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An evaluation of methods used to obtain the railroad preemption queue clearance time

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AN EVALUATION OF METHODS USED TO OBTAIN THE RAILROAD PREEMPTION QUEUE CLEARANCE TIME

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering

in

The Department of Civil and Environmental Engineering

By:

DeeAngela R. Kenon
B.S., University of Illinois, 1996
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ABSTRACT

Because of the potential for serious train-vehicle accidents at or near railroad-highway grade crossings, preemption of traffic signals is a very important supplement to an active warning system. Preemption is the transfer of normal signal phasing to a special control mode with the purpose of clearing any vehicles that are queued within the dynamic envelope as the train approaches, and prohibiting signal phases that would allow additional vehicles in the track area while the train is present.

The focus of this research was the determination of the Clear Track Green Interval (or the Queue Clearance Time). The clear track green interval is the most important component of the preemption process because this is the time allotted to clear any vehicles that are queued within the track dynamic envelope. The estimation of the amount of time needed for the Clear Track Green Interval is often left to the discretion of the traffic engineer. To date, the Louisiana Department of Transportation and Development has no explicit guidelines for the traffic engineers in their design of railroad preemption for traffic signals.

This research describes the evaluation of three methodologies that can be used to acquire the clear track green interval for an intersection. The study provides a comparison of the calculated values versus the field (or observed) values with the objective being to show if the calculated times are adequate or if they provide too much time for the action thereby causing adverse affects to the intersection. The second objective of this research is to provide guidance to the traffic engineers in the design of railroad preemption for traffic signals.

Based on the results and analysis of this research, the field observed method yielded a lower clear track green interval 71% of the time. Out of the remaining two methods, the Marshall/Berg method yielded lower results 29% of the time and the Northwestern method always yielded a
longer time because of its conservative approach. The instances when the Marshall/Berg method yielded lower results has varying causes. The reasons included: intersections where the side approaches shared the phasing causing the track side approach to have to compete with the other approach to move beyond the track, red light runners causing the drivers to hesitate before proceeding out into the intersection, and geometry issues.
CHAPTER 1  INTRODUCTION AND OBJECTIVES

1.1 BACKGROUND

With trains being faster and more frequent and more and more Americans choosing cars as their primary source of transportation, intersections where there are traffic signals near railroad grade crossings pose a potential safety hazard. At intersections where this type of arrangement exists, there is a potential for traffic queues to back up across the tracks. This could lead to a stationary vehicle being caught within the dynamic envelope when a train approaches. Despite the fact that there has been a reduction in the number of accidents and fatalities at railroad-highway grade crossings nationwide, the numbers still remain high, making this type of intersection a high safety priority.

According to the Manual on Uniform Traffic Control Devices (MUTCD), the dynamic envelope is typically 18 feet wide, which includes 6 feet of track width plus 6 feet of clearance on either side (1).

![Figure 1. Typical placement of warning signs and pavement markings at highway-rail grade crossings (1)](image)

Because of the risk of being caught in the dynamic envelope, railroad preemption at signalized intersections must be a priority (2).
The Federal Highway Administration (FHWA) has mandated that traffic signals be designed to ensure the proper preemption time. This comes because of the large number of vehicle-train accidents that have occurred in the last several years. The increased concern is due to the severity of accidents that have taken place, especially involving school buses.

Preemption is the transfer of normal operations of traffic signals to a special control mode with the purpose of clearing any vehicles that are queued within the dynamic envelope as the train approaches (1). Preemption ensures that there is not a collision between the vehicular traffic and any approaching train. Once it is established that there is a need for preemption, the proper analysis must take place to determine how long the total preemption time should be. Included in the total preemption time is the clear track green interval. The clear track green interval is the time required for the design vehicle stopped within the dynamic envelope to start up and move through the dynamic envelope (3). There are many methodologies used to calculate the clear track green interval, but without considering the prevailing conditions at each intersection, do they really produce accurate times to be used when programming the controller for preemption?

1.2 OBJECTIVES

Numerous procedures are available for the determination of the queue lengths and clearance times at railroad-highway grade crossings. As an alternative to these computations, the actual saturation flow rates for prevailing conditions can be measured directly from the field. According to the Highway Capacity Manual (HCM), it is preferable that the local prevailing saturation flow rates be observed directly (4).

This research has two main objectives. The primary objective is to provide a comparison of the calculated and field (or observed) values for estimating the clear track green interval. From this comparison the adequacy of the calculated values can be examined. This will show whether
or not the calculated values provide a reasonable estimation of the clear track green interval or if the clear track green interval should always be obtained from the field. The selection of a reasonable estimation for the clear track green interval is important for several reasons. An estimation that is too low can cause a vehicle to be in the dynamic envelope when a train approaches resulting in injury or even death. An estimation that is too high can adversely affect the intersection in the way of queuing, delays, and overall intersection efficiency.

Although the estimation of the amount of time needed for the clear track green interval is left to the discretion of the traffic engineer, the Louisiana Department of Transportation and Development currently has no explicit guidelines for estimating this time. The second objective of this research is to provide guidance to the traffic engineers in the design of railroad preemption for traffic signals.
CHAPTER 2  LITERATURE REVIEW

2.1 RAILROAD-HIGHWAY GRADE CROSSINGS

The railroad-highway grade crossing is unique in that it constitutes the intersection of two transportation modes, which differ both in the physical characteristics of their traveled ways and in their operations. Initially, safety at railroad-highway grade crossings was not considered to be a problem. Trains were few in number and slow, as were highway travelers who were on horseback, carriage, or on foot. By the late 1900’s, however crossing accidents were increasing and communities became concerned about safety and delays at crossings. Many states, cities, and towns adopted laws, ordinances, and regulations that required the railroads to eliminate some crossings and provide safety improvements at others. The number of railroad-highway grade crossings grew with the growth in highway miles. Today, there are approximately 3,400 existing interconnected (the electrical connection between the railroad active warning system and the traffic signal controller assembly for the purpose of preemption) railroad and highway signal systems. This makes up 1.4% of the nearly 252,000 rail-highway grade crossings (3).

2.2 RAILROAD-HIGHWAY GRADE CROSSING ACCIDENTS

National statistics on crossing accidents have been kept since the early 1900’s as a result of the requirements of the Accident Reports Act of 1910 (5). The Act required rail carriers to submit reports of accidents involving railroad personnel and railroad equipment, including those that occurred at crossings. At that time, not all of the accidents were reported. The railroads were required to report only those accidents that resulted in:

1. A fatality
2. An injury to a person sufficient to incapacitate him or her for a period of 24 hours in the aggregate during the 10 days immediately following; or
3. More than $750 damage to railroad equipment, track or roadblock.
The above requirements remained unchanged until 1975 when the Federal Railroad Administration (FRA) redefined a reportable railroad-highway grade crossing accident. Under the new guidelines, any impact “between railroad on-track equipment and automobiles, buses, trucks, motorcycles, bicycles, farm vehicles, pedestrians or other highway user at a railroad-highway grade crossing ‘must be reported’.” (5)

As shown in Figure 2, in 2002, there were 357 motor vehicle fatalities at railroad-highway grade crossings among a total of approximately 42,815 highway motor vehicle fatalities from all causes. Even though railroad-highway grade crossing accidents account for less than 1% of all highway fatalities, they represent a large portion of all railroad accidents (6).

2.3 PREEMPTION

Because of the potential for serious train-vehicle accidents, preemption of traffic signals is a very important supplement to an active warning system. The active warning systems at railroad-highway grade crossings often include flashing light signals, automatic gates, and bells.

2.3.1 RAILROAD PREEMPTION

Preemption is required to clear any vehicles that might be queued within the dynamic envelope as the train approaches and to prohibit signal phases that would allow additional vehicles from crossing the tracks. The vehicles stopped within the dynamic envelope need to be permitted to clear the area before a train arrives at the crossing. The objective of a successful preempt is to provide for the passage of a train, no matter where in the normal traffic signal operation the preempt occurs. This ensures that the separate railroad and intersection traffic control system do not conflict with each other.
2.3.2 PREEMPTION NEED

Determining the need for preemption is one of the fundamental issues considered in the preemption assessment process. According to the MUTCD, “when a highway-rail grade is equipped with a flashing-light signal system and is located within 200 ft of an intersection or mid-block location controlled by a traffic control signal, the traffic control signal should be provided with preemption in accordance with Section 4D.13.” Based on the site conditions, it may be appropriate to interconnect a location where the signal is more than 200 feet from a set of tracks. This must be considered when the traffic backed up from a nearby downstream railroad grade crossing interferes with another signalized highway intersection (1).
2.3.3 PREEMPTION TYPES

There are two types of preemption: “simultaneous” and “advanced.” The preemption is simultaneous if the normal train detection time (minimum of 20 seconds) is adequate to preempt the normal phase sequence and if necessary, to clear the dynamic envelope. During simultaneous preemption a notification of an approaching train is forwarded to the traffic signal controller and railroad active warning devices at the same time (7). Figure 3 shows a sample simultaneous preemption time line. The preemption is advanced if the normal train detection time is not adequate. Since not all intersections are the same, more time may need to be added to the preemption sequence for things like pedestrian or other vehicle clearances. Also, in areas where there are high-speed trains, extra warning time may be needed. When that is the case, notification of an approaching train is forwarded to the traffic signal controller by railroad equipment for a period of time prior to activating the railroad active warning devices. The advanced preemption time is the difference in the maximum preemption time required for traffic signal operation and the minimum warning time needed for railroad operations (7). For simultaneous preemption, the advanced preemption time is zero. Advanced preemption is required when there is not enough time available under simultaneous preemption to clear traffic safely out of the dynamic envelope. The amount of advanced time needed must be closely coordinated between the highway and railroad and also requires a more sophisticated and expensive circuitry on the part of the railroad signals. Figure 4 shows a sample advance preemption time line.

2.3.4 A TYPICAL RAIL PREEMPTION OF A TRAFFIC SIGNAL CONTROLLER

Rail preemption of a traffic signal controller typically consists of the following sequence (8):

“Right of way transfer, Track clearance time, Dwell time, and return to normal operations. During the right of way transfer period the preemption call has to be recognized by the traffic signal controller and any active signal phases (both vehicular and pedestrian) that conflict with the phases controlling the movement that could be within the dynamic envelope has to
Figure 3. Sample simultaneous preemption time line (7)
be terminated. The time required for right of way transfer includes any railroad or traffic signal control equipment time to react to a preemption call, and any traffic signal green, pedestrian walk and clearance, yellow change, and red clearance intervals for conflicting traffic (9). The duration of the right of way transfer period is variable, and can vary from almost zero (where no active phases conflict with the phases controlling the movement that could be within the dynamic envelope, requiring only that the preempt call be recognized) to a maximum amount of time needed in the case (where the largest possible amount of clearance time is required).”

During the track clearance interval the track clearance signal phase(s) – those phases controlling movement across the tracks towards the intersection – will be active. The queue that may be within the dynamic envelope will start moving before the arrival of the train at the crossing. The track clearance phases may remain active for some time after the arrival of the train to allow traffic between the tracks and the intersection to clear the intersection stop line during the track clearance interval. The duration of the track clearance phases are studied in this paper. It can be either calculated from equations that use assumptions that are sometimes not related to the intersection in question or it can obtained from data collected in the field which measured prevailing conditions (4).

The dwell time starts after termination of the track clearance phase(s). During this period, the automatic gates (if on site) should be down, blocking the pertinent vehicular movements, but other movements will not be restricted and will be allowed to take place. According to the MUTCD, while the dwell period is in session, traffic control signals operating under preemption control or under priority control should be operated in a manner designed to keep traffic moving (1).

After the train clears the crossing and the automatic gates (if on site) are raised, preemption ends and traffic control must return to normal operations. This occurs through the termination of
Figure 4. Sample advance preemption time line (7)
those phases that are active at the end of the preemption, followed by the activation of one or more return phases.

The return phases are usually selected from those phases to be serviced during the dwell period to service queues that have built up during the dwell period before normal operations are resumed.

2.4 CURRENT STATE OF THE PRACTICE

For years, there has been published information pertaining to the preemption of traffic signals. The Association of American Railroads has provided calculation instruction and recommendations on approach warning times as well as track circuitry information. The MUTCD has prescribed minimum warning times for flashing-light actuation and time delays. There has also been a compilation of state-of-the-art information on railroad-highway grade crossings presented by the Federal Highway Administration. As of late, the industry standard has been “A Recommended Practice” published by the Institute of Transportation Engineers which provides recommendation for when to preempt traffic signals near active railroad crossing and which preemption sequences to use. Despite all of the efforts made, there has always been little discussion concerning the timing of the queue clearance intervals (10). Eventually, there emerged several methods that can be used to estimate the clear track green interval. What follows is brief synopsis of those methods and a relatively new method done by Dr. Long and the University of Florida. Although the University of Florida method is not considered in the research itself, it is presented here to expose the reader to its concepts. Finally, there is a discussion about where the field observed method of this research fits into the current state of practice.
2.4.1 NORTHWESTERN TRAFFIC INSTITUTE METHOD

The Northwestern Traffic Institute (11) method is the applied application of various theories and methods that have been developed over time, including those of the Institute of Transportation Engineers and the Greenshield’s model. In light of this, the results from this method will be representative of ITE and all of the other research that went into its development. This method uses a conservative approach in that it clears the entire intersection versus just the dynamic envelope. For this reason, it tends to yield longer but relatively safe clear track interval times. The logic of the procedure can be explained as follows:

a) The length of the Clear Track Green Interval is dependent upon: the distance from the tracks to the signalized intersection, the start-up time characteristics of the vehicles in the queues within that distance, and the geometry of the crossing, including the number of tracks.

b) Desirably, the Clear Track Green Interval should be long enough to allow all vehicles stored between the grade crossing stop line and the signalized intersection to move forward and clear the intersection. Time required to clear a queue of n vehicles can be estimated as: 
   \[ t = 4 + 2n \text{ seconds} \]

c) If the crossing is a significant distance from the intersection it may not be necessary to clear all of the vehicles. In this case, the time interval necessary to allow a vehicle to move from the track area to a safe location can be defined as the sum of two subintervals: the time needed for the vehicle ahead to begin to move out of the way \( (t_1) \) and the time needed for the subject vehicle to accelerate and move to a position clear of the tracks \( (t_2) \).
The time before the vehicle ahead begins to move can be estimated as:

\[ t_1 = 1 + 1.2n \text{ seconds} \]

where \( n \) is the number of vehicles queued ahead of the most critical vehicle that must be allowed to clear the tracks.

The second component of the Clear Track Green Interval involves determining how long it will take a design vehicle stopped on or near the tracks to accelerate to a position of safety once the queue in front of it has begun to move.

The time required for this movement can be estimated as:

\[ t_2 = \frac{2(L + TCD)}{a} \]

where:
- \( L \) = length of design vehicle (ft)
- \( TCD \) = Track Clearance Distance (ft)
- \( a \) = acceleration rate for the design vehicles (ft/sec\(^2\))

Suggested values for acceleration rates are: a passenger (P) design vehicle, 4.4 (ft/sec\(^2\)), a single unit (SU) design vehicles, 2.5 (ft/sec\(^2\)); and a multiple unit (MU) design vehicle, 1.6 (ft/sec\(^2\)).

d) The total duration of the Clear Track Green Interval calculated thus far assumes that an approaching train will arrive at the crossing just as a vehicle stopped on the tracks has cleared. Because of the potential high severity involved in a vehicle-train accident some agencies provide an additional safety factor or “Separation Time, typically 4 to 8 seconds. The Separation Time is particularly important when:

1. The tracks are relatively far from the intersection (and hence a long queue needs to be cleared).
2. Train speeds are high.
3. There is a high percentage of trucks in the traffic stream.

