Reliability ("NHPP_Period") with the following values:[19]
   a. 6:00 a.m.–10:00 a.m., weekdays.
   b. 10:00 a.m.–4:00 p.m., weekdays.
   c. 4:00 p.m.–8:00 p.m., weekdays.
   d. 6:00 a.m.–8:00 p.m., weekends.
5. Create a new data element for time periods for Freight Reliability ("Freight_Period"), with the following values:[20]
   a. 6:00 a.m.–10:00 a.m., weekdays.
   b. 10:00 a.m.–4:00 p.m., weekdays.

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[17] 23 CFR 490.101 defines "mainline highways" as the through travel lanes of any highway. Mainline highways specifically exclude ramps, shoulders, turn lanes, crossovers, rest areas, and other pavement surfaces that are not part of the roadway normally traveled by through traffic. Mainline highways in HPMS is identified by Facility Type data value equal to 1, 2, or 6. Please see Chapter 4 in the HPMS Field Manual (December 2016). https://www.fhwa.dot.gov/policyinformation/hpms/fieldmanual/

[18] 23 CFR 490.609(c)

[19] 23 CFR 490.511(b)

[20] 23 CFR 490.611(a)

c. 4:00 p.m.–8:00 p.m., weekdays.

d. 8:00 p.m.–6:00 a.m., all days.

e. 6:00 a.m.–8:00 p.m., weekends.

Table 2.2 Example calculation, deriving time and date data elements.

Existing Data Elements		New Data Elements			
tmc_code	measurement_tstamp	Hour	Day_of _Week	NHPP_Period	Freight_Period
116N04675	2017-03-01 13:00:00	13	Weekday	10:00 a.m.–4:00 p.m., weekdays	10:00 a.m.–4:00 p.m., weekdays

6. If the PHED metric is to be computed, create new data elements for the following vehicle occupancies:[21]
   a. Average car occupancy (AVO_c).
   b. Average bus occupancy (AVO_b).
   c. Average truck occupancy (AVO_t).
7. If the PHED metric is to be computed, create data elements for the following traffic proportions:[22]
   a. Percent of cars in the traffic stream (P_c).
   b. Percent of buses in the traffic stream (P_b).
   c. Percent of trucks in the traffic stream (P_t).
8. If the PHED metric is to be computed, create a new data element for Posted Speed Limit ("Posted_Speed_Limit").[23]
9. If the PHED metric is to be computed, create a new data element that indicates the percent of AADT that occurs in the hour on this reporting segment ("Hourly_Percent_Traffic").[24] Section 1 of this report discusses the procedure for deriving these factors. It is likely that the factors will reside in a separate data set and will need to be joined. If the hourly percent factor is based on peaking characteristics of traffic, then the peaking characteristics of the reporting segment must first be determined. For example, if the hourly percent factor is based on weekday peaking in the AM and PM periods,

[21] 23 CFR 490.711(b) & (e)

[22] 23 CFR 490.711(e)

[23] 23 CFR 490.711(c)

[24] 23 CFR 490.711(e)

average weekday speeds from the NPMRDS can be used to determine if the reporting segment peaks in the AM or PM. That is, if average speeds are lower in the AM, then it is assumed the reporting segment peaks in the AM.[25]

10. If the PHED metric is to be computed, create a new data element that is the volume of total traffic that occurs on the reporting segment for the 15-minute epoch ("Volume15"). This is done by multiplying AADT by Hourly_Percent_Traffic in the above step, then dividing by 4. The result should be rounded to the nearest tenth.[26]

Table 2.3 Example calculation for creating 15-minute volumes.

