

Iowa DOT System Performance and Freight Measures

May 20, 2018

Performance measures

Through the Moving Ahead for Progress in the 21st Century (MAP-21) Act, Congress required the establishment of measures to assess performance in several areas, including performance of the Interstate and non-Interstate National Highway System (NHS), now codified in 23 CFR 490.507, and freight movement on the Interstate System, now codified in 23 CFR 490.607. The State Departments of Transportation (DOTs), as well as metropolitan planning organizations (MPOs) with applicable roadways within their metropolitan planning areas, will set targets for the following performance measures, known as “PM3”¹.

1. Percent of the person-miles traveled on the Interstate that are reliable (referred to as the Interstate Travel Time Reliability measure)
2. Percent of the person-miles traveled on the non-Interstate NHS that are reliable (referred to as the Non-Interstate Travel Time Reliability measure).
3. Freight movement on the Interstate System - the Truck Travel Time Reliability (TTTR) Index (referred to as the Freight Reliability measure)

Targets are set for all roadways on the applicable system within a State or MPO, regardless of ownership. States must set 2- and 4-year targets for these measures by May 20, 2018. While targets will be set on this date and communicated to MPOs at that time, they will not be officially reported to FHWA until the submittal of State baseline performance period reports on October 1, 2018.

Data and methodology

Data for these measures is provided by FHWA through the National Performance Management Research Data Set (NPMRDS). This is a national data set of average travel times on the NHS. Since February 2017, speed and travel time data from INRIX has been used for the NPMRDS, which is hosted by the University of Maryland Center for Advanced Transportation Technology Laboratory (CATT Lab). States and MPOs can access the raw data at no cost. CATT Lab has also developed a MAP-21 tool to assist States and MPOs in calculating PM3 measures. This tool is available through a pooled fund effort led by the American Association of State Highway and Transportation Officials (AASHTO). Iowa DOT has joined the pooled fund for a five-year period, which provides access to the MAP-21 tool and output for the State and Iowa MPOs.

In addition to joining the pooled fund, Iowa DOT has downloaded the NPMRDS data and processed it internally to calculate the PM3 measures. Long-term, Iowa DOT anticipates continuing to conduct this analysis in-house to improve its understanding of the measures and the raw data. The internal analysis and CATT Lab output have both evolved over the winter and

¹ This target-setting process and memo focuses only on PM3 measures applicable to Iowa. The final rule for PM3 also contains measures related to air quality; targets for these measures are not required for Iowa or its MPOs as there are no non-attainment or maintenance areas in the State. Also, as of May 2018, a PM3 measure related to greenhouse gas (GHG) has been proposed to be repealed. If it is not repealed, States will have to set a target for the GHG measure by September 28, 2018.

spring of 2018, as clarifications have been provided from FHWA on the measure calculations. Additionally, January 2017 NPMRDS data has been reformatted to match the February-December 2017 NPMRDS data, to allow for a full baseline year of consistent data.

The updated CATT Lab output for Iowa's PM3 measures in 2017 was downloaded on April 30, 2018, and is being used for target-setting, with Iowa DOT's internal analysis being used for validation purposes. The decision was made to use CATT Lab output for target setting for two main reasons. It leads to slightly more conservative targets than the current internal output, which is preferable due to the lack of history with this dataset and the inability to use trend data to develop forecasts. It is also a nationally recognized tool that FHWA has helped support and that many States and MPOs, including Iowa MPOs, will be able to use.

NPMRDS data has been collected for several years, but due to a change in vendor, only one full year of data is available from NPMRDS that is formatted in the manner data is currently being collected. This creates challenges in setting targets because there is not enough information to create trends or understand variability in the annual measure. As a proxy for annual variation, the monthly variance of each measure in 2017 is used. The monthly output is assumed to follow a normal distribution. For each measure, the standard deviation of the 2017 monthly data is calculated, and the cumulative distribution properties of a normal distribution are used to derive probabilistic (risk-based) targets. This is described for each target below.