**2.4.2 MARSHALL AND BERG METHOD**

The next method was found in an article written by authors Marshall and Berg (2). The time interval necessary to allow a vehicle to move from the track area to a safe location can be defined as the sum of two subintervals: the time needed for the vehicle ahead to begin to move out of the away (t₁), and time needed for the subject vehicle to accelerate and move to a position clear of the tracks (t₂). The time required to move a vehicle within a stopped queue of a given length will depend on several parameters such as start-up delay, traffic composition, vehicle acceleration rates and headways. In addition, roadway parameters such as lane width, geometrics and grades will affect driver behavior. As a simplified approach to this computational problem, a shockwave methodology can be applied in which the rate of queue dissipation is equal to the rate at which the “starting” wave moves backwards through the queue. The length of queue to be removed is then divided by the dissipation rate to obtain the time required for the back of the queue to move away from the tracks. Assuming a parabolic relationship between flow rate and density, the speed of the starting wave (mph) can be expressed as:

\[
U_w = \frac{2s}{k_j}
\]

where:  
\( s = \text{saturation flow rate (vph)} \)  
\( k_j = \text{jam density (vpm)} \)

As noted earlier, the Highway Capacity Manual can be used to estimate the saturation flow rate. Alternatively, default values of 1,600 vph for through lanes and 1,400 vph for exclusive turn lanes can be used (5). Once a saturation flow rate has been calculated and a suitable value for jam density has been selected (e.g., 240 vpm), the speed of the shockwave can be determined
using the above equation. The time in seconds until the last vehicle in the blocking queue departs can then be expressed as:

$$t_1 = \frac{Lk_j}{2.94s}$$

where:
- $L$ = the length of queue to be cleared, as measured from the intersection stop line to the point where a vehicle needing to be cleared may be stopped (ft)
- $k_j$ = jam density (vpm)
- $s$ = saturation flow rate (vph)

The second component of the track clearance phase involves determining how long it will take a vehicle stopped on or near the tracks to accelerate to a position of safety once the queue in front of it has begun to move. The first step is to define the area at the tracks from which vehicles must be removed. Obviously, vehicles stopped directly over the tracks will be in danger, but it will also be desirable to clear vehicles that stop between the tracks and the upstream grade crossing signal. One definition of the area that should be cleared (as well as a methodology for determining the time required for a vehicle to accelerate across this area) is found in the AASHTO procedures for determining sight distance requirements at rail-highway grade crossings. As shown in figure 5, any vehicle located within a 15-ft hazard zone (D) on either side of the tracks must be cleared completely out of this one before the arrival of a train. The critical vehicle for preemption design purposes is the last one stopped within the 15-ft hazard zone approaching the tracks. To clear safely, the rear of that vehicle must reach a position past the 15-ft hazard zone on the other side of the tracks before the train arrives at the crossing.
Figure 5. Marshall and Berg crossing clearance geometry (2).

The time in seconds required for this maneuver can be expressed as:

$$t_2 = \sqrt{\frac{2(L + 2D + W)}{a}}$$

where:  
L = length of the design vehicle  
D = clearance distance on either side of the tracks (assume 15 feet)  
W = width of the crossing or distance between the outermost rails (ft)  
\(a\) = acceleration rate for the design vehicle (ft/sec\(^2\))

2.4.3 LONG AND UNIVERSITY OF FLORIDA METHOD

The final method discussed uses models for determining the time required to clear the nth vehicle in a queue off a track. The models adopt a high level of confidence to minimize the risk of accidents. The models require very limited input information. The inputs are the minimum track clearance distance, the clear storage distance, and the types of vehicles permitted to use the roadway. Where special conditions exist, such as driveways intercepting the roadway in the
queue storage area, additional factors can affect queue clearance times and my need to be applied as adjustments. Estimation guidance for adjustment factors is provided. Track clearance time is considered as two components. One component is the time delay incurred after a traffic signal changes to green that a vehicle in jeopardy at the track must wait while leading vehicles move forward before the vehicle in jeopardy can move forward. This is designated as startup delay time. The second component is the repositioning time while the vehicle in jeopardy accelerates forward out of harm’s way. The method’s procedure is as follows:

1) Determine whether the signalized intersection is within 200 ft of the railroad crossing, as specified in the MUTCD, or whether expected maximum queues are likely to extend back as far as the track, using included tables or equations, such that traffic signal preemption for queue clearance is needed.

2) Identify the appropriate design vehicle in compliance with the MUTCD.

3) Obtain the design length and acceleration category of the design vehicle by consulting included tables.

4) Determine the minimum track clearance distance in compliance with the MUTCD as illustrated.

5) Determine the clear storage distance in compliance with the MUTCD as illustrated.

6) Add the minimum track clearance distance and the clear storage distance to get the critical queue length.

7) Enter the given figure or equation with the critical queue length and get the expected progressive startup delay.

8) Add any needed special adjustments.
9) Add the design vehicle length and the minimum track clearance distance to get the repositioning distance.

10) Enter the given figure or equation with the repositioning distance, the design vehicle type and acceleration category and get the expected maximum repositioning time.

11) Add the expected maximum startup delay and expected maximum repositioning time to get the expected safe track-clearance time.

12) Add the train-detection equipment-delay time, pedestrian minimum truncation time, yellow change interval time, train separation time and other necessary time adjustments to the expected safe track-clearance time to the expected safe minimum-preemption time. (Outside the scope of this project.) (10)

As was shown from the information presented, there are relatively few guidelines published in the area of estimating the clear track green interval for preemption. The methods of the Northwestern Traffic Institute and Marshall and Berg give the traffic engineer guidance but they are calculated methods and do not take into account the actual prevailing field conditions at the intersection. The method done by Dr. Long and the University of Florida seems like it would render a good estimation but it is fairly new and unused. This research will be important because it is simple, takes into account the actual condition at the intersection being studied, will provide data in the Louisiana area, and would not be difficult to transfer for use in other parts of the country.
CHAPTER 3  METHODOLOGY

3.1 INTRODUCTION

The Northwestern Traffic Institute (11), Marshall and Berg (2), and field observed methods were compared to acquire the clear track green interval at several pre-determined locations. Two of the methods involve calculations while the third involves field (or observed) values with the objective being to see if the calculated times provide too much or too little time for the action.

3.2 STUDY SITES

Using the guidelines from the MUTCD, 24 sample study sites were selected. Table 1 and Figure 6 show the 24 sites in East Baton Rouge Parish that served as sample sites. All of the study sites were signalized intersections within 200 feet of a railroad crossing.

3.3 FIELD (OR OBSERVED) METHOD

This method involved data measured in the field that was based on the saturation flow field measurement outlined in the Highway Capacity Manual (4). It takes the theory of observing the prevailing field conditions and the maximum clear track green interval observed at each intersection to provide the traffic engineer with an efficient and safe clearance time.

3.3.1 TIME OF DAY CONSIDERATIONS

The first factor that was considered was the time of day. Each intersection had three daily peak periods, including an AM, a noon, and a PM peak. The research was conducted during each intersection’s highest peak time. In doing so, the track clearance time was based on the time when the intersection volumes were at their highest. This ensured that no matter when the preemption occurred, there was enough time for all of the vehicles that might have been in the dynamic envelope throughout the day to be cleared.
Table 1. Research study sites.

<table>
<thead>
<tr>
<th>CITY</th>
<th>ARTERIAL</th>
<th>CROSS STREET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker</td>
<td>LA 19 (Main Street)</td>
<td>Groom Road</td>
</tr>
<tr>
<td>Baker</td>
<td>LA 19 (Main Street)</td>
<td>LA 3006 (Lavey Lane &amp; Magnolia Drive)</td>
</tr>
<tr>
<td>Baker</td>
<td>LA 19 (Main Street)</td>
<td>Ray Weiland Drive &amp; Truman Street</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 19 (Scotland Avenue)</td>
<td>LA 423 (Thomas Road)</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 19 (Scotland Avenue)</td>
<td>Rafe Meyer Road &amp; Gibbens Road</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>US 61 (Scenic Highway)</td>
<td>LA 19 &amp; Swan Avenue</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>US 61/190 (River Road)</td>
<td>Casino Rouge Entrance</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 3164 (Scenic Highway)</td>
<td>Choctaw Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 67 (Plank Road)</td>
<td>Choctaw Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>US 61/190 (Airline)</td>
<td>Choctaw Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>Choctaw Drive</td>
<td>North Acadian Throughway East</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>Choctaw Drive</td>
<td>Wooddale Boulevard</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>Choctaw Drive</td>
<td>North 38th Street</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>Choctaw Drive</td>
<td>North Foster Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>Choctaw Drive</td>
<td>North Ardenwood Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>South Choctaw Drive</td>
<td>Lobdell Boulevard</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>South Choctaw Drive</td>
<td>Oak Villa Boulevard</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>South Choctaw Drive</td>
<td>Monterrey Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>South Choctaw Drive</td>
<td>Sherwood Forest Boulevard</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 427 (Perkins Road)</td>
<td>Congress Boulevard</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 30 (Nicholson Drive)</td>
<td>Bob Pettit Boulevard &amp; Jennifer Jean Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 30 (Nicholson Drive)</td>
<td>Brightside Drive &amp; West Lee Drive</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 30 (Nicholson Drive)</td>
<td>LA 327 Spur (Gardere Lane)</td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>LA 30 (Nicholson Drive)</td>
<td>LA 42 (Burbank Drive &amp; Gourrier Avenue)</td>
</tr>
</tbody>
</table>
Figure 6. Research study sites.
3.3.2 CALCULATED NUMBER OF TRIALS VIA A PILOT STUDY

The next step was to calculate the number of trials that needed to be recorded at each intersection. A trial consisted of recording the green time required to move a vehicle that was stopped on the tracks, out of the track dynamic envelope. To accomplish this, a pilot study was conducted. The site selected for the pilot study was LA 427 (Perkins) at College and Lee and the study lasted three days. Figure 7 shows the traffic volumes for LA 427 (Perkins) at College and Lee. The intersection’s P.M. peak hour volumes are higher than it’s A.M. and noon peak volumes. Of all of the sites, LA 427 (Perkins) @ College and Lee had the highest peak volumes during its afternoon peak and also met the MUTCD criteria. For these reasons this site was selected for the pilot study.

Figure 7. Pilot study intersection peak volumes.
By using this site, the estimation for the number of trials needed will be more than enough to ensure a 95% confidence range at all of the other sites. This site has 4 lanes: two left turn lanes, one through lane, and one exclusive right turn lane. The data was collected on the one through lane. Once the data was collected, a statistical analysis was performed to estimate the number of trials that needed to be recorded. Over the three-day period, 89 cycles were observed, but only 65 of the cycles had traffic stopped in the dynamic envelope. From the 65 trials with traffic in the dynamic envelope, a mean of 19.7 seconds and standard deviation 2.48 seconds were calculated. From the various estimates, the tolerance of 1.2 seconds was selected, which resulted in an estimated sample size at least 24 trials with traffic in the dynamic envelope. It was estimated that this would take approximately 2 days per intersection because congested conditions in which the traffic is backed up to the grade crossing is needed to make a valid observation (12).

3.3.3 PROCEDURE

Data from the trials were recorded on the Louisiana Department of Transportation and Development (LADOTD) Traffic Operations and Engineering Field Observation Method Railroad Preemption Worksheet. The procedure for recording the green time required to move a vehicle that was stopped on the tracks, out of the track dynamic envelope was as follows: 1) General tasks - The survey identification and geometric measurements were filled out and an observation point was selected where the track dynamic envelope and the corresponding signal heads were clearly visible. 2) Analysis tasks – as the queue built up during the red phase, the number and types of vehicles were recorded. The number of the last vehicle in the dynamic envelope was noted and recorded. When the light turned green, the timer was started. When the bumper of the last vehicle cleared the dynamic envelope, the timer was stopped and the time was recorded. 3) Any unusual events that may have influenced the track clearance time were noted,
this included weather, buses receiving or discharging passengers, stalled vehicles, and unloading trucks (13). This procedure was done repeatedly until the number of trials needed was obtained. Figure 8 shows an example field observation sheet. The field observation sheets for each intersection are included in Appendices A-X.

Figure 8. Louisiana Department of Transportation and Development field observation worksheet (13).
CHAPTER 4  STATISTICAL ANALYSIS

For each intersection, the calculated and field values, as shown in Appendices A-X, were determined and then a comparison made. The comparison was made using a two-tailed single-sample hypothesis sign test. This test uses hypothesis testing and yields a 95% confidence interval for the population median. The sign test, a nonparametric method, was used because these types of methods do not depend on the distribution of the population being sampled. A parametric method, such as the t-test, was not used because normality assumptions can not be made for the research data. Each of the calculated methods was individually compared to the track clearance times obtained from the field data.

First the data was converted to (+) and (-) signs according to whether the data was more or less than the null hypothesis value (for this research, the null hypothesis value was the value obtained from one of the calculated methods). A plus sign was assigned to each field trial with a clearance time higher than the null hypothesis value. A minus sign was assigned to each field trial with a clearance time lower than the null hypothesis value, and a zero to those equal to the hypothesis value. The sign test uses only the plus and minus signs; therefore, the zeros are discarded and the usable sample size may have to be adjusted. The procedure is as follows:

Number of field observations under the null hypothesis value (denoted as n(-))
Number of field observations equal to the null hypothesis value
Number of field observations over the null hypothesis value (denoted as n(+))
Number of usable observations: (n(-) + n(+))

Step 1 The Set-Up:

a. Describe the population parameter of interest.

b. State the null hypothesis (H₀) and the alternative hypothesis (Hₐ).
Step 2  The Hypothesis Test Criteria

a. Check the assumptions. For the sign test, the assumptions are that the samples are selected independently and that the population is continuous.

b. Identify the test statistic to be used. The test statistic that will be used is the number of the less frequent sign; the smaller of \( n(+) \) and \( n(-) \). We will want to reject the null hypothesis whenever the number of the less frequent sign is extremely small. The sign test critical value table gives the maximum allowable number for the less frequent sign, \( k \), which will allow us to reject the null hypothesis. That is, if the number of the less frequent sign is less than or equal to the critical value in the table, we will reject \( H_0 \). If the observed value of the less frequent sign is larger than the table value, we will fail to reject \( H_0 \). In the table, \( n \) is the total number of signs, not including zeros.

c. Determine the level of significance, \( \alpha \). \( \alpha \) equals 0.05 for a two-tailed test.

Step 3  The Sample Evidence

a. The sample information.

b. The test statistic.

Step 4  The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical value(s) from the sign test critical value table. The critical region is split into two equal parts since the \( H_a \) expresses concern for the values related to “not equal to.” Since the table is for two-tailed tests, the critical value is located at the intersection of the \( \alpha \) column and the \( n \)th row of the table.

| Reject \( H_0 \) | Fail to reject \( H_0 \) |
Number of the less frequent sign

b. Determine whether or not the calculated test static is in the critical region.

Step 5 The Results

a. State the decision about $H_0$.

b. State the conclusion about $H_a$. (12)

Figure 9 shows an example of the sign test statistical analysis data sheet. The statistical analysis data sheets for each intersection are included in Appendices A-X.
CHOCTAW DR @ N ACADIAN THROUGHWAY EAST

Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 28 (denoted as n(-))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 28 (n(-) + n(+) )

Step 1 The Set-Up:
   a. Describe the population parameter of interest. 
      \[ T, \text{ vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis \((H_0)\) and the alternative hypothesis \((H_a)\).
      \[
      H_0 : T = 14 \\
      H_a : T \neq 14 
      \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 28; \text{ the observed value of the test statistic is } x = n(+) = 0. \)
   b. The test statistic.
      \( x^* = n(+) = 0. \)

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test. 
      The critical value is located at the intersection of the \( x = 0.05 \) column and the \( n = 28 \) row or 8.

\[
\begin{array}{c|c}
0 & 8 & 9 \\
\hline
\text{Reject } H_0 & \text{Fail to reject } H_0 \\
\end{array}
\]

Number of less frequent sign

b. Determine whether or not the calculated test statistic is in the critical region.
   \( x^* \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_0 \).
      
   b. State the conclusion about \( H_0 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 14 sec.

Figure 9. Sample statistical analysis data sheet.
CHAPTER 5  RESULTS

5.1 RESULTS FROM THE THREE TRACK CLEARANCE TIME METHODOLOGIES

In this section, the results from the three track clearance time methodologies are discussed. The results from the intersection of Choctaw Drive and North Acadian Throughway East, shown in Figure 9, are used as an example.