tmc_code	AADT	faciltype	Dir_AADT	Time	Hour	Hourly_Percent_ Traffic	Volume15
116N04675	16,600	1	16,600	17:00–17:15	17	0.03500	145.3
116N04675	16,600	1	16,600	17:15–17:30	17	0.03500	145.3
116N04675	16,600	1	16,600	17:30–17:45	17	0.03500	145.3
116N04675	16,600	1	16,600	17:45–18:00	17	0.03500	145.3
118P05761	90,000	2	45,000	8:00–8:15	8	0.03248	365.4
118P05761	90,000	2	45,000	8:15–8:30	8	0.03248	365.4
118P05761	90,000	2	45,000	8:30–8:45	8	0.03248	365.4
118P05761	90,000	2	45,000	8:45–9:00	8	0.03248	365.4

NATIONAL HIGHWAY PERFORMANCE PROGRAM RELIABILITY METRICS

CALCULATION STEPS

1. For MPO reporting, only reporting segments within the MPO Planning Boundary are used in these calculations.
2. For each reporting segment (e.g., TMC) and NHPP time period (NHPP_Period) combination, compute the 50th and 80th percentile travel times for all vehicles.[27] Do not round the percentiles. These statistics are derived from travel time distributions that are created for each of the four time periods and for each of the reporting segments individually. Figure 2.1 shows the distribution of travel times for a TMC located on an urban

[25] See Section 1.0.

[26] 23 CFR 490.711(d)(2).

[27] 23 CFR 490.511(c)

freeway. Table 2.4 shows how the percentiles are actually calculated from an example data set of 100 observations. The observations are sorted from lowest to highest travel time values. The 50th percentile is the value where 50 percent of the observations are below it; the 80th percentile is the value where 80 percent of the observations are below it.

3. For each of the four time periods for a TMC, compute a Level of Travel Time Reliability Metric (LOTTR) as the 80th percentile travel time divided by the 50th percentile travel time. Round the LOTTR metrics to the nearest hundredth.[28] Table 2.5 shows example calculations and Figure 2.3 shows a visual example of the process.

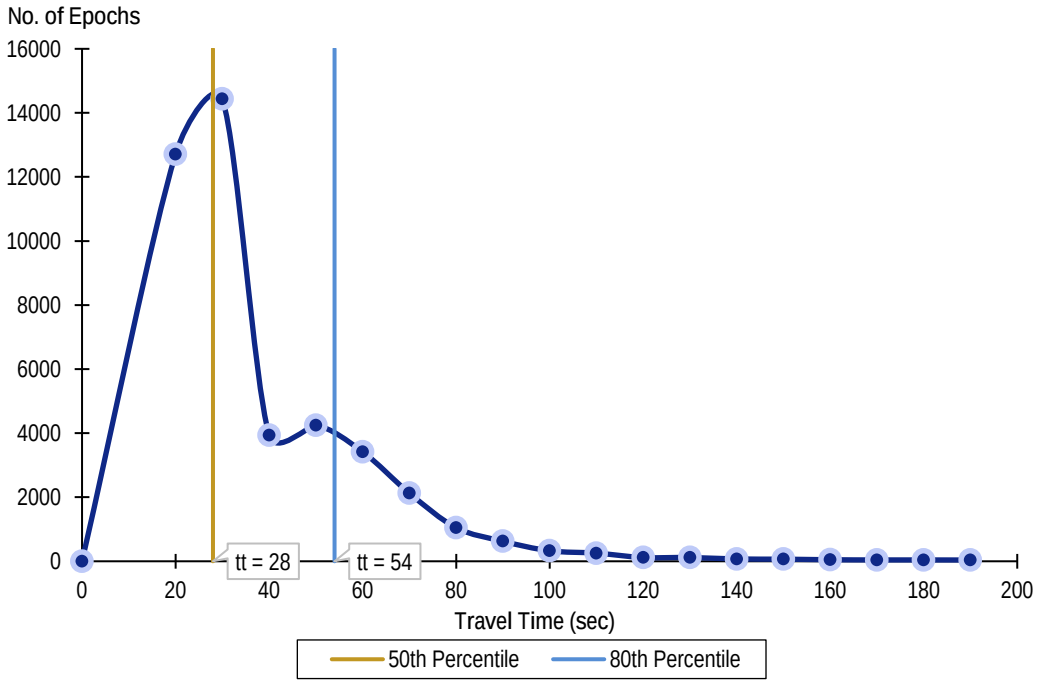


Figure 2.1 Graph. Distribution of travel times on an urban freeway (weekdays, 6:00 a.m. to 10:00 a.m.).