Measure 1: Interstate travel time reliability measure

State DOTs must establish 2- and 4- year targets for the percent of reliable person-miles on the Interstate system. This measure is calculated in the same manner as non-Interstate NHS reliability (measure 2).

The level of travel time reliability (LOTTR) is the metric for determining the performance measure. The LOTTR is calculated for four time periods:

1. Weekdays from 6:00 a.m. - 10:00 a.m.
2. Weekdays from 10:00 a.m. - 4:00 p.m.
3. Weekdays from 4:00 p.m. - 8:00 p.m.
4. Weekends from 6:00 a.m. - 8:00 p.m.

For each time period across an entire year, the LOTTR is defined as the ratio of the longer travel time (80th percentile) to a "normal" travel time (50th percentile) for all vehicles. Data are analyzed based on 15-minute groupings of speeds and travel times for traffic message channels (TMCs), which are highway segments that NPMRDS data are reported for. FHWA defines a segment as reliable if its LOTTR is less than 1.5 during all four time periods. If the highest LOTTR is 1.5 or above, the segment is unreliable. To translate the LOTTR to the performance measure, the length of each segment is multiplied by its annual average daily traffic (AADT) and average occupancy factor for all vehicles (FHWA's default is 1.7), which results in person-miles. This calculation is done for reliable segments and for all segments. Dividing the sum of reliable segment person-miles by the sum of all segment person-miles provides the measure of percent of travel time reliability².

² More detail on the metric and measure calculation can be found in this FHWA presentation: <https://www.fhwa.dot.gov/tpm/rule/170601pm3.pdf>.

To develop targets, the percentage of reliable Interstate person-miles was calculated for each month in 2017. The standard deviation of the 12 months' values was calculated. This output is assumed to follow a normal distribution. As shown in Figure 1, using the cumulative distribution properties of a normal distribution helps arrive at probabilistic (risk-based) targets. For example, to be at least 75 percent confident in achieving the target, that would correspond to a multiplier of 0.67 for the standard deviation estimate (this is often known as the "z-value"). Therefore, the target at a 75 percent confidence level would be established using the 2017 annual baseline of $100.0 - (0.67 \times 0.345) = 99.5$ (rounded down from 99.77 to the nearest half-percent).