5.1.1 NORTHWESTERN TRAFFIC INSTITUTE METHOD

For the Northwestern Traffic Institute method, the equation states that the track clearance time = (4 + 2n) + separation time. n is the number of vehicles queued between the intersection stop bar and anywhere within the dynamic envelope. This value was calculated by dividing L (the distance, in feet, between the intersection stop bar and the dynamic envelope added to the dynamic envelope width) by the length of the average vehicle present at the intersection. The distance between the intersection stop bar and the dynamic envelope varied depending on the intersection. Typically, the dynamic envelope width was 18ft, but there were situations where this was not be the case. These values were measured and verified in the field for each intersection. For the intersection of Choctaw Drive and North Acadian Throughway East, L was calculated by adding 33ft to 18ft for a total of 51ft. The average vehicle lengths were obtained from A Policy on Geometric Design of Highways and Streets (14). The lengths used were as follows: passenger vehicles 19ft, single unit vehicles 30ft, and tractor-trailers 50ft. The average vehicle at this intersection was a passenger vehicle and thus L was divided by 19ft. Therefore, n for this equation equals 3 vehicles. The suggested separation time is typically 4 to 8 seconds. For this research, 4 seconds was used. Putting the calculated n and the separation time into the equation yielded a track clearance time of 14 seconds.
5.1.2 MARSHALL AND BERG METHOD

For the Marshall and Berg method, the equation states that the track clearance time is equal to \( t_1 + t_2 \). \( t_1 \) is the time needed for the subject vehicle ahead to begin to move out the way or the time until the last vehicle in the blocking queue departs. \( t_1 \) is equal to \( \frac{L k_j}{2.94} \). \( L \) is the length, in feet, of the queue to be cleared, as measured from the intersection stop bar to the point where a vehicle needing to be cleared may be stopped within the dynamic envelope. As in the previous methods, the values that make up \( L \) were measured and verified in the field. For the intersection of Choctaw Drive and North Acadian Throughway East, \( L \) was calculated by adding 33 ft to 18 ft for a total of 51 ft. \( k_j \) is the jam density measured in vehicles per mile (vpm). For this research a value of 240 vpm was used (2). \( s \) is the saturation flow rate measured in vehicles per hour (vph). For this research a value of 1900 vph was used (4). Entering these values into \( t_1 \) yields a value of 2.19 seconds.

\( t_2 \) is the time needed for the subject vehicle to accelerate and move to a position clear of the dynamic envelope or the time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection. \( t_2 \) is equal to the square root of \( \frac{2(L + 2D + W)}{a} \). \( L \) is the length of the longest design vehicle expected at the intersection. From the field observation, the longest vehicle using this intersection was a single unit vehicle. The value used for \( L \) is therefore 30 ft. \( D \) is the clearance distance on either side of the tracks which is typically 15 ft. \( W \) is the width of the crossing or distance between the outermost rails which is typically 6 ft. \( a \) is the acceleration rate, measured in ft per sec\(^2\), for the design vehicle used. The acceleration rates used were as follows: passenger vehicles 4.4 ft/sec\(^2\), single unit vehicles 2.5 ft/sec\(^2\), and tractor-trailers 1.6 ft/sec\(^2\) (2). Inputting the above values into \( t_2 \) yielded a value of 7.27 seconds. Adding \( t_1 \) and \( t_2 \) together yielded a track clearance time of 9.46 seconds.
5.1.3 FIELD OBSERVATION METHOD

For the field observed method, the track clearance time was taken from the field observation sheets. Once the number of trials needed was obtained, the maximum time for any vehicle to clear the dynamic envelope was used as the track clearance time. This was done as a safety precaution so that no matter what vehicle comes through the intersection, the allotted time should be enough to get any vehicle through the intersection. For the intersection of Choctaw Drive and North Acadian Throughway East, the maximum time to clear the dynamic envelope was timed at 9 seconds.

5.1.4 INTERSECTION SUMMARY OF METHODS

Figure 10 is an example of an intersection summary sheet, which shows the estimation and comparison of results from each procedure. The values for the Northwestern and Marshall and Berg procedures were entered into each procedure’s equations to calculate their estimated track clearance time. The observed value, from the field observation method, was taken from the field observation sheet and added to the summary sheet. Finally, a graph was created to show the variation in the track clearance times for three methods. The intersection summary sheet for each intersection is included in Appendices A-X.

5.1.5 METHODOLOGY COMPARISON

After the computations were completed for all 25 intersections, the next step was to compare the methods. The approach adopted in assessing the methods was to recognize that any method that estimated a track clearance time less than the observed time was, potentially, generating a dangerous situation. Estimates that were higher than the observed clearance times would only be wasteful of the time required, but they would be safe. Thus, the method with the lowest clearance time was identified for each of the intersections. Table 2 shows a summary of
**CHOCTAW DR @ N ACADIAN THROUGHWAY EAST INTERSECTION SUMMARY**

**Northwestern:**

\[
\text{Track Clearance time} = (4 + 2n) + \text{separation time}
\]

\[
n = \frac{L}{\text{avg vehicle length}} = \frac{51 \text{ ft}}{19 \text{ ft}} = 3 \text{ vehicles}
\]

\[
\text{separation time} = 4 \text{sec}
\]

\[
\text{Track Clearance time} = 14 \text{ sec}
\]

**Marshall/Berg:**

\[
\text{Track Clearance time} = t(1) + t(2)
\]

\[
t(1) = L^*k(d)/2.94's = 2.19
\]

(time until the last vehicle in the blocking queue departs)

\[
L = \text{Length of the queue to be cleared (51ft)}
\]

\[
k(d) = \text{jam density (assumed to be 240)}
\]

\[
s = \text{saturation flow rate (assumed to be 1900)}
\]

\[
t(2) = \sqrt{2(L + 2'D + W/a)} = 7.27
\]

(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)

\[
L = \text{Length of the longest design vehicle expected at the intersection (assumed to be 30ft)}
\]

\[
D = \text{Clearance distance on either side of the tracks (assumed to be 15ft)}
\]

\[
W = \text{Width between the outermost rails (assumed to be 6 ft)}
\]

\[
a = \text{Acceleration rate for the design vehicle (2.5ft/sec}^2)
\]

\[
\text{Track Clearance time} = 9.46 \text{ sec}
\]

**Field Observation:**

\[
\text{Total counts} = 28; \text{ Max # of veh.} = 3; \text{ Max time to clear envelope} = 9 \text{ sec}
\]

<table>
<thead>
<tr>
<th>Northwestern</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshall/Berg</td>
<td>9.46</td>
</tr>
<tr>
<td>Field Observation</td>
<td>9</td>
</tr>
</tbody>
</table>

![Graph showing the track clearance times for Northwestern, Marshall/Berg, and Field Observation.](image)

Figure 10. Sample intersection summary sheet.
Table 2 Track clearance time methodology results

<table>
<thead>
<tr>
<th>Intersection</th>
<th>FO</th>
<th>M/B</th>
<th>NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choctaw Drive at North 38th Street</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Choctaw Drive at North Acadian Throughway East</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Choctaw Drive at North Ardenwood Drive</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Choctaw Drive at North Foster Drive</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>LA 19 (Main Street) at Groom Road</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LA 19 (Main Street) at LA 3006 (Lavey Lane &amp; Magnolia Drive)</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LA 19 (Main Street) at Ray Wieland Drive &amp; Truman Street</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>LA 19 (Scotland Avenue) at LA 423 (Thomas Road)</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>LA 19 (Scotland Avenue) at Rafe Meyer Road &amp; Gibbens Road</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>LA 30 (Nicholson Drive) at Bob Petit Boulevard &amp; Jennifer Jean Drive</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>LA 30 (Nicholson Drive) at Brightside Drive &amp; West Lee Drive</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>LA 30 (Nicholson Drive) at Burbank Drive &amp; Gourrier Avenue</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>LA 30 (Nicholson Drive) at LA 327 Spur (Gardere Lane)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>LA 3164 (Scenic Highway) at Choctaw Drive</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>LA 427 (Perkins Road) at Congress Boulevard</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>LA 67 (Plank Road) at Choctaw Drive</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>South Choctaw Drive at Lobdell Boulevard</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>South Choctaw Drive at Monterrey Drive</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>South Choctaw Drive at North Sherwood Forest Boulevard</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>South Choctaw Drive at Oak Villa Boulevard</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>South Choctaw Drive at Wooddale Boulevard</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>US 61 (Airline Highway) at South Choctaw Drive</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>US 61 (Scenic Highway) at LA 19 (Scotland Avenue) &amp; Swan Avenue</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>US 61/190 (River Road) at Casino Rouge Entrance</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**TOTAL TIMES WHEN METHOD WAS THE LOWEST CLEAR TRACK GREEN INTERVAL**

| 17 | 7 | 0 |
the results. In the table, FO (field observed), M/B (Marshall and Berg), and NW (Northwestern) represents the procedures tested. For each intersection, the procedures were ranked from 1 to 3, with 1 being the procedure with the lowest clearance track time and 3 being the highest. For seventeen of the intersections, the field observation method had the lowest track clearance time. For the remaining seven intersections, the Marshall and Berg method had the lowest time. In looking at the seven intersections, there are numerous reasons why the field observation method did not have the lowest track clearance time.

At the intersections of LA 30 (Nicholson Drive) at Bob Petit Boulevard & Jennifer Jean Drive and LA 19 (Main Street) at Groom Road, the Marshall and Berg method was lower than the field observation because of the intersection phasing. At these two intersections, the side streets received the green light at the same time. During the peak volume times, the traffic volumes were so heavy that vehicles on the railroad approach side had to wait for a gap in the opposing traffic before they could begin moving. This caused the vehicles trying to get out of the dynamic envelope to wait an extended amount of time to begin moving. Consequently, there was an increase in the time required to clear the dynamic envelope.

At the intersection of LA 19 (Main Street) at Ray Wieland Drive & Truman Street, red light runners were a problem. When the green indication came on for the side approaches, where the railroad tracks are, the vehicles in the area between the stop bar and dynamic envelope were slow to move because the lead vehicle would have to delay departure due to red light runners.

At the intersections of US 61 (Scenic Highway) at LA 19 (Scotland Avenue) & Swan Avenue and LA 67 (Plank Road) at Choctaw Drive, the stop bar is located behind the dynamic envelope. With that being the case, the field-measured value of the time to clear the dynamic envelope tended to be larger because of driver effects. The grade crossing at these intersections
was uneven. Drivers tended to show some hesitancy about going over railroad tracks because of the potential wear that this might cause their vehicle. This tendency, when added to a driver’s perception reaction time, further elongated the time it took the driver to start to move and the vehicles following the lead vehicle to slow down at the tracks even after starting to move.

At the intersection of LA 19 (Main Street) at LA 3006 (Lavey Lane) & Magnolia Drive, the approach with the track on it had a slight incline and also shared the phase with the opposing movement. These two items may contribute to extending the vehicle start up time. In addition, this intersection of LA 19 is known for drivers driving at high speeds and not being able to stop in time at a red light. For drivers that are familiar with the area, this may also have caused them to hesitate when beginning to move out into the intersection.

The final intersection is LA 427 (Perkins Road) at Congress Boulevard. At this intersection, drivers may tend to hesitate to cross Perkins because of the high speed of vehicles in the area and red light runners. The hesitation and caution extended the time that the vehicles are in the dynamic envelope.

Figure 11 illustrates a graph of the clear track green interval methodology comparison. The x-axis represents L, the distance in feet from the intersection stop bar to the furthest part of the dynamic envelope. The y-axis represents the clear track green interval time in seconds obtained by calculation or observation. In looking at the individual intersection points, the consistency or variability of each method can be seen.

The points associated with the Northwestern method are linearly consistent and generally the time to clear the intersection increases with the distance L. Because this method clears the entire approach, it will always yield longer clearance times than the other two methods.
Figure 11. Clear track green interval methodology comparison.
The points associated with the Marshall and Berg method are less consistent and vary over a much larger range. For this method, the distance does not dictate that there will be an increase in the time to clear the intersection. The first part of the Marshall and Berg method, the time until the last vehicle in the blocking queue departs, depends primarily on L, the length of queue to be cleared. Because L was its dependent variable, this part of the method would consistently yield more time for longer distances. But part two of this method, the time to clear a vehicle that was stopped in the dynamic envelope that was farthest from the intersection, was where the methods variability came in. The L for this part of the equation was the length of the longest design vehicle expected at the intersection. This method, unlike the other two, gave some weight to the vehicle mix at the intersection. If there was only one tractor-trailer observed throughout the entire time that the trials were being recorded, the length of that vehicle was used for L in the equation. With the other two methods, the vehicle mix was not necessarily given any attention. Using the Northwestern method, n was obtained by dividing L by the average vehicle length. For the purposes of this research, the average vehicle type length was used, which often tended to be the passenger car. During the field observations, the recorder wrote down the different types of vehicles that arrived, but then merely recorded the time observed in each trial.

The points associated with the field observation method are also less consistent than the Northwestern method, but they vary less than the Marshall and Berg method. Adding trend lines to the graph shows that generally the field observed method yields lower clear track green interval times than the other two methods. For the field observed method, the fact that the trend line gradually slopes downward as the L increases, shows the affects of 1) intersections where the side approaches shared the phasing causing the track side approach to have to compete with
the other approach to move beyond the track, 2) red light runners causing the drivers to hesitate before proceeding out into the intersection, and 3) intersections with geometry issues.

5.2 STATISTICAL ANALYSIS RESULTS

From Table 2, it was apparent that the field observation method was lower than the other methods 17 out of 24 times. While the Marshall and Berg method was lower 7 of the aforementioned times, the question is whether the Marshall and Berg values on these occasions were significantly different from the field observations or not.

Table 3 shows a summary of the hypothesis testing results. In the table, a check mark indicates whether or not the null hypothesis was rejected for both the Northwestern and Marshall and Berg methods. For all of the intersections, with the exception of LA 19 (Main Street) at Ray Wieland Drive and Truman Street, it can be said that the values of both methods differ significantly from the field observed values.

The statistical analysis for LA 19 (Main Street) at Ray Wieland Drive and Truman Street yielded a rejection of the null for the Northwestern method and a fail to reject the null for the Marshall and Berg method. At this intersection, the Marshall and Berg method yielded a time of 6.42 seconds. The majority of the field observed times were more than this value because of the red light runners.
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Based on the results and analysis of this research, the field observed method yielded a lower clear track green interval 71% of the time. Out of the remaining two methods, the Marshall and Berg method yielded lower results 29% of the time and the Northwestern method was always the longest because of its conservative approach. The instances when the Marshall and Berg method yielded lower results were caused by varying circumstances. The reasons included: intersections where the side approaches shared the phasing causing the track side approach to have to compete with the other approach to move beyond the track, red light runners causing the drivers to hesitate before proceeding out into the intersection, and geometry issues.

From graphing the intersection clear track green interval times versus the distance L, the consistency or variability of the three methods could be seen. The Northwestern method was the least variable and the Marshall and Berg method was the most variable. Adding a trend line to this graph showed that overall the field observed method provided the shortest clear track green interval but the Marshall and Berg method followed closely.

From the two-tailed single-sample hypothesis sign test for the population mean, it can be concluded that the values of both methods differ significantly from the field observed values. The one exception to this was due to red light runners at a particular intersection.

Comparing the values from the Northwestern method to the field observations, the difference in track clearance green times ranged from the Northwestern method being 3 seconds lower than the field method to it being 19 seconds higher. With the exception of two intersections, this method’s times were more than the field observations. Generally, the Northwestern times were more than the field observed times because the conservative nature of this method clears the entire approach instead of just the dynamic envelope. Even though this method is safe in its
estimation of the clear track green interval, it overestimates the time needed for the action. In some cases this time overestimation was as little as two seconds and would generally not adversely impact the intersection. In other cases, the time overestimation was 19 seconds and this could adversely affect the intersection in the way of queuing, delays and overall intersection efficiency.