(Source: Created for this report.)

Table 2.4 Example of how to calculate 50th and 80th percentiles.

TMC	Travel Time	Obs. No.
116+04098	17.1	1
116+04098	19.0	2

[28] 23 CFR 490.511(b)(3).

TMC	Travel Time	Obs. No.
116+04098	21.9	3
116+04098	22.0	4
116+04098	22.6	5
116+04098	23.1	6
116+04098	23.6	7
116+04098	23.9	8
116+04098	23.9	9

Table 2.4 Example of how to calculate 50th and 80th percentiles (continuation).

TMC	Travel Time	Obs. No.
116+04098	24.0	10
116+04098	24.4	11
116+04098	24.6	12
116+04098	25.5	13
116+04098	25.8	14
116+04098	25.9	15
116+04098	26.1	16
116+04098	26.1	17
116+04098	26.2	18
116+04098	26.2	19
116+04098	26.3	20
116+04098	26.3	21
116+04098	26.4	22
116+04098	26.6	23
116+04098	26.6	24
116+04098	27.1	25
116+04098	27.2	26
116+04098	27.3	27
116+04098	27.3	28
116+04098	27.5	29
116+04098	27.9	30
116+04098	28.0	31
116+04098	28.3	32

116+04098	28.4	33
116+04098	28.5	34
116+04098	28.5	35
116+04098	28.8	36
116+04098	28.8	37
116+04098	28.8	38
116+04098	29.1	39
116+04098	29.1	40

Table 2.4 Example of how to calculate 50th and 80th percentiles (continuation).

TMC	Travel Time	Obs. No.
116+04098	29.1	41
116+04098	29.1	42
116+04098	29.2	43
116+04098	29.2	44
116+04098	29.3	45
116+04098	29.4	46
116+04098	29.6	47
116+04098	29.6	48
116+04098	29.7	49
116+04098	30.2	50 (50th percentile)
116+04098	30.4	51
116+04098	31.0	52
116+04098	31.0	53
116+04098	31.3	54
116+04098	31.4	55
116+04098	31.5	56
116+04098	31.5	57
116+04098	32.2	58
116+04098	32.3	59
116+04098	33.2	60
116+04098	33.4	61
116+04098	33.6	62

116+04098	33.6	63
116+04098	34.5	64
116+04098	34.6	65
116+04098	34.6	66
116+04098	34.7	67
116+04098	35.2	68
116+04098	35.3	69
116+04098	35.6	70
116+04098	35.6	71

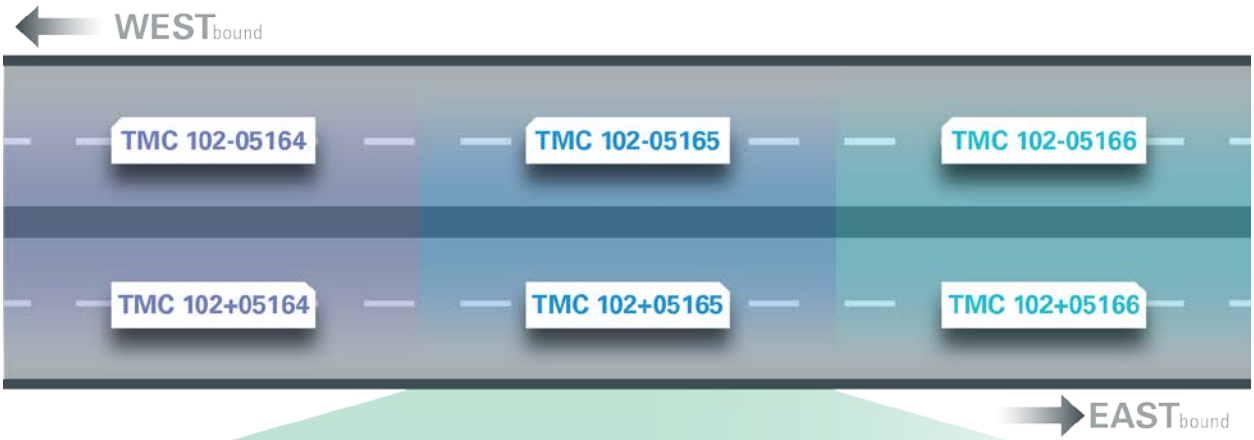
Table 2.4 Example of how to calculate 50th and 80th percentiles (continuation).