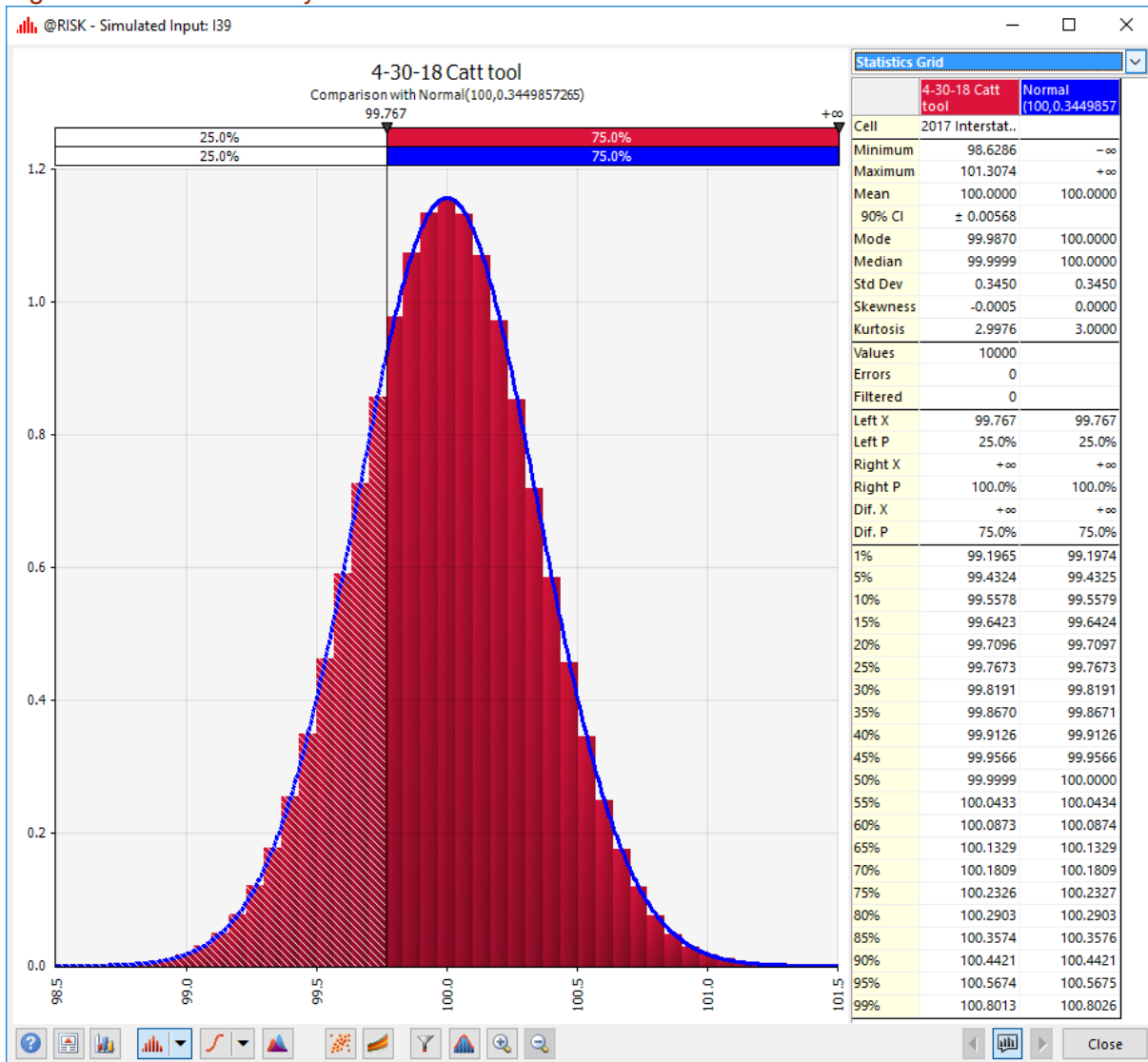
Monthly and annual CATT Lab output and possible targets at various risk levels are shown in Table 1. It is important to note that the relationship between monthly and annual data is not straightforward, as the LOTTR is recalculated based on the 80th and 50th percentile travel times for the specific timeframe being evaluated. This can result in annual values that are different than the average of monthly values.

Table 1: Level of travel time reliability for the Interstate System
Monthly and annual output and targets at various confidence levels

Month	CATT tool output
January 2017	100.0
February 2017	99.5
March 2017	100.0
April 2017	99.7
May 2017	99.7
June 2017	98.8
July 2017	99.8
August 2017	100.0
September 2017	99.7
October 2017	100.0
November 2017	100.0
December 2017	99.9
2017 Annual Baseline	100.0
Standard Deviation	0.345
Confidence Level	Target
70 percent	99.82%
75 percent	99.77%
80 percent	99.71%
85 percent	99.64%
90 percent	99.56%
95 percent	99.43%

The target value is rounded down to the nearest half percent. Using a 75 percent confidence level results in a target of 99.5% for person-miles traveled on the Interstate that are reliable. Figure 1 shows the statistical analysis using a 75 percent confidence level.

Figure 1: Statistical analysis for the Interstate LOTTR measure



Measure 2: Non-Interstate NHS travel time reliability measure

State DOTs must also establish 2- and 4-year targets for the percent of reliable person-miles on the non-Interstate NHS. For the first reporting period, 2-year targets are not required for this measure. The metrics and measure are calculated in the same manner as measure 1, and the same methodology was used to derive targets.