The difference in the Marshall and Berg method values and the field observation values was totally unexpected. The Marshall and Berg values ranged from being almost 7 seconds lower to being 4.5 seconds higher. Overall, this method was impressive. It clearly is better than the Northwestern method and in my opinion is a good estimation of track clearance green time. Although it is true that an overestimation of time can hamper intersection operations, 4.5 seconds will affect the intersection but that time might be recoverable. The one downfall of this method is that at times it underestimates the time needed to clear the dynamic envelope. An underestimation of the time needed could lead to injury or death. If used, this method should be used in conjunction with another method to ensure that it is not under estimating the time, which could put someone’s life at risk.

Although there are other methods currently used to estimate the clear track green interval, the field observed method appears to be a better approximation of the clear track green interval. The field observed method uses the maximum time observed at the intersection to accommodate all of the queues that might occur there. The other methods, with the exception of the Northwestern Traffic Institute method and the method suggested by Gary Long at the University of Florida, only yield an average estimation for the clear track green interval. This average estimation does well at times and can fail at times. Using the field observation method in current practice would alter the preemption process. Traffic engineers using this method would be able to achieve clear
track green interval times that would keep in step with the volumes at the intersections under their charge, maintain the intersection efficiency because the times would not be too high, and know that the clear track green interval times being used are relatively safe. Despite the good of the field observation method, it is understood that there will be special cases where the traffic engineer’s judgment might call for extra time to be added to the clear track green interval as a safety factor.

Even with all of the options available to calculate the intersection clear track green time, it is recommended that every intersection that has a railroad-grade crossing be investigated by field observation. No matter what procedure is used to calculate the clear track green interval, the most efficient design can only be obtained by observing the prevailing field conditions, which are not considered in calculated procedures. The field observations do not take that much time and the information gathered while doing them is critical to achieving and maintaining high levels of safe operation at railroad highway grade crossings.
CHAPTER 7  FUTURE WORK

In this area, there are many avenues for future research. They include:

1. Searching out intersections with the intersection of railroad grade crossings and signalized intersections beyond 95ft to see what kinds of results the methods produce. In this research there is a gap because none of the areas had lengths beyond this distance.

2. This research could be further expanded by testing the field observed and calculated methods out in other cities. Since each city has drivers with different styles and characteristics, there is a possibility that the calculated methods might yield better results elsewhere or vice versa.

3. Further analysis could be done to see how important the separation time included in the Northwestern equation really is.

4. A study could be done to see how the Marshall and Berg equation reacts when the longest design vehicle at an intersection is not used.
REFERENCES


LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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Geometric Input

- Route: St Name: N 38TH ST
- Railroad Co.: [X] Mainline, [X] Spur
- Number of Tracks 1
- Dynamic Envelope: 10 ft
- Distance Between Envelope and Stop Bar: 45 ft
- Railroad Control: [X] Crossbucks, [X] Lights/Ground
- Route: St Name: CHOCTAW DR
- Envelope and Stop Bar

Input Field Measurement

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Glossary and Notes

- Dynamic Envelope: Typically 18 ft for 90 deg crossing, 8 ft back width plus 6 ft clearance on either side.
- Single Unit Vehicles: Delivery Trucks and Buses
- Tractor Trl Vehicles: Tractor Trailer Vehicles
- Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
# LaDOTD Traffic Operations and Engineering

## Field Observation Method

### Railroad Preemption Worksheet

#### General Information
- **Analyst**: DRK
- **District**: 61
- **Parish**: EBR
- **TSI No.**: C-0022
- **Date**: 8/7/2003
- **Time**: 4:00 PM
- **Area Type**: rural, or **X** urban

#### Geometric Input
- **Route**: St Name: N 38TH ST
- **Railroad Co.**: X X or Spur
- **Number of Tracks**: 1
- **Dynamic Envelope**: 18 ft
- **Distance Between Envelope and Stop Bar**: 45 ft
- **Railroad Control**: **X** Crossbucks
- **Lights/Foul Ground**: **X** Lights/Tuss
- **Dates**:

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### Glossary and Notes
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Busses
- **Tractor Trlr**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth vehicle clears Dynamic Envelope

**rev 5/02**
## Field Observation Method

### Railroad Preemption Worksheet

#### General Information
- **Analyst**: DRK
- **District**: 61
- **Parish**: EBR
- **T5I No.**: C-0022
- **Date**: 87/0003
- **Time**: 4:00 PM
- **Area Type**: _X_ urban

#### Geometric Input

- **Route**: St Name: N 36TH ST
- **Distance Between Envelope and Stop Bar**: 
- **Dynamic Envelope**: 
- **Railroad Co.**: Mainline
- **Number of Tracks**: 1
- **Distance Between Envelope and Stop Bar**: 45 ft
- **Railroad Control**: _X_ Crossbucks

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#### Glossary and Notes
- **Total counts = 28; Max # of veh. = 4; Max time to clear envelope = 9 sec**
  - **Dynamic Envelope**: Typically 18 ft for 60 deg crossing, 5 ft track width plus 6 ft clearance on either side.
  - **Single Unit Vehicles**: Delivery Trucks and Buses
  - **Tractor Trailers**: Tractor Trailer Vehicles
  - **5th Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
  - **Time to Clear**: Time from start of green until back of 5th Vehicle clears Dynamic Envelope.

---

*rev 5/02*
CHOCTAW DR @ N 38TH ST INTERSECTION SUMMARY

Northwestern:

Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 63 ft / 19 ft = 3 vehicles
separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:

Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L \cdot k(j)}{2.94} \cdot s = 2.71 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (63 FTP)
K(j) = jam density (assumed to be 240)
s = saturation flow rate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2 \cdot D + W)} / a = 7.27 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 30 ft)
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (2.5 ft/sec^2)

SUV

Track Clearance time = 9.97 sec

Field Observation:

Total counts = 28; Max # of veh. = 3; Max time to clear envelope = 9 sec
CHOCTAW BR @ N 38TH ST
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 28 (denoted as n(-))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 28 (n(-) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H₀) and the alternative hypothesis (H₁).
      \[ H₀: T = 14 \]
      \[ H₁: T ≠ 14 \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of n (+) and n (-), which is n (+) for this research. The test statistic is \[ x^* = n(+) \].
   c. Determine the level of significance.
      \[ α = 0.05 \] for a two-tailed test

Step 3 The Sample Evidence
   a. The sample information.
      \[ n = 28; \] the observed value of the test statistic is \[ x = n(+) = 0 \].
   b. The test statistic.
      \[ x^* = n(+) = 0 \]

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \[ α = 0.05 \] column and the \[ n = 28 \] row or 8.

   b. Determine whether or not the calculated test statistic is in the critical region.
      \[ x^* \] is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \[ H₀ \]
      Reject \[ H₀ \].
   b. State the conclusion about \[ H₁ \]
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 14 sec.
Number of field observations under 9.97: 28 (denoted as \( n(-) \))
Number of field observations equal to 9.97: 0
Number of field observations over 9.97: 0 (denoted as \( n(+) \))

Number of usable observations: 28 \((n(-) + n(+)\))

Step 1  The Set-Up:

a. Describe the population parameter of interest.
   - \( T \), vehicle median time to clear dynamic envelope
b. State the null hypothesis (\( H_0 \)) and the alternative hypothesis (\( H_a \)).
   
   \[
   H_0 : T = 9.97 \\
   H_a : T \neq 9.97
   \]

Step 2  The Hypothesis Test Criteria

a. Check the assumptions.
   - The 28 field observations were independently obtained and the variable envelope clearance time is continuous.

b. Identify the test statistic to be used.
   - The test statistic that will be used is the number of less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( \chi^2 = n(+) \).

c. Determine the level of significance.
   - \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence

a. The sample information.
   - \( n = 28 \); the observed value of the test statistic is \( \chi = n(+) = 0 \).

b. The test statistic.
   - \( \chi^2 = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.
   - The critical value is located in the table of critical values of the sign test.
   - The critical value is located at the intersection of the \( \chi^2 = 0.05 \) column and the \( n = 28 \) row or 8.

b. Determine whether or not the calculated test statistic is in the critical region.
   - \( \chi^2 \) is in the critical region (see figure above)

Step 5  The Results

a. State the decision about \( H_0 \).
   - Reject \( H_0 \).

b. State the conclusion about \( H_a \).
   - The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 9.97 sec.
APPENDIX B: CHOCTAW DRIVE AT NORTH ACADIAN THROUGHWAY
EAST INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPT WORKSHEET

**General Information**

<table>
<thead>
<tr>
<th>Analyst</th>
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<td>Area Type</td>
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<td></td>
<td></td>
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**Geometric Input**

- Route: St Name: N. ACADIAN THROWAY EAST
- Mainline: _X_ or Spur: __________
- Number of Tracks: 1
- Dynamic Envelope: _18_ ft
- Distance Between Envelope and Stop Bar: _33_ ft
- Railroad Control: _X_ Crossbucks
- Lights/Gates: __________
- St Name CHOCTAW DR

**Input Field Measurement**

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Tril Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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**Maximum**

- 9

**Minimum**

- 1

**Average**

- 5

**Glossary and Notes**

- Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft back width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
- Tractor Tril = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

Analyst: DRK
District: 61
Parish: EBR
TSI No.: C-001
Date: 3/1/2003
Time: 4:00 PM
Area Type: ___ rural, or ___ urban

Geometric Input

Route: St Name: N. ACADIAN
THROUGH EAST

Railroad Co. ___ Mainline ___ or Spur ___
Number of Tracks 1
Dynamic Envelope ___ ft
Distance Between Envelope and Stop Bar ___ ft
Railroad Control ___ Crossbucks
___ Lights/Signals
___ Gates

Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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Maximum: 3
Minimum: 2
Average: 2

Glossary and Notes:

Total counts = 28; Max # of veh. = 3; Max time to clear envelope = 9 sec

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft back width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trl = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
CHOCTAW DR @ N ACADIAN THROUGHWAY EAST INTERSECTION SUMMARY

Northwestern:

Track Clearance time = \( (4 + 2n) \) + separation time
\( n = L / \text{avg vehicle length} = 51 \text{ ft} / 19\text{ft} = 3 \text{ vehicles} \)
separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:

Track Clearance time = \( t(1) + t(2) \)
\( t(1) = Lk(j)2.94s = 2.19 \)  
(time until the last vehicle in the blocking queue departs)
\( L = \text{Length of the queue to be cleared (51ft)} \)
\( k(j) = \text{jam density (assumed to be 240)} \)
\( s = \text{saturation flowrate (assumed to be 1900)} \)

\( t(2) = \sqrt{2(2L + 2D + W)a} = 7.27 \)  
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
\( L = \text{Length of the longest design vehicle expected at the intersection (assumed to be 30ft)} \)  
\( D = \text{Clearance distance on either side of the tracks (assumed to be 15ft)} \)
\( W = \text{Width between the outermost rails (assumed to be 6 ft)} \)
\( a = \text{Acceleration rate for the design vehicle (2.5ft/sec^2)} \)

Track Clearance time = 9.46 sec

Field Observation:

Total counts = 28; Max # of veh. = 3; Max time to clear envelope = 9 sec
CHOCTAW DR @ N ACADIAN THROUGHWAY EAST
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 28 (denoted as \( n(-) \))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as \( n(+) \))

Number of usable observations: 28 (\( n(-) + n(+) \))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (\( H_0 \)) and the alternative hypothesis (\( H_a \)).
      \[
      H_0: T = 14 \\
      H_a: T \neq 14
      \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \( n = 28 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the \( n = 28 \) row.
      \[
      \text{Reject } H_a \\
      \text{Fail to reject } H_a
      \]
      Number of less frequent sign
      0 8 9
   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( H_a \).
      Reject \( H_a \).
   b. State the conclusion about \( H_a \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 14 sec.
CHOCTAW DR @ N ACADIAN THROUGHWAY EAST
Sign Test for the Assumption that the Median Time is Equal to the

Number of field observations under 9.46: 28 (denoted as n(-))
Number of field observations equal to 9.46: 0
Number of field observations over 9.46: 0 (denoted as n(+))

Number of usable observations: 28 (n(-) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      \[ T, \text{ vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis (H0) and the alternative hypothesis (Ha).
      \[
      H_0 : T = 9.46 \\
      H_a : T \neq 9.46
      \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n (+) and n (-), which is n (+) for this research. The test
      statistic is \[ x^* = n(+) \].
   c. Determine the level of significance.
      \[ \alpha = 0.05 \text{ for a two-tailed test} \]

Step 3 The Sample Evidence
   a. The sample information.
      \[ n = 28 \text{, the observed value of the test statistic is } x = n(+) = 0. \]
   b. The test statistic.
      \[ x^* = n(+) = 0. \]

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \[ \alpha = 0.05 \]
      column and the \[ n = 28 \] row or row 8.
      \[
      \begin{array}{ccc}
      \text{Reject } H_0 & \text{Fail to reject } H_0 \\
      0 & 8 & 9 \\
      \end{array}
      \]
      Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \[ x^* \] is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \[ H_0 \].
      \[ \text{Reject } H_0. \]
   b. State the conclusion about \[ H_0 \].
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 9.46 sec.
### APPENDIX C: CHOCTAW DRIVE AT NORTH ARDENWOOD DRIVE
### INTERSECTION DATA SHEETS

#### 1 of 3

**LaDOTD TRAFFIC OPERATIONS AND ENGINEERING**
**FIELD OBSERVATION METHOD**
**RAILROAD PREEMPTION WORKSHEET**

### General Information
- **Agent:** DRK
- **District:** 01
- **Parish:** EBR
- **TSI No.:** 0.0017
- **Date:** 7/6/2003
- **Time:** 6:00 AM
- **Area Type:** __X__ urban

#### Geometric Input

- **Route:**
  - **StName:** N ARDENWOOD DR
  - **Railroad Co.:** Mainline __X__ or Spur __
  - **Number of Tracks:** 1
  - **Dynamic Envelope:** __18 ft__
  - **Distance Between Envelope and Stop Bar:** __47 ft__
  - **Railroad Control:** __X__ Crossbucks
  - __Lights/Ground__
  - __Lights/Truss__
  - __Gates__

#### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trif Vehcles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle in Envelope</th>
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#### Glossary and Notes
- **Dynamic Envelope** = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles** = Delivery Trucks and Buses
- **Tractor Trif** = Tractor Trailer Vehicles
- **Nth Vehicle** = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear** = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

*rev 5/02*
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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<tr>
<th>Analyst</th>
<th>DRK</th>
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<td>Time</td>
<td>6:00 AM</td>
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<tr>
<td>Area Type</td>
<td>___ rural, or ___ urban</td>
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Geometric Input

Route:
- STName: N ARDENWOOD DR
- Railroad Cn: ___ or Spur ___
- Number of Tracks: 1
- Dynamic Envelope: 18 ft
- Distance Between Envelope and Stop Bar: 47 ft
- Railroad Control: ___ Crossbucks
- ___ Lights/Ground
- ___ Lights/Truss
- ___ Gates

Input Field Measurement

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Glossary and Notes

- Dynamic Envelope = Typically 18 ft for 60 deg crossing, 8 ft track width plus 8 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Busses
- Tractor Trl = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 9/02
# LaDOTD Traffic Operations and Engineering

## Field Observation Method

### Railroad Preemption Worksheet

#### General Information
- **Analyst**: DRK
- **Date**: 7/16/2003
- **District**: EBR
- **Time**: 8:00 AM
- **TIS No.**: C-0017

#### Geometric Input
- **Route**: St Name: N ARDENWOOD DR
- **Railroad Co.**: Mainline
- **Number of Tracks**: 1
- **Dynamic Envelope**: 18 ft
- **Distance Between Envelope and Stop Bar**: 47 ft
- **Railroad Control**: X Crossbuck
- **Lights**: X Lights/Ground

#### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</table>

#### Glossary and Notes
- **Total counts**: 28; **Max # of veh.**: 4; **Max time to clear envelope**: 10 sec
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trlr Vehicles**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

**rev 5/02**
CHOCTAW DR @ N ARDEHWOOD DR INTERSECTION SUMMARY

Northwestern:

Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 65ft / 19ft = 3 vehicles
separation time = 4sec