TMC	Travel Time	Obs. No.
116+04098	35.9	72
116+04098	35.9	73
116+04098	37.5	74
116+04098	38.1	75
116+04098	38.4	76
116+04098	38.9	77
116+04098	39.9	78
116+04098	40.5	79
116+04098	40.7	80 (80th percentile)
116+04098	40.9	81
116+04098	41.0	82
116+04098	41.3	83
116+04098	41.4	84
116+04098	41.8	85
116+04098	42.5	86
116+04098	42.6	87
116+04098	43.2	88
116+04098	43.3	89
116+04098	43.8	90
116+04098	43.8	91
116+04098	44.7	92

116+04098	45.7	93
116+04098	46.4	94
116+04098	46.6	95
116+04098	49.3	96
116+04098	49.4	97
116+04098	51.3	98
116+04098	52.1	99
116+04098	56.2	100

Table 2.5 Chart. Example Calculation, LOTTR

		Travel Time		
TMC	Period	50th Percentile	80th Percentile	LOTTR
102+04099	6–10 Weekdays	41.4	45.2	1.09
102+04099	10–4 Weekdays	41.3	44.8	1.07
102+04099	4–8 Weekdays	42.0	55.0	1.31
102+04099	Weekend	39.4	42.6	1.08
102+04100	6–10 Weekdays	37.3	40.1	1.08
102+04100	10–4 Weekdays	38.2	41.9	1.08
102+04100	4–8 Weekdays	41.7	139.4	3.39
102+04100	Weekend	35.7	38.8	1.09
102+04101	6–10 Weekdays	17.1	18.3	1.06
102+04101	10–4 Weekdays	17.1	18.3	1.06
102+04101	4–8 Weekdays	29.6	67.1	2.31
102+04101	Weekend	16.4	17.8	1.06
102+04102	6–10 Weekdays	1.4	1.4	1.00
102+04102	10–4 Weekdays	1.4	1.4	1.00
102+04102	4–8 Weekdays	1.4	3.0	3.00
102+04102	Weekend	1.4	1.4	1.00
102+04103	6–10 Weekdays	20.2	23.4	1.15
102+04103	10–4 Weekdays	20.2	24.0	1.20
102+04103	4–8 Weekdays	62.4	80.7	1.29
102+04103	Weekend	19.5	20.2	1.05



Create travel time distributions from 15-minute data

NHPP_Period	50th Percentile	80th Percentile	LOTTR
6 to 10 a.m.	101.0	150.0	1.49
10 a.m. to 4 p.m.	99.5	121.5	1.22
4 to 8 p.m.	96.0	185.0	1.93
Weekend 6 a.m. to 8 p.m.	104.0	135.0	1.30

Figure 2.2 Illustration. Creating NHPP Reliability Metrics by TMC.

(Source: Created for this report.)