To develop targets, the percentage of reliable non-Interstate NHS person-miles was calculated for each month in 2017. The standard deviation of the 12 months' values was calculated. This output is assumed to follow a normal distribution. As shown in Figure 2, using the cumulative distribution properties of a normal distribution helps arrive at probabilistic (risk-based) targets. For example, to be at least 75 percent confident in achieving the target, that would correspond to a multiplier of 0.67 for the standard deviation estimate (this is often known as the “z-value”). Therefore, the target at a 75 percent confidence level would be established using the 2017 annual baseline of 95.6 - (0.67*0.843) = 95.0 (rounded down from 95.03 to the nearest half-percent).

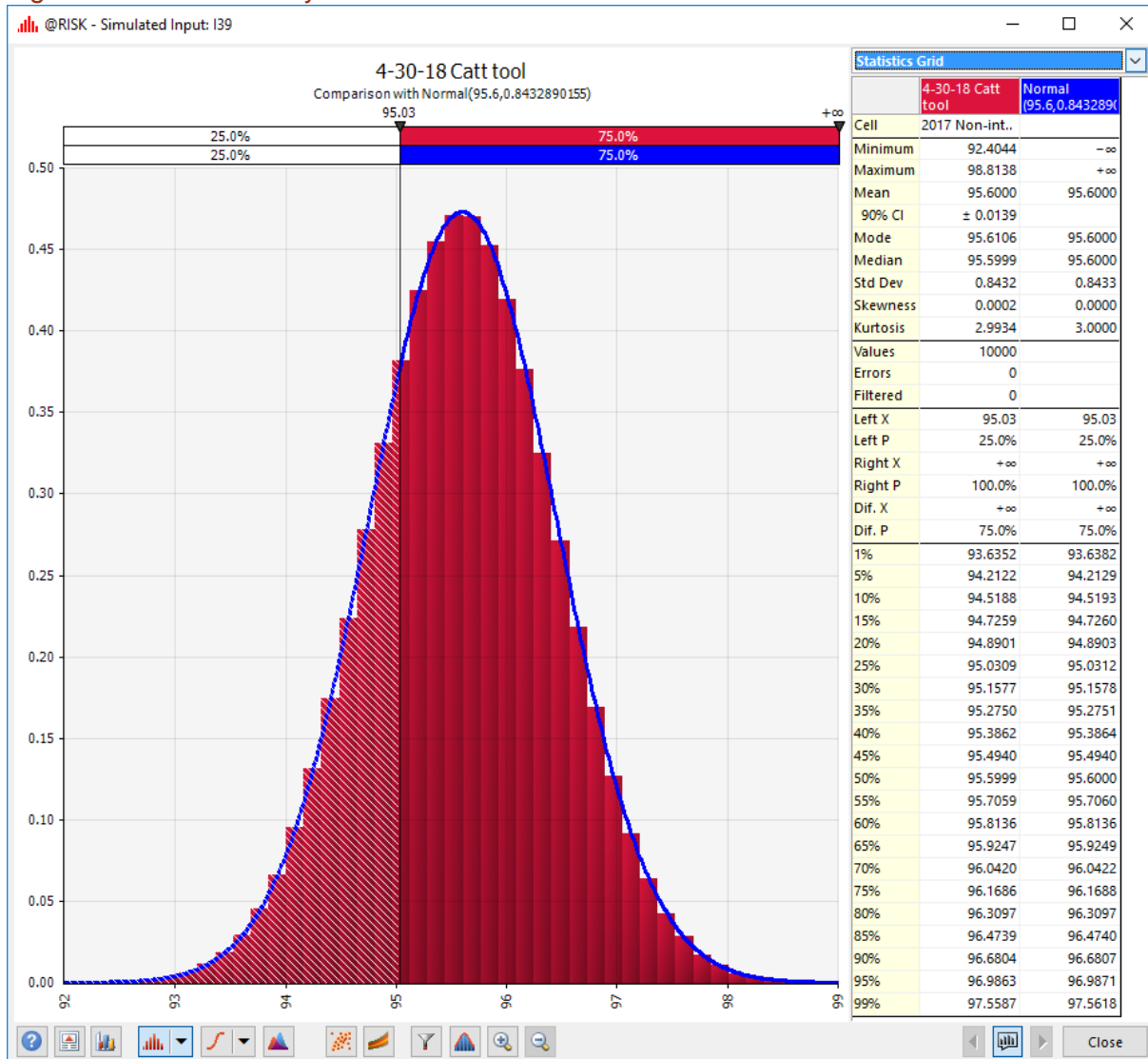
Monthly and annual CATT Lab output and possible targets at various risk levels are shown in Table 2. It is important to note that the relationship between monthly and annual data is not straightforward, as the LOTTR is recalculated based on the 80th and 50th percentile travel times for the specific timeframe being evaluated. This can result in annual values that are different than the average of monthly values.