Track Clearance time = 14 sec

Marshall/Berg:

Track Clearance time \( t(1) + t(2) \)

\( t(1) = L'k(j)/2.94' s = 2.79 \)
(time until the last vehicle in the blocking queue departs)
\( L' = \) Length of the queue to be cleared (65FT)
\( k(j) = \) jam density (assumed to be 240)
\( s = \) saturation flowrate (assumed to be 1900)

\( t(2) = \text{square root} \left( \frac{2(L + 2\cdot D + W)}{a} \right) = 10.37 \)
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
\( L = \) Length of the longest design vehicle expected at the intersection (assumed to be 50ft)
\( D = \) Clearance distance on either side of the tracks (assumed to be 15 ft)
\( W = \) Width between the outermost rails (assumed to be 6 ft)
\( a = \) Acceleration rate for the design vehicle (1.6ft/sec^2)

Track Clearance time = 13.16 sec

Field Observation:

Total counts = 28; Max # of veh. = 4; Max time to clear envelope = 10 sec

![Bar chart showing Northwestern, Marshall/Berg, and Field observation results. Northwestern has 16 vehicles, Marshall/Berg has 13.16 vehicles, and Field observation has 10 vehicles.](chart.png)
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 28 (denoted as \( n(-) \))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as \( n(+) \))

Number of usable observations: 28 (\( n(-) + n(+) \))

Step 1 The Set-Up:

a. Describe the population parameter of interest.
   \( T \) : vehicle median time to clear dynamic envelope

b. State the null hypothesis (\( H_0 \)) and the alternative hypothesis (\( H_a \)).

\[
\begin{align*}
H_0 &: T = 14 \\
H_a &: T \neq 14
\end{align*}
\]

Step 2 The Hypothesis Test Criteria

a. Check the assumptions.
   The 28 field observations were independently obtained and the variable envelope clearance time is continuous.

b. Identify the test statistic to be used.
   The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( x^* = n(+) \)

c. Determine the level of significance.
   \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence

a. The sample information.
   \( n = 28 \); the observed value of the test statistic is \( x = n(+) = 0 \).

b. The test statistic.
   \( x^* = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.
   The critical value is located in the table of critical values of the sign test.
   The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the \( n = 28 \) row.

\[
\begin{array}{c|c}
0 & 8.9 \\
\hline
\text{Reject } H_0 & \text{Fail to reject } H_0 \\
\end{array}
\]

b. Determine whether or not the calculated test statistic is in the critical region.
   \( x^* \) is in the critical region (see figure above)

Step 5 The Results

a. State the decision about \( H_0 \)
   \[ \text{Reject } H_0 \]

b. State the conclusion about \( H_0 \)
   The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 14 sec.
CHOCTAW DR @ N ARDENWOOD DR
Sign Test for the Assumption that the Median Time is Equal to the

Number of field observations under 13.16: 28 (denoted as n(-))
Number of field observations equal to 13.16: 0
Number of field observations over 13.16: 0 (denoted as n(+))
Number of usable observations: 28 (n(-) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H_0) and the alternative hypothesis (H_1).
      \[
      H_0: T = 13.16 \\
      H_1: T \neq 13.16
      \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable
evelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test
statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 28 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
The critical value is located at the intersection of the \( \alpha = 0.05 \) column
and the \( n = 28 \) row or 8.

   

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<thead>
<tr>
<th>Number of less frequent sign</th>
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b. Determine whether or not the calculated test statistic is in the critical region.
\( x^* \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_1 \).
      \( \text{Reject } H_0 \).
   b. State the conclusion about \( H_1 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
median dynamic envelope clearance time is not equal to 13.16 sec.
APPENDIX D: CHOCTAW DRIVE AT NORTH FOSTER DRIVE INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

- Analyst: DRK
- Date: 7/16/2003
- District: 81
- Time: 7:00 AM
- Parish: EBR
- Area Type: X urban
- TSI No.: C-0057

Geometric Input

- Route: N FOSTER DR
- St Name: CHOCTAW DR
- Railroad Co.: 
- Mainline: X
- Number of Tracks: 1
- Dynamic Envelope: 18 ft
- Distance Between Envelope and Stop Bar: 30 ft
- Railroad Control: X Crossbucks
- X Lights/Ground
- X Lights/Truss
- Gates

Input Field Measurement

<table>
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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</tr>
</tbody>
</table>

Glossary and Notes

- Dynamic Envelope: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles: Delivery Trucks and Buses
- Tractor Trl: Tractor Trailer Vehicles
- Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
# LaDOTD Traffic Operations and Engineering
## Field Observation Method
### Railroad Preemption Worksheet

### General Information
- **Analyst:** DRK
- **Date:** 7/15/2003
- **District:** 61
- **Time:** 7:00 AM
- **Parish:** EBR
- **TSI No.:** C-0051
- **Area Type:** _X_ rural, ___ urban

### Geometric Input

- **Route:** N FOSTER DR
  - **Railroad Co.:** ___
  - **Mainline:** ___ or Spur ___
  - **Number of Tracks:** ___
  - **Dynamic Envelope:** 18 ft
  - **Distance Between Envelope and Stop Bar:** 30 ft
  - **Railroad Control:** _X_ Crossing
  - **Lights/Ground:** _X_ Lights/Truss
  - **Lights/Truss:** ___ Gates

### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>Minimum</td>
<td>Average</td>
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</table>

### Glossary and Notes
- **Total counts = 25; Max # of veh. = 3; Max time to clear envelope = 8 sec**
- **Dynamic Envelope:** Typically 18 ft for 60 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trl:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth vehicle clears Dynamic Envelope.

*rev 5/02*
CHOCTAW DR @ N FOSTER DR INTERSECTION SUMMARY

Northwestern:

Track Clearance time = (4 + 2n) + separation time
\[ n = \frac{L}{\text{avg vehicle length}} = \frac{48 \text{ ft}}{19 \text{ ft}} = 3 \text{ vehicles} \]
separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:

Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L \cdot k(j)}{2.94 \cdot s} = 2.06 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (48 FT)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2D + W/a)} = 7.27 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 30t)
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (2.5 ft/sec^2)

Track Clearance time = 9.33 sec

Field Observation:

Total counts = 25; Max # of veh. = 3; Max time to clear envelope = 8 sec
CHOCTAW DR @ N FOSTER DR

Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 25 (denoted as n(-))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 25 (n(-) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      \[ T, \text{ vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis (H0) and the alternative hypothesis (H1).
      \[
      \begin{align*}
      H_0: T &= 14 \\
      H_1: T &\neq 14
      \end{align*}
      \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 25 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(+) and n(-), which is n(+) for this research. The test
      statistic = \( x^* = n(+) \).
   c. Determine the level of significance.
      \[ \alpha = 0.05 \text{ for a two-tailed test.} \]

Step 3 The Sample Evidence
   a. The sample information.
      \[ n = 25; \text{ the observed value of the test statistic is } x = n(+) = 0. \]
   b. The test statistic.
      \[ x^* = n(+) = 0. \]

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the \( n = 25 \) row or 7.

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above).

Step 5 The Results
   a. State the decision about \( H_0 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_1 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 14 sec.
CHOCTAW BR & N FOSTER BR

Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 9.33 sec.

Number of field observations under 9.33: 25 (denoted as n(-))
Number of field observations equal to 9.33: 0
Number of field observations over 9.33: 0 (denoted as n(+))

Number of usable observations: 25 (n(-) + n(+))

Step 1  The Set-Up:
  a. Describe the population parameter of interest.
     \[ T, \text{ vehicle median time to clear dynamic envelope} \]
  b. State the null hypothesis (H₀) and the alternative hypothesis (Hₐ).
     \[ H₀: T = 9.33 \]
     \[ Hₐ: T \neq 9.33 \]

Step 2  The Hypothesis Test Criteria
  a. Check the assumptions.
     The 25 field observations were independently obtained and the variable envelope clearance time is continuous.
  b. Identify the test statistic to be used.
     The test statistic that will be used is the number of the less frequent sign, the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic \( x⁰ = n(+) \).
  c. Determine the level of significance.
     \[ \alpha = 0.05 \text{ for a two-tailed test.} \]

Step 3  The Sample Evidence
  a. The sample information.
     \[ n = 25, \text{ the observed value of the test statistic is } x = n(+) = 0. \]
  b. The test statistic.
     \[ x⁰ = n(+) = 0. \]

Step 4  The Probability Distribution using the Classical Procedure
  a. Determine the critical region and critical values.
     The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \( 0.05 \text{ column} \) and the \( n = 25 \text{ row} \).

\[
\begin{array}{cc}
0 & 78 \\
\hline
\text{Number of less frequent sign} & \\
\end{array}
\]

b. Determine whether or not the calculated test statistic is in the critical region.
   \( x⁰ \) is in the critical region (see figure above)

Step 5  The Results
  a. State the decision about \( Hₐ \).
     [Reject \( H₀ \)].
  b. State the conclusion about \( Hₐ \).
     The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 9.33 sec.
APPENDIX E: LA 19 (MAIN STREET) AT GROOM ROAD
INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>Dr. K.</th>
</tr>
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<tbody>
<tr>
<td>District</td>
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<tr>
<td>Parish</td>
<td>EBR</td>
</tr>
<tr>
<td>Test No.</td>
<td>6</td>
</tr>
</tbody>
</table>

Date: 7/24/2003  Time: 7:00 AM
Area Type: ___ rural, ___ urban

Geometric Input

- Route: LA 19
- St Name: MAIN ST
- Railroad Co. __
- Mainline X___ or Spur __
- Number of Tracks 1
- Dynamic Envelope ___ ft
- Distance between Envelope ___ ft
- Railroad Control X___ Crossbucks
- Lights/Ground ___
- Lights/Truss ___
- Gates ___

Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
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<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</tbody>
</table>

Glossary and Notes

- Dynamic Envelope: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles: Delivery Trucks and Buses
- Tractor Trlr Vehicles: Tractor Trailer Vehicles
- Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
## LaDOTD Traffic Operations and Engineering
### Field Observation Method
#### Railroad Preemption Worksheet

**General Information**
- **Analyst:** DRK
- **Date:** 7/21/2003
- **District:** 01
- **Date:** 7.00 AM
- **Parish:** EBR
- **Area Type:** _X_ urban
- **TSI No.:** 6

**Geometric Input**
- **Route:** LA 19
- **St Name:** MAIN ST
- **Railroad Co.:** _X_ Mainline
- **Mainline or Spur:** _X_
- **Number of Tracks:** 1
- **Dynamic Envelope:** 18 ft
- **Distance Between Envelope and Stop Bar:** 13 ft
- **Railroad Control:** _X_ Crossbucks
- **Lights/Ground:** _X_
- **Lights/Truss:** _X_
- **Gates:** _X_

**Input Field Measurement**

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<th>Cycle</th>
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_rev 5/02_
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FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

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<th>District</th>
<th>Time</th>
<th>Parish</th>
<th>Area Type</th>
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Geometric Input

Route: St Name: GR OOM RD
Railroad Co.: Mainline _X_ or Spur __
Number of Tracks: 1
Dynamic Envelope: 18 ft
Distance Between Envelope and Stop Bar: 13 ft
Railroad Control: _X_ Crossbucks
Lights/Ground: _X_
Lights/Truss: _X_
Gates: _X_

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<tr>
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Glossary and Notes

Total counts = 25; Max # of veh. = 3; Max time to clear envelope = 10 sec
Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trlr = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LA 19 (MAIN ST) @ GROOM RD INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 31 ft / 19 ft = 2 vehicles
separation time = 4 sec

Track Clearance time = 12 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L \cdot k(j)}{2.34 \cdot s} = 1.33 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (31 FT)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2^2D + W/s)} = 7.27 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 30 ft)  SUV
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
s = Acceleration rate for the design vehicle (2.5 ft/sec^2)  SUV

Track Clearance time = 8.6 sec

Field Observation:
Total counts = 26; Max # of veh. = 3; Max time to clear envelope = 10 sec
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 12 sec.

Number of field observations under 12: 25 (denoted as n(−))
Number of field observations equal to 12: 0
Number of field observations over 12: 0 (denoted as n(+))

Number of usable observations: 25 (n(−) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H₀) and the alternative hypothesis (Hₐ).
      \[
      \begin{align*}
      H₀ : & \quad T = 12 \\
      Hₐ : & \quad T \neq 12
      \end{align*}
      \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 25 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(−) \), which is \( n(+) \) for this research. The test statistic \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \( n = 25 \), the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( x^* = 0.05 \) column and the \( n = 25 \) row or 7.
      \[
      \begin{array}{c|c}
      \text{Reject } Hₐ & \text{Fail to reject } Hₐ \\
      \hline
      0 & 7 \ \text{8} \end{array}
      \]

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( Hₐ \).
      \( \text{Reject } Hₐ \).
   b. State the conclusion about \( Hₐ \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 12 sec.
Number of field observations under 8.6: 21 (denoted as n(-))
Number of field observations equal to 8.6: 0
Number of field observations over 8.6: 4 (denoted as n(+))

Number of usable observations: 25 \((n(-) + n(+))\)

Step 1 The Setup:
   a. Describe the population parameter of interest.
      \(T\), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[H_0 : T = 8.6\]
      \[H_1 : T \neq 8.6\]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 25 field observations were independently obtained and the variable
      envelope clearance time is continuous.

   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of \(n(+)\) and \(n(-)\), which is \(n(+)\) for this research. The test
      statistic = \(x^* = n(+)\).

   c. Determine the level of significance.
      \(\alpha = 0.05\) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \(n = 25\), the observed value of the test statistic is \(x^* = n(+) = 4\).

   b. The test statistic.
      \(x^* = n(+) = 4\).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \(\alpha = 0.05\) column
      and the \(n = 25\) row or 7.

      \[\begin{array}{c|c}
      \hline
      \text{Reject } H_0 & \text{Fail to reject } H_0 \\
      \hline
      0 & 7.8 \\
      \hline
      \end{array}\]

   b. Determine whether or not the calculated test statistic is in the critical region.
      \(x^*\) is in the critical region (see figure above).