RELATION OF THE LOTTR METRICS TO THE NHPP RELIABILITY MEASURE[29]

For each reporting segment, the four LOTTR values are compared to a threshold value of 1.50. If **all four** of the LOTTR values are below this threshold, the reporting segment is deemed to be reliable; if not, it is deemed to be unreliable. The NHPP reliability **measure** is then calculated as the total person miles that are reliable divided by the total person miles. Separate measures are computed for the Interstate system and non-Interstate NHS routes:

$$NHPP\ Reliability\ Measure\ = \frac{\sum_{r=1}^{R} SL_i \times AV_i \times OF_j}{\sum_{t=1}^{T} SL_i \times AV_i \times OF_j}$$

Figure 2.3 Equation.

(Source: 23 CFR 490.513(b).)

Where:

[29] 23 CFR 490.513

SL_i = the segment length of reporting segment *i* (nearest thousandth) for the highway system being considered.

AV_i = annual traffic volume of reporting segment i.

$= AADT \times Directional\ Factor \times 365.$

Directional Factor = factor for splitting AADT by direction (0.5 if faciltype = 2 or 6; 1 if faciltype = 1).

OF_j = occupancy factor for vehicles on the NHS within a specified geographic area j within the State/Metropolitan planning area.

R = total number of Interstate or non-Interstate reporting segments exhibiting an LOTTR below 1.50 for all 4 time periods.

T = total number of Interstate or non-Interstate reporting segments.

ANNUAL REPORTING REQUIREMENTS[30]

Starting in 2018 and annually thereafter, State DOTs must report the LOTTR metrics, in accordance with HPMS Field Manual by June 15th of each year for the previous year's measures. Metrics are reported to HPMS by reporting segment. All reporting segments where the NPMRDS is used must be referenced by NPMRDS TMC(s) or HPMS section(s). If a State DOT elects to use, in part or in whole, the equivalent data set, all reporting segment must be referenced by HPMS section(s).

The LOTTR metric (to the nearest hundredths) must be reported for each of the four time periods. The corresponding 80th percentile travel times (to the nearest second), the corresponding 50th percentile travel times (to the nearest second), and directional AADTs. If a State DOT does not elect to use FHWA supplied occupancy factor, that State DOT must report vehicle occupancy factor (to the nearest tenth) to HPMS.

The reporting of the reporting segment length to HPMS must be based on the proportion of the segment that is designated as the NHS. The data element "nhs_pct" is used to produce this length.

FREIGHT RELIABILITY METRICS

CALCULATION STEPS

1. Only reporting segments on the Interstate system are used in the calculation of the Freight Reliability metrics (where f_system = 1).

[30] 23 CFR 490.511(e)

2. For MPO reporting, only reporting segments within the MPO Planning Boundary are used in these calculations.
3. Create a new data element that takes on the value of truck travel time if truck travel time is not null or not zero, and the travel time of combined trucks and passenger cars if truck travel time is null or zero.[31]
4. For each reporting segment (e.g., TMC) and Freight Reliability time period (Freight_Period) combination, compute the 50th and 95th percentile travel times. Do not round the percentiles. As with the NHPP Reliability calculation, these percentiles are derived from the distribution of travel times similar to the one shown in Figure 2.1 and Table 2.4, except the percentiles are now the 50th and 95th.[32]
5. Compute the Truck Travel Time Reliability (TTTR) metric as the 95th percentile travel time divided by the 50th percentile travel time for each of the five time periods for each reporting segment. Round the TTTR metric to the nearest hundredth.

Table 2.6 Example calculation, TTTR.

		Travel Time		
TMC	Period	50th Percentile	95th Percentile	TTTR
102+04099	6–10 Weekdays	41.3	85.2	2.06
102+04099	10–4 Weekdays	41.3	54.3	1.31
102+04099	4–8 Weekdays	42.7	155.8	3.65
102+04099	Overnight	40.0	51.2	1.28
102+04099	Weekend	39.4	48.5	1.23
102+04100	6–10 Weekdays	37.1	75.3	2.03
102+04100	10–4 Weekdays	38.4	97.7	2.54
102+04100	4–8 Weekdays	42.5	188.0	4.42
102+04100	Overnight	35.8	45.8	1.28
102+04100	Weekend	35.4	43.5	1.23
102+04101	6–10 Weekdays	17.0	25.1	1.48
102+04101	10–4 Weekdays	17.9	54.6	3.05
102+04101	4–8 Weekdays	30.3	88.9	2.93
102+04101	Overnight	15.5	19.3	1.25
102+04101	Weekend	16.3	57.4	3.52
102+04102	6–10 Weekdays	46.7	55.5	1.19
102+04102	10–4 Weekdays	45.1	49.9	1.11

[31] 23 CFR 490.609 and 490.611.