**Table 2: Level of travel time reliability for the non-Interstate NHS
Monthly and annual output and targets at various confidence levels**

Month	CATT tool output
January 2017	95.2
February 2017	94.9
March 2017	95.0
April 2017	93.0
May 2017	93.3
June 2017	93.2
July 2017	93.9
August 2017	93.0
September 2017	93.0
October 2017	93.9
November 2017	94.0
December 2017	94.7
2017 Annual Baseline	95.6
Standard Deviation	0.843
Confidence Level	Target
70 percent	95.16%
75 percent	95.03%
80 percent	94.89%
85 percent	94.73%
90 percent	94.52%
95 percent	94.21%

The target value is rounded down to the nearest half percent. Using a 75 percent confidence level results in a target of 95.0% for person-miles traveled on the non-Interstate NHS that are reliable. Figure 2 shows the statistical analysis using a 75 percent confidence level.

Figure 2: Statistical analysis for the non-Interstate NHS LOTTR measure



Measure 3: Truck travel time reliability

State DOTs must establish 2- and 4-year targets for truck travel time reliability (TTTR) on the Interstate System. This measure is calculated similarly to measures 1 and 2, but the metric's parameters are different and it is not translated into a percentage of reliable miles. This measure also uses a subset of the NPMRDS data that contains only truck data, rather than the all-vehicle data used for measures 1 and 2.

The TTTR index is the metric for determining the performance measure. The TTTR is calculated for five time periods:

1. Weekdays from 6:00 a.m. - 10:00 a.m.
2. Weekdays from 10:00 a.m. - 4:00 p.m.
3. Weekdays from 4:00 p.m. - 8:00 p.m.
4. Overnight (all days) from 8:00 p.m. - 6:00 a.m.
5. Weekends from 6:00 a.m. - 8:00 p.m.

For each time period across an entire year, the TTTR is defined as the ratio of the longer truck travel time (95th percentile) to a "normal" truck travel time (50th percentile). Data are analyzed based on 15-minute groupings of speeds and travel times for TMCs. For each TMC, the highest TTTR value is carried forward into the measure calculation. To translate the individual TMC values into the overall TTTR index, the length of each segment is multiplied by its maximum TTTR of the five time periods. These length weighted TTTRs are then added together and divided by the sum of all segment lengths to result in the TTTR index for the performance measure³.

To develop targets, the TTTR was calculated for each month in 2017. The standard deviation of the 12 months' values was calculated. This output is assumed to follow a normal distribution. As shown in Figure 3, using the cumulative distribution properties of a normal distribution helps arrive at probabilistic (risk-based) targets. For example, to be at least 75 percent confident in achieving the target, that would correspond to a multiplier of 0.67 for the standard deviation estimate (this is often known as the "z-value"). Therefore, the target at a 75 percent confidence level would be established using the 2017 annual baseline of $1.12 + (0.67 \times 0.027) = 1.14$ (rounded up from 1.138 to the nearest hundredth).