Step 5 The Results
   a. State the decision about \(H_0\).
      Reject \(H_0\).

   b. State the conclusion about \(H_1\).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 8.6 sec.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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<tr>
<th>Analyst</th>
<th>Date</th>
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Area Type: _urban_

Geometric Input

Route: LA 3006
St Name: LAVEY LN & MAGNOLIA DR

Railroad Co: _Crossbucks_
Mainline: _Crossbucks_
Number of Tracks: 1
Dynamic Envelope: _18 ft_
Distance Between Envelope and Stop Bar: _45 ft_
Railroad Control: _Crossbucks_
Lights/Truss: _Crossbucks_
Gates: _Crossbucks_

Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in Nth Vehicle of Envelope?</th>
<th>Nth Vehicle Time to Clear</th>
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Maximum: 3 7
Minimum: 2 3
Average: 2 3

Glossary and Notes

Dynamic Envelope = Typically 10 ft for 90 deg crossing, 0 ft back width plus 0 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Busses
Tractor Trlr = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
# LaDOTD Traffic Operations and Engineering
## Field Observation Method
### Railroad Preemption Worksheet

#### General Information
- **Analyst:** DRK
- **Date:** 7/21/2003
- **District:** 61
- **Time:** 4:00 PM
- **Parish:** EBR
- **Area Type:** Rural, or X Urban
- **TSI No.:** 8

#### Geometric Input
- **Route:** LA 3006
- **St Name:** LA VEY LN & MAGNOLIA DR
- **Railroad Ctr:**
- **Mainline X or Spur:**
- **Number of Tracks:** 1
- **Distance Between Envelope:** 18 ft
- **Number of Envelope and Stop Bar:** 45 ft
- **Railroad Control:** X Crossbucks

#### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
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#### Glossary and Notes
- **Dynamic Envelope:** Typically 18 ft for 60 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trl:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

---

**rev 5/02**
## General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>D.R.K.</th>
<th>Date</th>
<th>7/21/2003</th>
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## Geometric Input

Route: LA 3006  
St Name: LAVEY LN & MAGNOLIA DR  

Railroad Co.:  
Mainline _X_ or Spur ___  
Number of Tracks: 1  
Dynamic Envelope: 18 ft  
Distance Between Envelope and Stop Bar: 45 ft  
Railroad Control: X Crossbucks  
Lights/Signs: Gates

## Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trf Vehicles</th>
<th>Is a Vehicle Stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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## Glossary and Notes

- **Dynamic Envelope** = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles** = Delivery Trucks and Buses
- **Tractor Trf** = Tractor Trailer Vehicles
- **Nth Vehicle** = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear** = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
### General Information

<table>
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<tr>
<th>Analyst</th>
<th>Date</th>
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### Geometric Information

- **Route:** LA 306
- **St. Name:** LAVEY LN & MAGNOLIA DR
- **Distance Between Envelope and Stop Bar:** 45 ft
- **Railroad Cont.:** X Crossbucks
- **Railroad Co.:**
- **Railroad Contractor:**
- **Number of Tracks:** 1
- **Dynamic Envelope:** 18 ft

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### Glossary and Notes

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trif:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
## Geometric Input

**Route:** LA 3006

**St Name:** LAVEY LN &

**Railroad Co.**
**Mainline X or Spur**

**Number of Tracks:** 1

**Distance Between Envelope and Stop Bar:** 45 ft

**Railroad Control:** X Crossbucks

**Lights/Ground Lights/Tuss:**

**Gates:** 0

## Input Field Measurement

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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Queue at start of Green</th>
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**Maximum**

**Minimum**

**Average**

**Total counts = 24; Max # of veh. = 3; Max time to clear envelope = 8 sec**

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 5 ft track width plus 5 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trl.** = Tractor Trailer Vehicles
- **Nth Vehicle:** = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LA 19 (MAIN ST) @ LA 3006 (LAVEY LN) & MAGNOLIA DR INTERSECTION SUMMARY

Northwestern:

Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 63 ft / 19 ft = 3 vehicles
separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:

Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L \cdot k(j)}{2.94 \cdot s} = 2.71 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (63 FT)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \sqrt{\frac{2(L + 2D + W)}{a}} = 5 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 19 ft)
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
V = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (4.4 ft/sec^2)

Track Clearance time = 7.71 sec

Field Observation:

Total counts = 24; Max # of veh. = 3; Max time to clear envelope = 8 sec
Number of field observations under 14: 24 (denoted as $n(-)$)
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as $n(+)$)

Number of usable observations: 24 ($n(-) + n(+)\)

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      $T$, vehicle median time to clear dynamic envelope
   b. State the null hypothesis ($H_0$) and the alternative hypothesis ($H_a$).
      
      $H_0 : T = 14$
      $H_a : T \neq 14$

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 24 field observations were independently obtained and the variable
evelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
the smaller of $n(+) + n(-)$, which is $n(+) for this research. The test statistic $= x^* = n(+)$.  
   c. Determine the level of significance.
      $\alpha = 0.05$ for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      $n = 24$, the observed value of the test statistic is $x = n(+) = 0$.  
   b. The test statistic.
      $x^* = n(+) = 0$.

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
The critical value is located at the intersection of the $\alpha = 0.05$ column
and the $n = 24$ row or 6.

   b. Determine whether or not the calculated test statistic is in the critical region.
   $x^*$ is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about $H_a$
      Reject $H_a$.
   b. State the conclusion about $H_a$
      The sample shows sufficient evidence at the 0.05 level to conclude that the
median dynamic envelope clearance time is not equal to 14 sec.
Number of field observations under 7.71: 23 (denoted as n(-))
Number of field observations equal to 7.71: 0
Number of field observations over 7.71: 1 (denoted as n(+))

Number of usable observations: 24 (n(-) + n(+))

**Step 1 The Set-Up:**

a. Describe the population parameter of interest.
   $T$, vehicle median time to clear dynamic envelope

b. State the null hypothesis (H₀) and the alternative hypothesis (Hₐ).
   
   $H₀ : T = 7.71$
   $Hₐ : T ≠ 7.71$

**Step 2 The Hypothesis Test Criteria**

a. Check the assumptions.
   The 24 field observations were independently obtained and the variable envelope clearance time is continuous.

b. Identify the test statistic to be used.
   The test statistic that will be used is the number of the less frequent sign: the smaller of n (+) and n (-), which is n (+) for this research. The test statistic $= x^* = n(+)$.  

c. Determine the level of significance.
   $\alpha = 0.05$ for a two-tailed test.

**Step 3 The Sample Evidence**

a. The sample information.
   $n = 24$, the observed value of the test statistic is $x = n(+) = 1$.

b. The test statistic.
   $x^* = n(+) = 1$.

**Step 4 The Probability Distribution using the Classical Procedure**

a. Determine the critical region and critical values.
   The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the $\alpha = 0.05$ column and the $n = 24$ row or 6.

   ![Critical Region and Critical Values](image)

b. Determine whether or not the calculated test statistic is in the critical region.
   $x^*$ is in the critical region (see figure above)

**Step 5 The Results**

a. State the decision about $H₀$.
   Reject $H₀$.

b. State the conclusion about $Hₐ$.
   The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 7.71 sec.
### APPENDIX G: LA 19 (MAIN STREET) AT RAY WIELAND DRIVE & TRUMAN STREET INTERSECTION DATA SHEETS

#### 1 of 4

**LaDOTD TRAFFIC OPERATIONS AND ENGINEERING**
**FIELD OBSERVATION METHOD**
**RAILROAD PREEMPTION WORKSHEET**

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<td>Single Unit Vehicles</td>
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<td>Nth Vehicle</td>
<td>= The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.</td>
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<td>Time to Clear</td>
<td>= Time from start of green until back of Nth Vehicle clears Dynamic Envelope.</td>
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[rev 5/02]
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

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**Geometric Input**

- **Route:** St Name: RAY WIELAND DR @ TRUMAN ST
- **Railroad Co.:** Mainline __X__ or Spur ____________
- **Number of Tracks 1:** ____________
- **Dynamic Envelope:** 18 ft
- **Distance Between Envelope and Stop Bar:** 15 ft
- **Railroad Crossing:**__X__ Crossbuck
- **Lights/Ground:** ____________
- **Lights/Tuss:** ____________
- **Gates:** ____________

**Input Field Measurement**

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<th>Number of Single Unit Vehicles</th>
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**Glossary and Notes**

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 5 ft back width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Busses
- **Tractor Trl:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

*rev 5/02*
LA DOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information
Analyst: DRK
District: 61
Parish: EBR
TSI No.: 7
Date: 8/5/2003
Time: 4:00 PM
Area Type: rural

Geometric Input
Route:
St Name: RAY WIELAND DR
& TRUMAN ST

Railroad Co.: __
Mainline _X_ or Spur ___
Number of Tracks: 1
Dynamic Envelope 18 ft
Distance Between Envelope and Step Bar 15 ft
Railroad Control: ___ Crossbucks
___ Lights/Ground
___ Lights/Truss
___ Gates

Input Field Measurement

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<th>Number of Passenger Vehicles</th>
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<th>Is a Vehicle stopped in envelope?</th>
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Maximum: 2
Minimum: 2
Average: 2

Glossary and Notes
Dynamic Envelope = Typically 13 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trl = Tractor/Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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Glossary and Notes

Total counts = 27; Max # of veh. = 3; Max time to clear envelope = 12 sec

Dynamic Envelope = Typically 18 ft for 60 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trl = Tractor Trailer Vehicles
8th Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of 8th Vehicle clears Dynamic Envelope.

rev 5/02
LA 19 (MAIN ST) @ RAY WIELAND DR & TRUMAN ST INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 33 ft / 19 ft = 2 vehicles
separation time = 4 sec

Track Clearance time = 12 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = L \cdot k(j) \cdot 2.94 \cdot s = 1.42 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (33 ft)
k(j) = Jam density (assumed to be 240)
s = Saturation flowrate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2 \cdot D + W \cdot a)} = 5 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 19 ft)
PV
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (4.4 ft/sec^2) PV

Track Clearance time = 6.42 sec

Field Observation:
Total counts = 27; Max # of veh. = 3; Max time to clear envelope = 12 sec
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 12 sec.

Number of field observations under 12: 25 (denoted as n(-))
Number of field observations equal to 12: 2
Number of field observations over 12: 0 (denoted as n(+))

Number of usable observations: 25 (n(-) + n(+) )

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \[ T \text{, vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis (H_0) and the alternative hypothesis (H_a).
      \[
      \begin{align*}
      H_0 : T &= 12 \\
      H_a : T &\neq 12
      \end{align*}
      \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 27 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of n (+) and n (-), which is n (+) for this research. The test statistic is \[ x^* = n(+) \]
   c. Determine the level of significance.
      \[ \alpha = 0.05 \text{ for a two-tailed test.} \]

Step 3  The Sample Evidence
   a. The sample information.
      \[ n = 25 \text{, the observed value of the test statistic is } x = n(+) = 0. \]
   b. The test statistic.
      \[ x^* = n(+) = 0. \]

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \[ \alpha = 0.05 \] column and the \[ n = 25 \] row or 7.
      \[
      \begin{array}{c|c|c}
      \text{Number of less frequent sign} & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
      \hline
      0 & 7 & 8
      \end{array}
      \]
   b. Determine whether or not the calculated test statistic is in the critical region.
      \[ x^* \text{ is in the critical region (see figure above).} \]

Step 5  The Results
   a. State the decision about \[ H_0 \].
      Reject \[ H_0 \].
   b. State the conclusion about \[ H_a \].
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 12 sec.
Number of field observations under 6.42: 9 (denoted as $n(-)$)
Number of field observations equal to 6.42: 0
Number of field observations over 6.42: 18 (denoted as $n(+)$$\)

Number of usable observations: 27 ($n(-) + n(+)$$\)

**Step 1**  The Set-Up:

a. **Describe the population parameter of interest.**
   \[ T, \text{ vehicle median time to complete dynamic envelope} \]

b. **State the null hypothesis (H₀) and the alternative hypothesis (H₁).**
   \[
   H₀: T = 6.42 \\
   H₁: T \neq 6.42
   \]

**Step 2**  The Hypothesis Test Criteria

a. **Check the assumptions.**
   The 27 field observations were independently obtained and the variable envelope clearance time is continuous.

b. **Identify the test statistic to be used.**
   The test statistic that will be used is the number of the less frequent sign: the smaller of $n(+)$$\) and $n(-)$$\), which is $n(-)$$\) for this research. The test statistic is $x^* = n(-)$$\).

c. **Determine the level of significance.**
   \[ \alpha = 0.05 \text{ for a two-tailed test.} \]

**Step 3**  The Sample Evidence

a. **The sample information.**
   $n = 27$; the observed value of the test statistic is $x^* = n(-) = 9$.

b. **The test statistic.**
   $x^* = n(-) = 9$.

**Step 4**  The Probability Distribution using the Classical Procedure

a. **Determine the critical region and critical values.**
   The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the $\alpha = 0.05$ column and the $n = 27$ row or 7.

\[
\begin{array}{c|c|c}
\text{Reject } H₀ & \text{Fail to reject } H₀ \\
0 & 7 & 8 \\
\end{array}
\]

Number of less frequent sign

b. **Determine whether or not the calculated test statistic is in the critical region.**
   $x^*$ is not in the critical region (see figure above)

**Step 5**  The Results

a. **State the decision about $H₀$.**
   Fail to reject $H₀$.

b. **State the conclusion about $H₁$.**
   The sample does not show sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 6.42 sec.
APPENDIX H: LA 19 (SCOTLAND AVENUE) AT LA 423 (THOMAS ROAD)  
INTERSECTION DATA SHEETS

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| Analyst: DRK        | Date: 8/6/2003  
| District: 61         | Time: 4:00 PM  
| Parish: EBR          | Area Type: rural, or X urban  
| TSI No: 14           |  

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| Route: LA 423   | Railroad Co.  
| St Name: Thomas Rd | Mainline X or Spur  
|                 | Number of Tracks 1  
|                 | Dynamic Envelope 18 ft  
|                 | Distance Between Envelope  
|                 | and Stop Bar 26 ft  
|                 | Railroad Cont X Crossbucks  
|                 | Lights/Ground  
|                 | Lights/Truss  
|                 | Gates  

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| Queue at start of Green | Last Vehicle in Envelope  
| Cycle | Total Number of Vehicles | Number of Single Unit Vehicles | Number of Tractor Trlr Vehicles | Is a Vehicle stopped in envelope? | Nth Vehicle | Time to Clear Envelope |
| 1    | 1                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 9  |
| 2    | 1                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 5  |
| 3    | 1                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 5  |
| 4    | 1                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 5  |
| 5    | 1                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 5  |
| 6    | 1                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 5  |
| 7    | 2                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 9  |
| 8    | 2                   | 2                   | Yes/No                   | 2                         | Yes/No | 2 | 4  |
| 9    | 7                   | 7                   | Yes/No                   | 3                         | Yes/No | 3 | 7  |
| 10   | 3                   | 3                   | Yes/No                   | 2                         | Yes/No | 2 | 5  |
| 11   | 7                   | 7                   | Yes/No                   | 3                         | Yes/No | 3 | 7  |
| 12   | 1                   | 1                   | Yes/No                   | 1                         | Yes/No | 1 | 4  |
| 13   | 2                   | 2                   | Yes/No                   | 2                         | Yes/No | 2 | 5  |
| 14   | 3                   | 3                   | Yes/No                   | 2                         | Yes/No | 2 | 8  |
| 15   | 3                   | 3                   | Yes/No                   | 2                         | Yes/No | 2 | 6  |

<table>
<thead>
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<th>Glossary and Notes</th>
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</table>
| Dynamic Envelope   | = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.  
| Single Unit Vehicle | = Delivery Trucks and Busses  
| Tractor Trlr Vehicle | = Tractor Trailer Vehicles  
| Nth Vehicle        | = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.  
| Time to Clear      | = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.  

rev 9/02

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**LaDOTD Traffic Operations and Engineering**

**Field Observation Method**

**Railroad Preemption Worksheet**

### General Information
- **Analyst:** DRK
- **District:** 61
- **Parish:** EBR
- **TSI No.:** 14
- **Date:** 8/8/2003
- **Time:** 4:00 PM
- **Area Type:** \( \text{□} \) rural, \( \text{□} \) urban

### Geometric Input

- **Route:** LA 423
- **St Name:** THOMAS RD
- **Railroad Co.:**
- **Mainline X or Spur:**
- **Number of Tracks:** 1
- **Dynamic Envelope:** \( 18 \) ft
- **Distance Between Envelope and Stop Bar:** 25 ft
- **Railroad Control:** \( \text{□} \) Light Ground
- **Lights/Truss:** \( \text{□} \) Other

### Input Field Measurement

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<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
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### Glossary and Notes

- **Dynamic Envelope:** Typically \( 18 \) ft for 60 deg crossing, \( 8 \) ft track width plus \( 6 \) ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trk:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
**LaDOTD TRAFFIC OPERATIONS AND ENGINEERING**  
**FIELD OBSERVATION METHOD**  
**RAILROAD PREEMPTION WORKSHEET**

### General Information

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<tr>
<th>Analyst</th>
<th>Date</th>
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### Geometric Input

- Route: LA 423  
  St Name: THOMAS RD
- Route: LA 19  
  St Name: SCOTLAND AVE

- Railroad Co., X or Spur:  
- Number of Tracks: 1
- Dynamic Envelope: X ft
- Distance Between Envelope and Stop Bar: 25 ft
- Railroad Control: X Crossbucks
- Lights/Ground:  
  Lights/Truss:  
  6 ft

### Input Field Measurement

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<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
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**Maximum:** 3  
**Minimum:** 2  
**Average:** 2.5

### Glossary and Notes

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicle:** Delivery Trucks and Busses
- **Tractor Trlr:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
# LaDOTD Traffic Operations and Engineering

## Field Observation Method

### Railroad Preemption Worksheet

#### General Information

- Analyst: DRK
- District: 61
- Parish: EBR
- TSI No.: 14
- Date: 8/28/03
- Time: 4:00 PM
- Area Type: _X_ urban

#### Geometric Input

- Route: LA 423
- St Name: THOMAS RD
- Railroad Co.: _X_ Mainline
- Number of Tracks: 1
- Dynamic Envelope: 16 ft
- Distance Between Envelope and Stop Bar: 25 ft
- Railroad Control: _X_ Crossbucks
- Light/Ground: _X_ Lights/Tuss
- Another

#### Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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#### Glossary and Notes

**Total counts = 35; Max # of veh. = 4; Max time to clear envelope = 9 sec**

- Dynamic Envelope = Typically 13 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
- Tractor Trl = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope

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**rev 5/02**
LA 19 (SCOTLAND AVE) @ LA 423 (THOMAS RD) INTERSECTION SUMMARY

Northwestern:

Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 43 ft / 19 ft = 2 vehicles
separation time = 4 sec

Track Clearance time = 12 sec

Marshall/Berg:

Track Clearance time = t(1) + t(2)

\[ t(1) = L \cdot k(j) / 2.94 \cdot s = 1.85 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (43 FT)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \text{square root} \left( 2(L + 2D + W/a) \right) = 10.37 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 50 ft)
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (1.6 ft/sec^2)

Track Clearance time = 12.22 sec

Field Observation:

Total counts = 35; Max # of veh. = 4; Max time to clear envelope = 9 sec
LA 19 (SCOTLAND AVE) @ LA 423 (THOMAS RD)
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 12 sec.