[32] 23 CFR 490.611

		Travel Time		
TMC	Period	50th Percentile	95th Percentile	TTTR
102+04102	4–8 Weekdays	49.9	56.6	1.13
102+04102	Overnight	39.8	51.1	1.28
102+04102	Weekend	41.3	44.4	1.08
102+04103	6–10 Weekdays	20.2	42.6	2.11
102+04103	10–4 Weekdays	20.2	72.4	3.58
102+04103	4–8 Weekdays	61.3	108.4	1.77
102+04103	Overnight	18.4	26.0	1.41
102+04103	Weekend	19.4	24.4	1.26

RELATION OF THE TTTR METRICS TO THE FREIGHT RELIABILITY MEASURE[33]

For each reporting segment, the TTTR metric with the highest value of the five TTTR metrics is selected as the "maximum TTTR." The Freight Reliability Measure is then calculated as the produce of the maximum TTR times reporting segment length, divided by the

$$Freight\ Reliability\ = \frac{\sum_{i=1}^{T}(SL_i \times maxTTTR_i)}{\sum_{i=1}^{T}(SL_i)}$$

Figure 2.4 Equation.

(Source: 23 CFR 490.613(b).)

Where:

i is an Interstate reporting segment.

$maxTTTR_i$ = the maximum TTTR of all five time periods for segment *i* (nearest hundredth).

SL_i = length of segment *i* (nearest thousandth), which accounts for the proportion of the segment that is designated as NHS.

T = total number of Interstate segments.

ANNUAL REPORTING REQUIREMENTS[34]

Starting in 2018 and annually thereafter, State DOTs must report the TTTR metrics in accordance with the HPMS Field Manual by June 15th of each year for the previous year's Freight Reliability measures. All metrics must be reported to

[33] 23 CFR 490.613

[34] 23 CFR 490.611

HPMS by reporting segments. When the NPMRDS is used, metrics must be referenced by NPMRDS TMC(s) or HPMS section(s). If a State DOT elects to use, in part or in whole, the equivalent data set, all reporting segment must be referenced by HPMS section(s).

The TTTR metrics must be reported to HPMS for each reporting segment (to the nearest hundredths) for each of the five time periods. The corresponding 95th percentile travel times (to the nearest second) and the corresponding 50th percentile travel times (to the nearest second) also must be reported.

The reporting of the reporting segment length to HPMS must be based on the proportion of the segment that is designated as the NHS. The data element "nhs_pct" is used to produce this length.

ANNUAL HOURS OF PEAK HOUR EXCESSIVE DELAY (PHED) METRIC

In the calculation of the PHED metric, only reporting segments that meet the following criteria are used:

- Reporting segments must be within the urbanized area boundary.[35]
- Only weekday records for the following hourly periods are used:[36]
  - 6:00 a.m.–10 a.m.
  - Either (agency choice):
    - » 3:00 p.m.–7:00 p.m.
    - » 4:00 p.m.–8:00 p.m.

CALCULATION STEPS

Table 2.7 shows an example of the calculation steps discussed below.

1. Determine the Threshold Speed for when delay begins to be counted as the larger of:
   d. 20 mph, or
   e. Posted_Speed_Limit x 0.6; do not round this result.[37]

[35] 23 CFR 490.709(b).

[36] 23 CFR 490.705(b) and 490.711.

[37] 23 CFR 490.711(c).

