Chapter 12 Presentation Script

Welcome to the Manual on Uniform Traffic Studies, also called MUTS, computer-based training!

This training module will cover Chapter 12 - Vehicle Spot Speed Study.

This training contains audio, so please adjust your speakers accordingly.

An alternate version is available on the Resources page.

To begin select the start button or press Shift + N on your keyboard.

During this training module, we will refer to one form in excel format stored on the MUTS online library through the FDOT's Traffic Engineering and Operations Office website.

Before continuing the training, consider scanning the QR code using your phone camera which directs you to the online library shown in this slide.

The link to the form is also provided in the resources page to this training.

Please open Form number 750-010-03.

This chapter covers the procedure on how to conduct a vehicle spot speed study.

Through this study we will provide guidance for practitioners on how to measure speed characteristics of a specific location at a given time period.

Typical justifications to perform a spot speed study include determining traffic signal timing, conducting roadway capacity analysis, conducting improvement effectiveness analysis, and determining the need for speed zone installations.

The project scope helps engineers determine how and when the spot speed study is conducted.

There are two different methods to conduct a spot speed study.

There is the All Vehicle Sampling Method and the Individual Sampling Method.

This chapter focuses on the Individual Sampling Method
which takes the speed from individual vehicles during a defined study period.

Please refer to the ITE Manual of Transportation Engineering Studies 2nd Edition, Chapter 5.3
and the 2018 FDOT Manual on Speed Zoning for Highways, Roads, and Streets, Chapter 5
for additional information on the All Vehicle Sampling Method.

The equipment required to conduct a vehicle spot speed study
typically include radar or LiDAR technologies.

The positioning of the equipment will depend on the manufacturer's capabilities.

Both technologies, radar and LiDAR, can be effectively used to detect speeds.

Let's discuss some of the differences between the two.

Radar uses radio waves and the Doppler effect to determine the speed of vehicles passing by.

Radar guns have a wide cone of influence
which means that individual vehicle speeds may be lost in heavy traffic.

LiDAR uses a laser of ultraviolet, visible, or infrared light to record speeds.

LiDAR has a narrow cone and can pinpoint an individual vehicle easily.

Generally, the radar gun is less expensive than LiDAR.

Typically, one to two people are needed to conduct a spot speed study.

To record speeds, the personnel should point the equipment at the vehicle.

Personnel should locate themselves in an area with good visibility,
but also conceal themselves from motorists' sight to not influence driver behavior.

The personnel should minimize the angle of incidence with the vehicle, so the readings are accurate.

We will graphically show the measurement for the angle of incidence in the coming slide.

The angle of incidence should be less than 15 degrees.

An angle of incidence greater than 15 degrees will affect the accuracy of the speed gun.

In the image, the observer is positioned along the side of the road at the same elevation as the vehicle or ground level.

"X" represents the horizontal distance from the observer to the vehicle. *[cont.]*

"Y" is the offset distance from the observer to the vehicle.

The angle of incidence, or "w," should not exceed 15 degrees
to minimize the influence on the vehicle speed readings.

The observer should avoid influencing driver behavior
by positioning themselves slightly back from the roadway away from the line of sight of the vehicles.

The observer should maintain an angle of incidence less than 15 degrees.

Some speed detection units have built in calibration for potential errors
caused by the angle of incidence, and the analyst should check the capabilities
of the speed detection equipment prior the data collection.

It is suggested to use a smaller angle of incidence, if possible,
to provide increased accuracy in the recorded speeds.

In the image, the observer is on top of an overhead bridge looking down on traffic.

In this image, the observer is in a good location as they have a clear line of sight to the vehicle and do not influence driver behavior.

"X" represents the horizontal distance from the vehicle to the observer.

"Z" is the vertical distance from the observer to the vehicle at ground level.

The angle of incidence, "w" should not exceed 15 degrees
to minimize the influence on the vehicle speed readings as previously mentioned.

The FDOT Manual on Speed Zoning guides speed limits in Florida.

The posted speed limit should be rounded to the nearest 5 miles per hour to the 85th percentile or 10-miles per hour pace, whichever is less.

The posted speed limit should not differ from the 85th percentile speed limit
or the upper limit of the 10-miles per hour pace (whichever is less) by more than 3 miles per hour.

For a more detailed discussion on posted speeds,
please refer to Section 9.3 Posted Speed of the FDOT Speed Zoning Manual.

The Federal Highway Administration, or FHWA, *Technical Report Methods and Practices for Setting Speed Limits: An Informational Report*, discloses the 50th percentile speed may be used to determine the speed limit if one of the following criteria are met:

Signals per mile greater than 4.

Parking activity is high.

High pedestrian / bicyclist activity which is defined as greater than or equal to 100 pedestrians or bicyclists per hour.

Driveways per mile greater than 60.

The Vehicle Spot Speed Form available for this chapter automatically calculates both the 50th and 85th percentile speeds, as well as the 10-miles per hour pace when the data collection is recorded electronically in the form.