Monthly and annual CATT Lab output and possible targets at various risk levels are shown in Table 3. It is important to note that the relationship between monthly and annual data is not straightforward, as the TTTR is recalculated based on the 95th and 50th percentile travel times for the specific timeframe being evaluated. This can result in annual values that are different than the average of monthly values.

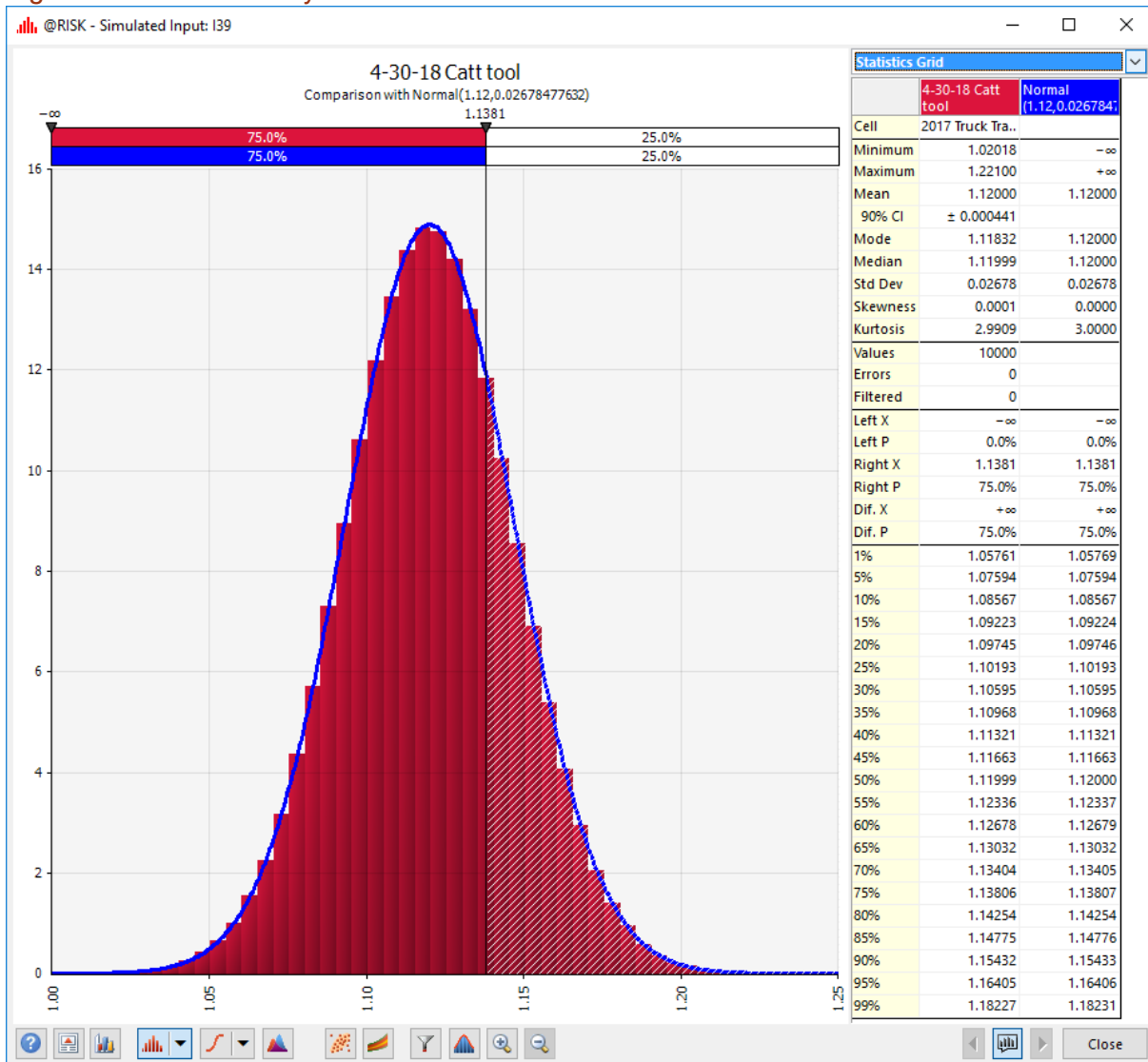
³ More detail on the metric and measure calculation can be found in this FHWA presentation: <https://www.fhwa.dot.gov/tpm/rule/170601pm3.pdf>.