Number of field observations under 12: 35 (denoted as n(-))
Number of field observations equal to 12: 0
Number of field observations over 12: 0 (denoted as n(+))

Number of usable observations: 35 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \[ H_0: T = 12 \]
      \[ H_a: T \neq 12 \]
   b. State the null hypothesis (H0) and the alternative hypothesis (Ha).

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 35 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of n (+) and n (-), which is n (+) for this research. The test statistic is \[ x^* = n(+) \].
   c. Determine the level of significance.
      \[ \alpha = 0.05 \] for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \[ n = 35 \]; the observed value of the test statistic is \[ x = n(+) = 0 \].
   b. The test statistic.
      \[ x^* = n(+) = 0 \].

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \[} \text{column and the } n = 35 \text{ row or 11} \text{.}
      \[ \text{Reject } H_0 \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ }
Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 12.22 sec.

Number of field observations under 12.22: 35 (denoted as n(−))
Number of field observations equal to 12.22: 0
Number of field observations over 12.22: 8 (denoted as n(+))

Number of usable observations: 36 (n(−) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \[ T, \text{ vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis (H₀) and the alternative hypothesis (H₁).
      \[
      \begin{align*}
      H₀ & : T = 12.22 \\
      H₁ & : T \neq 12.22
      \end{align*}
      \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 35 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic will be used is the number of less frequent sign: the smaller of n(−) and n(+), which is n(−) for this research. The test statistic is \[ x^* = n(−) \].
   c. Determine the level of significance.
      \[ \alpha = 0.05 \] for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \[ n = 35; \text{ the observed value of the test statistic is } x = n(+) = 0 \].
   b. The test statistic.
      \[ x^* = n(+) = 0 \].

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \[ x^* = 0.05 \] column and the \[ n = 35 \] row or 11.

   \[
   \begin{array}{c|c}
   \text{Number of less frequent sign} & \text{Reject } H₁ & \text{Fail to reject } H₀ \\
   \hline
   0 & 11 & 12
   \end{array}
   \]

   b. Determine whether or not the calculated test statistic is in the critical region.
      \[ x^* \] is in the critical region (see figure above).

Step 5  The Results
   a. State the decision about \[ H₁ \] and \[ H₀ \]
      Reject \[ H₀ \].
   b. State the conclusion about \[ H₁ \]
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 12.22 sec.


## APPENDIX I: LA 19 (SCOTLAND AVENUE) AT RAFe MEYER ROAD & GIBBENS ROAD INTERSECTION DATA SHEETS

### General Information
- Analyst: DRK
- Parish: EBR
- TSI No.: 242
- Date: 9/6/2003
- Time: 4:00 PM
- Area Type: _urban_

### Geometric Input
- Route: RAFE MEYER RD & GIBBENS RD
- Mainline: _X_ or Spur: _X_
- Number of Tracks: 1
- Dynamic Envelope: 18 ft
- Distance Between Envelope and Stop Bar: 47 ft
- Railroad Control: _X_ Crossbucks
- Lights/Grade: _X_ Gates

### Input / Field Measurement

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<th>Number of Tractor Trailer Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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### Glossary and Notes
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trailer Vehicles**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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Geometric Input

- **Route:** SName: RAPE MEYER RD & GIBBEN'S RD
- **Railroad Co.:** Multi-line __X__ or Spur __________
- **Number of Tracks:** 1
- **Distance Between Envelope and Stop Bar:** __47__ ft
- **Railroad Control:** __X__ Crossbucks __________
- **Lights/GroundLights/Trass:** __________ Gates

Input Field Measurement

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Glossary and Notes

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trlr:** Tractor Trailer Vehicles
- **N th Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of N th Vehicle clears Dynamic Envelope.

rev 5/02
**LaDOTD Traffic Operations and Engineering**  
**Field Observation Method**  
**Railroad Preemption Worksheet**

### General Information
- **Analyst:** DRK  
- **District:** 01  
- **Parish:** EBR  
- **TS No.:** 242
- **Date:** 9/6/2003  
- **Time:** 4:00 PM  
- **Area Type:** _urban

### Geometric Input
- **Route:** LA 19  
- **St Name:** BAFE MEYER RD & GIBBENS RD
- **Railroad Co.:**  
- **Mainline:** _X_ or Spur  
- **Number of Tracks:** 1  
- **Dynamic Envelope:** 18 ft
- **Distance Between Envelope and Stop Bar:** 47 ft
- **Railroad Crossing:** _X_ Crossbucks
- **Lights/Beacon:**  
- **Lights/Truss:**  
- **Gates:**

### Input Field Measurement

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<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trailers</th>
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<th>Time to Clear Envelope</th>
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**Maximum:** 3  
**Minimum:** 2  
**Average:** 1  

### Glossary and Notes
- **Total counts = 29; Max # of veh. = 3; Max time to clear envelope = 9 sec**
- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trair:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LA 19 (SCOTLAND AVE) @ RAFF MEYER RD & GIBBENS RD INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 - 2n) + separation time
n = L / avg vehicle length = 65 ft / 19 ft = 3 vehicles
separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L \cdot k(j) \cdot 2.94 \cdot s}{2} = 2.79 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (65 ft)
k(j) = jam density (assumed to be 240)
s = saturation flow rate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2 \cdot D + W)} = 10.37 \]
(time to clear 1 vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 50 ft)  TT
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 5 ft)
s = Acceleration rate for the design vehicle (1.6 ft/sec^2)  TT

Track Clearance time = 13.16 sec

Field Observation:
Total counts = 29; Max # of veh. = 3; Max time to clear envelope = 9 sec
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 29 (denoted as n(−))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+) )

Number of usable observations: 29 (n(−) + n(+) )

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[ H_0 : T = 14 \]
      \[ H_a : T \neq 14 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 29 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(+) and n(−), which is n(+) for this research. The test
      statistic = \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      n = 29; the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the \( n = 29 \) row or 8.
      
      
      \[ \text{Reject } H_0 \]  \[ \text{Fail to reject } H_0 \]
      Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( H_a \)
      Reject \( H_a \).
   b. State the conclusion about \( H_a \)
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 14 sec.
Number of field observations under 13.16: 23 (denoted as n(-))
Number of field observations equal to 13.16: 0
Number of field observations over 13.16: 0 (denoted as n(+))

Number of usable observations: 29 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[ H_0: T = 13.16 \]
      \[ H_a: T \neq 13.16 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 29 field observations were independently obtained and
      the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the
      less frequent sign: the smaller of n(+) and n(-), which
      is n(+) for this research. The test statistic is
      \( x^* = n(+) \)
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \( n = 29 \), the observed value of the test statistic is
      \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values
      of the sign test. The critical value is located at the
      intersection of the column and the \( n = 29 \) row or 8.

   \[
   \begin{array}{cc}
   \text{Reject } H_a & \text{Fail to reject } H_a \\
   0 & 8 \\
   9 &
   \end{array}
   \]

   Number of less frequent sign

   b. Determine whether or not the calculated test statistic is
      in the critical region.
      \( x^* \) is in the critical region (see figure above).

Step 5  The Results
   a. State the decision about \( H_a \).
      \( H_a \) is rejected.
   b. State the conclusion about \( H_a \).
      The sample shows sufficient evidence at the 0.05 level to
      conclude that the median dynamic envelope clearance time
      is not equal to 13.16 sec.
APPENDIX J: LA 30 (NICHOLSON DRIVE) AT BOB PETIT BOULEVARD & JENNIFER JEAN DRIVE INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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Geometric Input

- Route: St. Name BOB PETIT BLVD & JEN JEAN DR
- Railroad Ctrl: X Crossbucks
- Rail Grade: N/A
- Number of Tracks: 1
- Dynamic Envelope: 18 ft
- Distance Between Envelope and Stop Bar: 37 ft
- Railroad Ca. or Spur: N/A

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Maximum: 3; 10
Minimum: 2; 6
Average: 3; 8

Glossary and Notes

- Dynamic Envelope: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles: Delivery Trucks and Busses
- Tractor Trlr: Tractor Trailer Vehicles
- Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

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Geometric Input

Route: St Name BOB PETIT BLVD & JEN JEAN DR

Railroad Co.:
Mainline: ___ or Spur: ___
Number of Tracks: ___
Distance Between Envelope and Stop Bar: ___ ft
Railroad Control: ___ Crossbucks
Lights/Truss: ___ Gates

Input Field Measurement

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Maximum: 3 11
Minimum: 2 5
Average: 3 7

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 5 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trl = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
# LaDOTD Traffic Operations and Engineering

## Field Observation Method

### Railroad Preemption Worksheet

### General Information

- **Analyst**: DRK
- **Date**: 6/2/2003
- **District**: 01
- **Time**: 7:00 AM
- **Parish**: EBR
- **Area Type**: Rural, or X Urb
- **TSI No.**: 9-174

### Geometric Input

- **Route**: St Name Bob Petit Blvd & Jean Jean Dr
- **Railroad Co.**:
- **Mainline**: or Spur
- **Number of Tracks**: 1
- **Dynamic Envelope**: 18 ft
- **Distance Between Envelope and Stop Bar**: 37 ft
- **Railroad Control**: X Lights/Gates
- **Crossbucks**:
- **Route LA 50**: St Name Nicholson Dr

### Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle Stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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### Glossary and Notes

- **Total counts**: 25; **Max # of veh.**: 4; **Max time to clear envelope**: 17 sec
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing; 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trl**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until last of Nth Vehicle clears Dynamic Envelope.

**rev 5/03**
LA 30 (NICHOLSON DR) @ BOB PETIT BLVD & JEN JEAN DR INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 55 ft / 15 ft = 3 vehicles
separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = L \cdot k(j) \cdot 2.34 \cdot s = 2.36 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (55 FT)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \text{square root} (2(L + 2D + W \cdot a)) = 7.88 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 40 ft)
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (2.5 ft/sec^2)

Track Clearance time = 10.16 sec

Field Observation:
Total counts = 25; Max # of veh. = 4; Max time to clear envelope = 17 sec
Number of field observations under 14: 24 (denoted as n(-))
Number of field observations equal to 14: 0
Number of field observations over 14: 1 (denoted as n(+))

Number of usable observations: 25 (n(-) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H0) and the alternative hypothesis (Ha).
      \[ H_0 : T = 14 \]
      \[ H_a : T \neq 14 \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 25 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of n (+) and n (-), which is n (+) for this research. The test statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 25 \), the observed value of the test statistic is \( x^* = n(+) = 1 \).
   b. The test statistic.
      \( x^* = n(+) = 1 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the \( n = 25 \) row or 7.

\[
\begin{array}{c|c|c}
\text{Reject } H_0 & \text{Fail to reject } H_0 \\
\hline
0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\
\end{array}
\]

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* = 1 \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_a \).
      Reject \( H_a \).
   b. State the conclusion about \( H_a \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 14 sec.
Number of field observations under 10.16: 22 (denoted as \( n(\cdot) \))
Number of field observations equal to 10.16: 0
Number of field observations over 10.16: 3 (denoted as \( n(\cdot) \))

Number of usable observations: 25 \( (n(\cdot) + n(\cdot)) \)

**Step 1** The Setup:

a. **Describe the population parameter of interest.**
   \( T \), vehicle median time to clear dynamic envelope

b. **State the null hypothesis \((H_0)\) and the alternative hypothesis \((H_a)\).**
   \[
   H_0 : T = 10.16 \\
   H_a : T \neq 10.16
   \]

**Step 2** The Hypothesis Test Criteria

a. **Check the assumptions.**
   The 25 field observations were independently obtained and the variable envelope clearance time is continuous.

b. **Identify the test statistic to be used.**
   The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(\cdot) \) and \( n(\cdot) \), which is \( n(\cdot) \) for this research. The test statistic is \( x^* = n(\cdot) \).

c. **Determine the level of significance.**
   \( \alpha = 0.05 \) for a two-tailed test.

**Step 3** The Sample Evidence

a. **The sample information.**
   \( n = 25 \); the observed value of the test statistic is \( x = n(\cdot) = 3 \).

b. **The test statistic.**
   \( x^* = n(\cdot) = 3 \).

**Step 4** The Probability Distribution using the Classical Procedure

a. **Determine the critical region and critical values.**
   The critical value is located in the table of critical values of the sign test.
   The critical value is located at the intersection of the \( x \geq 0.05 \) column and the \( n = 25 \) row or 7.

   ![Reject \( H_0 \) or Fail to reject \( H_0 \) chart]

   Number of less frequent sign

   0 7 8

b. **Determine whether or not the calculated test statistic is in the critical region.**
   \( x^* \) is in the critical region (see figure above).

**Step 5** The Results

a. **State the decision about \( H_0 \).**
   Reject \( H_0 \).

b. **State the conclusion about \( H_0 \).**
   The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 10.16 sec.
APPENDIX K: LA 30 (NICHOLSON DRIVE) AT BRIGHTSIDE DRIVE & WEST LEE DRIVE INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING FIELD OBSERVATION METHOD RAILROAD PREEMPTION WORKSHEET

General Information

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<thead>
<tr>
<th>Analyst</th>
<th>Date</th>
<th>Time</th>
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<td>TSI No.</td>
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Geometric Input

Route:
- St Name: BRIGHTSIDE DR & W. LEE DR

Railroad Co.: X Mainline, __ Spur
- Number of Tracks: 1
- Dynamic Envelope: __18__ ft
- Distance Between Envelope: __45__ ft
- Railroad Control: X Crossbucks
- X Lights/Ground
- X Lights/Truss
- X Gates

Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
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<th>Queue at start of Green</th>
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Maximum: 4 7
Minimum: 2 5
Average: 3 6

Glossary and Notes

Dynamic Envelope: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles: Delivery Trucks and Buses
Tractor Trlr: Tractor Trailer Vehicles
Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

Analyst: DRK
District: 61
Parish: EBR
TSI No.: S-212

Date: 7/15/2003
Time: 4:00 PM
Area Type: ___ rural, or X urban

Geometric Input

Route: St Name: BRIGHTSIDE DR & W. LEE DR

Railroad Co.:
Mains: X or Spur
Number of Tracks: 1
Dynamic Envelope: 18 ft
Distance Between Envelope and Step Bar: 45 ft
Railroad Control: X Crossbucks

Envelope and Step Bar

Input Field Measurement

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Maximum: 5 8
Minimum: 3 5
Average: 3 7

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trk = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
**LaDOTD TRAFFIC OPERATIONS AND ENGINEERING**
**FIELD OBSERVATION METHOD**
**RAILROAD PREEMPTION WORKSHEET**

### General Information
- **Analyst:** DRK
- **District:** EBR
- **Parish:** EBR
- **TSI No.:** S-212
- **Date:** 7/16/2003
- **Time:** 4:00 PM
- **Area Type:** __ rural, or _ urban

### Geometric Input
- **Route:**
  - **St Name:** BRIGHT SIDE DR & W. LEE DR
- **Railroad Co.:**
- **Mainline:** X or Spur
- **Number of Tracks:** 1
- **Dynamic Envelope:** __ ft
- **Distance Between Envelope and Stop Bar:** __ ft
- **Railroad Center:**
  - X Crossbucks
  - X Lights/Truss
  - X Gates

### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>N-th Vehicle</th>
<th>Time to Clear Envelope</th>
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</tr>
</tbody>
</table>

### Glossary and Notes
- **Total counts = 26; Max # of veh. = 4; Max time to clear envelope = 8 sec**
- Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
- Tractor Trlr = Tractor Trailer Vehicles
- N-th Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until last of N-th Vehicle clears Dynamic Envelope.