2. Compute the Excessive Delay Threshold Travel Time (EDTTT), rounded to the nearest second.[38] The EDTTT is the travel time on the segment above which delay would be incurred and is calculated as:

$$Excessive\ Delay\ Threshold\ Travel\ Time_s = \left(\frac{Travel\ Time\ Segment\ Length_s}{Threshold\ Speed_s}\right) \times 3{,}600$$

Figure 2.5 Equation.

(Source: 23 CFR 490.711(c).)

Where: *s* is the reporting segment; *Travel Time Segment Length (s)* = Total length of travel time segment to the nearest hundredth of a mile for travel time reporting segment *s*.

3. Compute the travel time segment delay (RSD), rounded to the nearest second, as:[39]

$$RSD_{s,b} = Travel\ Time_{s,b} - EDTTT_s$$

Figure 2.6 Equation.

(Source: 23 CFR 490.711(c)(1).)

Where:

Travel Time$_{s,b}$ = travel time of **all vehicles** on segment *s* and 15-minute time bin *b*.

4. Compute the Excessive Delay (ED), rounded to the nearest thousandth hour, as:[40]

$$ExcessiveDelay_{s,b} = \begin{cases} \dfrac{RSD_{s,b}}{3{,}600} \ when\ RSD_{s,b} \geq 0 \\ or \\ 0\ when\ RSD_b < 0 \end{cases}$$

Figure 2.7 Equation.

(Source: 23 CFR 490.711(c)(2).)

5. Compute Average Vehicle Occupancy (AVO) from previously created data elements shown in Table 2.1:[41]

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[38] 23 CFR 490.711(c).

[39] 23 CFR 490.711(d)(1).

[40] 23 CFR 490.711(d)(2).

[41] 23 CFR 490.711(e).

$$AVO = (P_c \times AVO_c) + (P_b \times AVO_b) + (P_t \times AVO_t)$$

Figure 2.8 Equation.

(Source: 23 CFR 490.711(e).)

Average vehicle occupancies of cars, buses, and trucks: AVO_c, AVO_b, and AVO_t

Traffic proportions of cars, buses, and trucks: P_c, P_b, and P_t

6. Compute Total Delay (TD), rounded to the nearest thousandth, for each reporting segment and 15-minute epoch as:

$$TD_{s,b} = AVO \times ED_{s,b} \times Volume15_{s,b} \times (nhs\_pct \times 0.01)$$

Figure 2.9 Equation.

(Source: 23 CFR 490.711(e).)

nhs_pct is the percent of reporting segment length that is on the NHS. This attribute data value is provided in the NPMRDS and is not an HPMS attribute data. Weighing Total Delay by *nhs_pct* data value is recommended to account only the NHS portion of a reporting segments for the Delay computation. For example, *nhs_pct* data value of 100 means the entire length of a reporting segment is on the NHS, and *nhs_pct* data value equal 90 means 90% of a reporting segment length is on NHS.

Volume15 is the 15-minute volume for the travel time record

7. Compute Peak Hour Excessive Delay metric (PHED), rounded to the nearest thousandth, for each reporting segment in an applicable urbanized area for the entire year as:[42] $PHED_s = \sum_b TD_{s,b}$

Figure 2.10 Equation.

(Source: 23 CFR 490.711 (e).)

$TD_{s,b}$ is total delay from Step 6 above.

RELATION TO THE ANNUAL HOURS OF PEAK HOUR EXCESSIVE DELAY PER CAPITA MEASURE[43]

The PHED metric is used to compute the Annual Hours of Excessive Delay per Capita performance measure for Congestion Mitigation and Air Quality (CMAQ) Traffic Congestion by summing all the PHED values for an applicable urbanized area and dividing by the population of that urbanized area:

[42] The PHED metric is also known as the Total Excessive Delay, as per the Rule (23 CFR 490.711).