Table 3: Truck travel time reliability for the Interstate System
 Monthly and annual output and targets at various confidence levels

Month	CATT tool output
January 2017	1.17
February 2017	1.18
March 2017	1.13
April 2017	1.11
May 2017	1.12
June 2017	1.13
July 2017	1.12
August 2017	1.13
September 2017	1.12
October 2017	1.11
November 2017	1.11
December 2017	1.18
2017 Annual Baseline	1.12
Standard Deviation	0.027
Confidence Level	Target
70 percent	1.13
75 percent	1.14
80 percent	1.14
85 percent	1.15
90 percent	1.15
95 percent	1.16

The target is rounded up to the nearest hundredth. Using a 75 percent confidence level results in a target of 1.14 for truck travel time reliability on the Interstate system. Figure 3 shows the statistical analysis using a 75 percent confidence level.

Figure 3: Statistical analysis for the Interstate TTTR measure



Iowa DOT FHWA performance targets for system reliability and freight

Targets for the system reliability and freight performance measures are established by the State DOTs for 4-year performance periods, with the first set of 2- and 4-year targets being set by May 20, 2018 for target years 2020 and 2022. Data reported and evaluated in these target years will be collected in 2019 and 2021. For the first performance period, a 2-year target is not required for the non-Interstate NHS LOTTR measure as its existing dataset is less complete than the Interstate dataset. As discussed previously, there is a lack of historical data for these measures to determine trends. Thus, the same targets are being established for both the 2-year 2020 target and the 4-year 2022 target. States will have the opportunity to revisit the 4-year target halfway through the performance period, at which point changes can be made if additional data would result in revised assumptions.

Iowa DOT's 2017 baseline data and 2- and 4-year targets are shown in Table 4. The targets are being set at the 75 percent confidence level, highlighted on the table. The Iowa DOT has had several working groups for the various federal performance measures, and 75 percent has generally been identified as a threshold for acceptable risk for federal performance measures by the working groups and management.

Table 4: Iowa DOT 2017 baseline data and 2- and 4-year targets for system reliability and freight performance measures

	Interstate level of travel time reliability	Non-Interstate NHS level of travel time reliability	Truck travel time reliability index
2017 baseline	100.0%	95.6%	1.12
Confidence interval	2020 and 2022 target	2022 target*	2020 and 2022 target
70 percent	99.5%	95.0%	1.13
75 percent	99.5%	95.0%	1.14
80 percent	99.5%	94.5%	1.14
85 percent	99.5%	94.5%	1.15
90 percent	99.5%	94.5%	1.15
95 percent	99.0%	94.0%	1.16

**Per 23 CFR 490.105(e)(7), only a 4-year target is to be set for non-Interstate NHS for the first performance period.*

It is important to note that these targets are based on FHWA definitions of reliability, which have been nationally defined to achieve a standard measurement across States. These metrics and definitions of reliability may not be the same as other reliability metrics the Iowa DOT uses to evaluate system performance, and may not be the best indicator of what a typical traveler considers to be a reliable transportation system. Overall, these metrics suggest Iowa has a very reliable Interstate System and non-Interstate National Highway System. There are several possible caveats to consider regarding why non-Interstate NHS is shown as having a lower reliability than the Interstate System. These include that there is less data collected on non-Interstate routes; that non-Interstate NHS routes include many highways that travel through towns and urban areas and may not be free flowing due to intersections and traffic signals; and that travel time data does not exclude segments under construction - Interstate System construction is more likely to be done while the roadway still carries traffic, while non-Interstate routes are more likely to be subject to construction delays or detours.