Now that we have covered the background of a spot speed study, the necessary equipment, and recommended personnel to conduct one, we will discuss the relevant form and methodology.

The graphs on the right provide a visual representation of the pace as well as the 50th and 85th percentile from a sample of observed speeds.

The pace is defined as the 10-miles per hour bucket with the most observations. From the top graph, the pace is determined to be 30 to 40 miles per hour.
Using the bottom graph, it is concluded that 73% of vehicles fall within 10-miles per hour pace.
Distributions with a greater percentage of vehicles within the pace are preferred since this translates to less variation with the speed.

The 50th percentile is defined as the median of all speed observations and for the sample shown on the bottom graph it is determined to be 35 miles per hour.

The 85th percentile is 43 miles per hour from the bottom graph as well.
The electronic copy of the Form number 750-010-03:
Spot Speed Study will calculate these results automatically when field measurements are coded digitally into the form.

To recap this concept and definitions, the percent of vehicles within the 10-miles per hour pace helps practitioners understand the distribution of vehicles.

Form number 750-010-03 is the Spot Speed Study form.

Consider scanning the QR code on the slide using your phone camera
to access a copy of the form through the online library.

Before beginning the study, the header should be filled out completely.

The observed speeds should be logged in the pertinent speed categories.

There are four options to conduct a spot speed study.

Option 1 categorizes speed by direction.

Option 2 is a speed study that combines both directions and only one side of the form is used.

Options 3 and 4 break vehicles down into vehicle type.

Some common vehicle types often used include:
“C" is for passenger cars, "B" for buses, "T" for trucks, and "M" is multi-unit trucks.

Option 3 categorizes speed by direction.

Option 4 categorizes both directions in a single side of the form.

Note that the electronic copy of the forms does not automatically calculate the speed by vehicle type.

If the analyst desires to obtain the speed for each vehicle type,
a separate form should be completed for each vehicle type.

We will show an example on how to complete a separate form for each vehicle type
later in the training.

The minimum number of sampling requirements is defined by the FDOT Speed Zoning Manual.

100 vehicles are needed per direction
or all free-flowing vehicles during a 2-hour period with low volumes.

If a more accurate sampling requirement is needed, the following equation can be used.

MUTS Tables 12-1 and 12-2 provide the possible values for the equation variables.

MUTS Table 12-1 provides the Average Standard Deviation, “S”, by traffic area and highway type.

MUTS Table 12-2 provides the Constant, “K”, corresponding to the Level of Confidence.

“E”, or the allowable error, can be plus or minus 1 to 5 miles per hour.

Let’s take a look at an example on how to use this equation.

This variable’s typical permitted values range from plus or minus 1

to plus or minus 5 miles per hour.

Guidance on the value of E is given in MUTS Table 13-1.

The example shows how to calculate the number of required observations or sample size using the equation.

This example is for a two-lane roadway located in an intermediate area.

We will be using a 95% confidence level and an assumed allowable error of +2 miles per hour.

Using the equation, the minimum number of samples required in this scenario is 27 samples.

The form automatically calculates the 85^{th} percentile speed, 50^{th} percentile speed, and 10-miles per hour pace if the data is coded electronically.

If the electronic copy of the form cannot be used in the field, the data can be manually collected and transferred to the electronic version of the form in the office after.

Option 1 is used to record data on both directions of the roadway.

Let’s zoom in on where we will be inputting data.

The animation displays how the form can be used in the field.

As the vehicles travel along the roadway, the observer points the speed gun at the vehicle and records the relevant speed on the data sheet.

The electronic copy of the form will calculate the results once the data is recorded electronically.

Note the input cells do not have restrictions on format or character count.

For example, the user can type the number 20,

representing 20 vehicles, in a cell if desired.

Option 2 combines both directions when conducting a spot speed study.

The animation displays how the form can be used in the field.

The same steps are repeated for option one, however, the data is combined into one side of the form.

Like Option 1, the results will automatically be calculated
once the data is entered into the electronic copy of the form.

For Option 3, the speeds are logged for both respective directions,
and vehicle classification is logged.

The animation displays how the form can be used in the field. *[cont.]*

As the vehicles travel across the roadway, the speeds and type of vehicle are logged.

The form does not automatically calculate speeds by vehicle type,
so the data needs to be manually recorded and calculated.

An alternative to avoid manual calculation would be to use separate forms for each vehicle type.

Like with Option 3, Option 4 logs the vehicle speed and type of vehicle.

For Option 4 only one side of the form is used since it combines both directions.

The form does not automatically calculate speeds for each vehicle type,
so the data needs to be manually recorded and calculated.

An alternative to avoid manual calculation would be to use multiple forms for each vehicle type.

For vehicle speeds to be determined automatically by vehicle classification, the data will need to be transferred into multiple forms.

In this example, there are two vehicle types: cars and trucks,
so two forms would be needed to automate the calculations.

First, we transfer the car speeds into a form.

Then we transfer the truck speeds into a form.