[43] 23 CFR 490.713

$$\textbf{\textit{Annual Hours of PHED per capita}} = \frac{\sum_{s=1}^{T} \textbf{\textit{Total Excessive Delay}}_s}{\textbf{\textit{Total Population}}}$$

Figure 2.11 Equation.

(Source: 23 CFR 490.713 (b).)

Where:

Annual Hours of Excessive Delay per Capita = The cumulative hours of excessive delay, to the nearest tenth, experienced by all traffic traveling through all reporting segments in the applicable urbanized area for the full calendar year.

s = Travel time reporting segment within an urbanized area.

T = Total number of travel time reporting segments in the applicable urbanized area.

$Total\ Excessive\ Delay_s$ = Total hours of excessive delay for all traffic traveling through travel time reporting segment s during the calendar year.

Total Population = the total population in the applicable urbanized area from the most recent annual population published by the U.S. Census at the time that the State Biennial Performance Period Report is due to FHWA.[44]

[44] List of applicable urbanized area for the first performance period: https://www.fhwa.dot.gov/environment/air_quality/cmaq/measures/cmaq_applicability/page04.cfm.

Table 2.7 Chart. Example calculation, PHED metric.

Data Elements in the Master Data Set						Data Elements Created During PHED Processing				
TMC	Time	Posted_ Speed_ Limit (in mph)	Travel Time (in seconds)	Hourly_ Traffic_ Percent	Volume15	Threshold Speed	EDTTT	RSD	ED	TD
116+04101	7:00	65	88.2	0.0064	351	39.0	92	0	0.0000	0.0000
116+04101	7:15	65	90.1	0.0064	351	39.0	92	0	0.0000	0.0000
116+04101	7:30	65	100.9	0.0064	351	39.0	92	9	0.0024	0.9313
116+04101	7:45	65	120.0	0.0064	351	39.0	92	28	0.0077	2.9668
116+04101	8:00	65	125.1	0.0075	413	39.0	92	33	0.0091	4.1206
116+04101	8:15	65	115.6	0.0075	413	39.0	92	23	0.0063	2.8602
116+04101	8:30	65	118.3	0.0075	413	39.0	92	26	0.0071	3.2383
116+04101	8:45	65	106.9	0.0075	413	39.0	92	15	0.0041	1.8518
116+04101	9:00	65	83.3	0.0070	385	39.0	92	0	0.0000	0.0000
116+04101	9:15	65	70.5	0.0070	385	39.0	92	0	0.0000	0.0000
116+04101	9:30	65	55.1	0.0070	385	39.0	92	0	0.0000	0.0000
116+04101	9:45	65	52.0	0.0070	385	39.0	92	0	0.0000	0.0000
							TMC	116+04101:	PHED =	15.9690

Note: Posted_Speed_Limit, Hourly_Traffic_Percent, and Volume15 must be added to the master data set as described in the first section of this chapter. “nhs_pct” is assumed to be 100 percent in these calculations.

TMC Length = 1.0 mile.

AADT = 55,000. (Average Annual Daily Traffic)

AVO = 1.1.

EDTTT (in seconds) = TMC Length/Threshold Speed X 3,600. (Excessive Delay Threshold Travel Time)

RSD (in seconds) = Travel Time—EDTTT. (Travel Time Segment Delay)

ED (in hours) = RSD/3,600 (min = 0). (Excessive Delay)

TD (in person hours) = AVO * ED * Volume15. (Total Delay)

ANNUAL REPORTING REQUIREMENTS[45]

Starting in 2018 and annually thereafter, State DOTs must report the PHED metric (to the nearest one hundredth hour) in accordance with HPMS Field Manual by June 15th of each year for the previous year's PHED measures. The PHED metric must be reported for each reporting segment. All reporting segments of the NPMRDS must be referenced by NPMRDS TMC or HPMS section(s). If a State DOT elects to use, in part or in whole, the equivalent data set, all reporting segments must be referenced by HPMS sections.

[45] 23 CFR 490.711(f)