Transferring this data will allow the form to automatically calculate the 50th, 85th,
and 10-miles per hour pace for each vehicle type.

If there are multiple 10-miles per hour paces observed,
the form will generate a warning message at the bottom of the form.

Be aware that the form will show the highest 10-miles per hour pace only.

Multiple 10-miles per hour paces are not a common occurrence;
however, if it does occur the form is built to warn the user as shown in the screen.

If there are multiple 10-miles per hour paces, the highest 10-miles per hour pace
would be the pace that is used to determine the speed limit.

We will now discuss the logic to follow to determine changes to the posted speed limit
once the results from the spot speed study are calculated.

Once the field measurements are collected for a spot speed study,
the engineer should determine if the 50th percentile conditions are met.

As previously discussed, the 50th percentile speed conditions may be considered
if one of the following conditions are met:

Signals per mile are greater than 4.

Parking activity is high.

High pedestrian / bicyclist activity is greater than or equal to 100 per hour.

Driveways per mile are greater than 60.

If the 50th percentile conditions are met, the posted speed limit may be changed
to the closest 5 miles per hour multiple of the 50th percentile speed.

Note speed management strategies per Florida Design Manual
or FDM Section 202.3 must be incorporated with the revised posted speed.

If the 50th percentile conditions are not met, the 85th percentile speed
or the upper bound of the 10- miles per hour pace, whichever is lower, should be considered.

If the 85th percentile or the upper limit of the 10-miles per hour pace, whichever is lower,
is within 3 miles per hour, then the speed limit does not need to be changed.

If the 85th percentile or the upper limit of the 10-miles per hour pace, whichever is lower,
is more than 3 miles per hour different than the posted speed limit,
the posted speed limit may be changed to the closest 5-miles per hour multiple of the relevant speed.

This logic is intended to serve as a general application process for a spot speed study.

The FDOT Speed Zoning for Highways, Roads, and Streets in Florida Manual
must be consulted before recommending speed limit changes.

We will now walk through the application logic
to our last initial example of spot speed records.
In this case, the 50th and 85th percentile speeds
are 41 and 49 miles per hour, respectively.
The 10-miles per hour pace is 36 to 46 miles per hour.
The current posted speed limit is 50 miles per hour,
and the conditions for the 50th percentile speed application are not met.

First, the engineer must check if the 50th percentile conditions are met.
Because the 50th percentile conditions are not met,
the relevant speed is either the 85th percentile speed or upper bound
of the 10-miles per hour pace, whichever is lower.
In our example, this means we compare the posted speed
of 50 miles per hour to the 85th percentile speed of 49 miles per hour
and the upper limit of the pace of 46 miles per hour.
The upper limit of the pace is lower than the 85th percentile speed,
so we will compare 46 miles per hour to the posted speed limit.

In our example, there is a 4-miles per hour difference between
the upper bound of the pace and the current posted speed limit
which is greater than the 3-miles per hour threshold.
Therefore, there is evidence to change the posted speed limit
to nearest 5 miles per hour or 45 miles per hour.
This example demonstrates the logic application to the spot speed study results.
The engineer must always consult the FDOT Speed Zoning for Highways,
Roads, and Streets in Florida Manual before recommending
posted speed limit changes.

There are two different sampling methods to conduct a Spot Speed Study.

The individual sampling method and all vehicle sampling method.

This chapter focused on the individual sampling method.

To conduct a spot speed study, the engineer will need equipment
such as a radar or LiDAR speed gun.

In addition, one to two observers are required and should locate themselves
in a spot where they have good visibility, but also do not influence driver behavior.

The electronic copy of MUTS Form number 750-010-03: Spot Speed Study
automatically calculates the 50th and 85th percentile speeds in addition to the 10-miles per hour pace.

The results of a spot speed study can support the change of a posted speed limit on a roadway
per the Florida Speed Zoning manual.

This concludes the Manual on Uniform Traffic Studies computer based training,
Chapter 12 - Vehicle Spot Speed Study.

[Web]

You will now be directed to a 10-question quiz to test your knowledge and understanding
on the material presented in this computer-based training.

A passing grade of 70% is required to obtain the Certificate of Completion for the training.

If a grade below 70% is obtained, the trainees are required to re-take the full training
until a passing grade of 70% or higher is obtained.

If you do not pass the quiz, please return to the Index page
by selecting the Index button below and re-take this training.

Once you've received your certificate,
please continue to the next chapter by selecting the "NEXT" button below this CBT.

On the next slide, please read the directions carefully before continuing to the quiz.

Thank you for your time and attention.

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You will now take a 10-question quiz to test your knowledge and understanding on the material presented in this computer-based training.

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If you do not pass the quiz, please return to the Course Content tab and re-take this training.

You will receive your certification after completing the full MUTS training and passing the quiz for each chapter.

Please continue to the next chapter by returning to the MUTS course content tab and selecting the next chapter in the training.

On the next slide, please read the directions carefully before continuing to the quiz.

Thank you for your time and attention.