*Rev 9/02*
LA 30 (NICHOLSON DR) @ BRIGHTSIDE DR & W. LEE DR INTERSECTION SUMMARY

Northwestern:

Track Clearance time = \((4 + 2n) + \text{separation time}\)

\(n = \frac{L}{\text{avg vehicle length}} = \frac{63\text{ ft}}{19\text{ ft}} = 3\ \text{vehicles}\)

\(\text{separation time} = 4\text{ sec}\)

Track Clearance time = 14 sec

Marshall/Berg:

\(t(1) = L \cdot \sqrt{k(j)}/2.94 \cdot s = 2.71\)

(time until the last vehicle in the blocking queue departs)

\(L = \text{Length of the queue to be cleared (63 FT)}\)

\(k(j) = \text{jam density (assumed to be 240)}\)

\(s = \text{saturation flowrate (assumed to be 1900)}\)

\(t(2) = \text{square root} (2L + 2^3D - W)/a = 7.13\)

(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)

\(L = \text{Length of the longest design vehicle expected at the intersection (assumed to be 30ft)}\)

\(D = \text{Clearance distance on either side of the tracks (assumed to be 15 ft)}\)

\(W = \text{Width between the outermost rails (assumed to be 6 ft)}\)

\(a = \text{Acceleration rate for the design vehicle (2.5ft/sec^2)}\)

Track Clearance time = 9.83 sec

Field Observation:

Total counts = 26; Max # of veh. = 4; Max time to clear envelope = 8 sec
La 30 (Nicholson Dr) @ Brightside Dr & W. Lee Dr

Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 26 (denoted as n(-))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 26 (n(-) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).

      \[ H_0 : T = 14 \]
      \[ H_a : T \neq 14 \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 26 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(+) and n(-), which is n(+) for this research. The test
      statistic = \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 26 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( n = 26 \) column
      and the \( \alpha = 0.05 \) row or 7.

      \[ \begin{array}{c|c|c}
      0 & 7 & 8 \\
      \hline
      \end{array} \]
      Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_0 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_a \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 14 sec.
Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 9.83 sec.

Number of field observations under 9.83: 26 (denoted as n(-))
Number of field observations equal to 9.83: 0
Number of field observations over 9.83: 0 (denoted as n(+) )

Number of usable observations: 26 \((n(-) + n(+))\)

Step 1 \(\text{The Set-Up:}\)

a. Describe the population parameter of interest.
   \(T, \) vehicle median time to clear dynamic envelope

b. State the null hypothesis \((H_0)\) and the alternative hypothesis \((H_a)\).
   
   \[
   H_0: T = 9.83 \\
   H_a: T \neq 9.83
   \]

Step 2 \(\text{The Hypothesis Test Criteria}\)

a. Check the assumptions.
   The 26 field observations were independently obtained and the variable envelope clearance time is continuous.

b. Identify the test statistic to be used.
   The test statistic that will be used is the number of the less frequent sign: the smaller of \(n(+)\) and \(n(-)\), which is \(n(+)\) for this research. The test statistic \(x^* = n(+)\).

c. Determine the level of significance.
   \(\alpha = 0.05\) for a two-tailed test.

Step 3 \(\text{The Sample Evidence}\)

a. The sample information.
   \(n = 26\); the observed value of the test statistic is \(x = n(+) = 0\).

b. The test statistic.
   \(x^* = n(+) = 0\).

Step 4 \(\text{The Probability Distribution using the Classical Procedure}\)

a. Determine the critical region and critical values.
   The critical value is located in the table of critical values of the sign test.
   The critical value is located at the intersection of the \(n = 26\) row and the \(\alpha = 0.05\) column.

   ![Critical Values Table]

   - Reject \(H_0\)
   - Fail to reject \(H_0\)

   Number of less frequent sign

   0 \(\leq 7\)

b. Determine whether or not the calculated test statistic is in the critical region.
   \(x^*\) is in the critical region (see figure above)

Step 5 \(\text{The Results}\)

a. State the decision about \(H_0\).
   Reject \(H_0\).

b. State the conclusion about \(H_a\).
   The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 9.83 sec.
# LaDOTD Traffic Operations and Engineering

## Field Observation Method

### Railroad Preemption Worksheet

#### General Information
- Analyst: DRK
- District: 01
- Parish: EBR
- Date: 7/14/2003
- Time: 4:00 PM
- TSI No.: 5.274
- Area Type: Urban

#### Geometric Input
- Route: LA 30
- StName: NICHOLSON DR
- StName: BURBANK DR & GOURRIER AVE
- Dynamic Envelope: X
- Distance Between Envelope and Stop Bar: 48 ft
- Railroad Control: X
- Crossbucks: X
- Lights/Truss: X
- Gates: X

#### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

- Maximum: 3
- Minimum: 2
- Average: 2.5

#### Glossary and Notes
- Dynamic Envelope: Typically 13 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles: Delivery Trucks and Buses
- Tractor Trlr: Tractor Trailer Vehicles
- Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

Rev 5/02
**LaDOTD TRAFFIC OPERATIONS AND ENGINEERING**

**FIELD OBSERVATION METHOD**

**RAILROAD PREEMPTION WORKSHEET**

### General Information

- **Analyst**: DRK
- **District**: 61
- **Parish**: EBR
- **TSD No.**: 5-274
- **Date**: 7/14/2003
- **Time**: 4:00 PM
- **Area Type**: _X_ urban

### Geometric Input

- **Route**: Route:
  - StName: BURBANK DR & GOURRIER AVE
- **Railroad**: Railroad Co.:
  - Mainline _X_ or Spur _X_
- **Number of Tracks**: 1
- **Dynamic Envelope**: Distance Between Envelope and Stop Bar _48 ft_,
- **Route Control**: Road Control _X_ Crossbucks _X_ Lights/Truss _X_ Gates _X_

### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Queue at start of Green</th>
<th>Last Vehicle in Envelope</th>
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</thead>
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<td>Total Number of Passenger Vehicles</td>
<td>Number of Single Unit Vehicles</td>
<td>Number of Tractor Trlr Vehicles</td>
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<td>6</td>
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<tr>
<td><strong>Minimum</strong></td>
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</tr>
<tr>
<td><strong>Average</strong></td>
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</tr>
</tbody>
</table>

### Glossary and Notes

- **Dynamic Envelope**: Typically 13 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Busses
- **Tractor Tlr**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>DRK</th>
<th>Date</th>
<th>7/14/2003</th>
</tr>
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<tbody>
<tr>
<td>Parish</td>
<td>EBR</td>
<td>Time</td>
<td>4:00 PM</td>
</tr>
<tr>
<td>TSI No.</td>
<td>274</td>
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</tr>
</tbody>
</table>

Area Type: _X_ urban

Geometric Input

Route: St Name: BURBANK DR & SOURRIER AVE

Railroad Co.: _X_ or Spur
Number of Tracks: 1
Dynamic Envelope: 18 ft
Distance Between Envelope and Stop Bar: 49 ft
Route: LA 30 St Name: NICHOLSON DR

Geometric Input

Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Queue at start of Green</th>
<th>Last Vehicle in Envelope</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Passanger Vehicles</td>
<td>Number of Single Unit Vehicles</td>
<td>Number of Tractor Trl Vehicles</td>
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<tr>
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<td>3</td>
<td>3</td>
<td>Yes</td>
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<tr>
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<td>7</td>
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</tr>
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</tbody>
</table>

Maximum: 7 Min: 3 Average: 3

Glossary and Notes

Total counts = 24; Max # of veh. = 3; Max time to clear envelope = 7 sec

- Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Busses
- Tractor Trl = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LA 30 (NICHOLSON DR) @ BURBANK DR & GOURRIER AVE INTERSECTION SUMMARY

Northwestern:

Track Clearance time = \((4+2n) + \text{separation time}\)

\[ n = \frac{L}{\text{avg vehicle length}} = \frac{67 \text{ ft}}{19 \text{ ft}} = 4 \text{ vehicles} \]

\[ \text{separation time} = 4 \text{ sec} \]

Track Clearance time = 16 sec

Marshall/Berg:

Track Clearance time = \(t(1) + t(2)\)

\[ t(1) = \frac{L'k(j)}{2.94's} = 2.88 \]

(time until the last vehicle in the blocking queue departs)

\[ L' = \text{Length of the queue to be cleared} (67 \text{ ft}) \]

\[ k(j) = \text{jam density (assumed to be 240)} \]

\[ s = \text{saturation flow rate (assumed to be 1900)} \]

\[ t(2) = \sqrt{2(L + 2'D + W')a} = 5 \]

(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)

\[ L = \text{Length of the largest design vehicle expected at the intersection (assumed to be 19 ft)} \]

\[ D = \text{Clearance distance on either side of the tracks (assumed to be 15 ft)} \]

\[ W' = \text{Width between the outermost rails (assumed to be 5 ft)} \]

\[ a = \text{Acceleration rate for the design vehicle (4.4 ft/sec}^2) \]

Track Clearance time = 7.88 sec

Field Observation:

Total counts = 24; Max # of veh. = 3; Max time to clear envelope = 7 sec
LA 30 (NICHOLSON DR) @ BURBANK DR & GOURRIER AVE

Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 16 sec.

Number of field observations under 16: 24 (denoted as n(-))
Number of field observations equal to 16: 0
Number of field observations over 16: 0 (denoted as n(+))

Number of usable observations: 24 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \[ T, \] vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[ H_0: T = 16 \]
      \[ H_a: T \neq 16 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 24 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \[ \alpha = 0.05 \] for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \[ n = 24; \] the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \[ x^* = n(+) = 0 \]

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the \( n = 24 \) row or 6.

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( H_a \).
      Reject \( H_a \).
   b. State the conclusion about \( H_a \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 16 sec.
LA 30 (NICHOLSON DR) @ BURBANK DR & GOURRIER AVE
Sign Test for the Assumption that the Median Time is Equal to the

Number of field observations under 7.88: 24 (denoted as n(-))
Number of field observations equal to 7.88: 0
Number of field observations over 7.88: 0 (denoted as n(+))

Number of usable observations: 24 (n(-) + n(+))

Step 1  The Setup:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H0) and the alternative hypothesis (Ha).
      \[ H_0: T = 7.88 \]
      \[ H_a: T \neq 7.88 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 24 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n (-) and n (+), which is n(-) for this research. The test
      statistic \[ x^* = n(-) \].
   c. Determine the level of significance.
      \[ \alpha = 0.05 \] for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \[ n = 24 \]; the observed value of the test statistic is \[ x = n(+) = 0 \].
   b. The test statistic.
      \[ x^* = n(-) = 0 \].

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( G = 0.05 \) column
      and the \( n = 24 \) row or 6.

   b. Determine whether or not the calculated test statistic is in the critical region.
      \[ x^* \] is in the critical region (see figure above).

Step 5  The Results
   a. State the decision about \[ H_0 \] and \[ H_a \].
      Reject \[ H_0 \].
   b. State the conclusion about \[ H_a \] and \[ H_0 \].
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 7.88 sec.
APPENDIX M: LA 30 (NICHOLSON DRIVE) AT LA 327 SPUR (GARDERE LANE)
INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>D.R.K.</th>
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<tbody>
<tr>
<td>Parish</td>
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<tr>
<td>Time</td>
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Area Type: _X_ urban

Geometric Input

- Route: LA 327 SPUR
  St Name: GARDERE LN
- Railroad Co.: ____________
  Mainline: _X_ or Spur: ____________
- Number of Tracks: 1
- Dynamic Envelope: 18 ft
- Distance Between Envelope and Stop Bar: ____________ ft
  Railroad Control: ____________
  Crossbucks:_X_ Light/Truss
  _X_ Gates

Input Field Measurement

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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>N th Vehicle</th>
<th>Time to Clear Envelope</th>
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Glossary and Notes

- Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
- Tractor Trl = Tractor Trailer Vehicles
- N th Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of N th Vehicle clears Dynamic Envelope.

rev 5/02
LaDCTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
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<tr>
<th>Analyst</th>
<th>Date</th>
<th>District</th>
<th>Time</th>
<th>Parish</th>
<th>Area Type</th>
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Geometric Input

Route: LA 327 SPUR
St Name: GARDEREL LN

Railroad Co.
Mainline _ _ or Spur ______

Number of Tracks: _ _
Dynamic Envelope _ _ ft
Distance Between Envelope and Stop Bar _ _ ft
Railroad Control X Crossbucks
Lights/Truss
Lights/Gates

Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Queue at start of Green</th>
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<th>Is a Vehicle stopped in envelope?</th>
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Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Busses
Tractor Trk = Tractor Trailer Vehicles
Nth Veh = The last vehicle that stops for the signal and is in or just before the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
# LaDOTD Traffic Operations and Engineering
## Field Observation Method
### Railroad Preemption Worksheet

### General Information
- **Analyst:** DRK
- **District:** 61
- **Parish:** EBR
- **TSI No.:** 230
- **Date:** 6/2/2003
- **Time:** 4:00 PM
- **Area Type:** urban

### Geometric Input
- **Route:** LA 327 SPUR
- **St Name:** GARDERE LN
- **Railroad Co.:** X
- **Malalign or Spur:**
- **Number of Tracks:** 1
- **Distance Between Envelope and Stop Bar:** 48 ft
- **Railroad Control:** X Crossbucks
- **Lights/Ground:**
- **Gates:**

### Input Field Measurement

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<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
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<th>Last Vehicle in Envelope (Nth Vehicle, Time to Clear Envelope)</th>
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### Glossary and Notes
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- **Tractor Trlr:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

**rev 5/02**
### General Information

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<th>Analyst</th>
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<th>Time</th>
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### Geometric Input

Route: LA 327 SPUR  
St. Name: GARDEREL LN

Railroad Co.  
Number of Tracks 1  
Dynamic Envelope 18 ft  
Distance Between Envelope and Stop Bar 48 ft  
Railroad Control X Crossbucks  
Lights/Ground X Lights/Truss  
X 9 dates

### Input Field Measurement

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**Maximum** 4 8  
**Minimum** 3 3  
**Average** 3 5

### Glossary and Notes

- **Dynamic Envelope**: Typically 18’ ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trl**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

Rev 5/02
### General Information

- Analyst: DRK
- District: EBR
- Parish: EBR
- Date: 7/7/2003
- Time: 4:05 PM
- Area Type: __urban__

### Geometric Input

- Route: LA 327 Spur
- Station Name: GARDERE LN
- Railroad Co.:
- Mainline __X__ or Spur __
- Number of Tracks 1
- Dynamic Envelope __18__ ft
- Distance Between Envelope and Step Bar __48__ ft
- Railroad Control __X__ Crossbucks
- __X__ Lights/ground
- __X__ Lights/Truss
- Route: LA 30
- Station Name: NICHOLSON DR
- __X__ Gates

### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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<td><strong>No</strong></td>
<td><strong>3</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

### Glossary and Notes

- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trlr**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
# LaDOTD Traffic Operations and Engineering

## Field Observation Method
### Railroad Preemption Worksheet

**General Information**

<table>
<thead>
<tr>
<th>Analyst</th>
<th>Date</th>
<th>7/7/2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
<td>Time</td>
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<tr>
<td>Parish</td>
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</tr>
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<td>TSI No.</td>
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<td>239</td>
</tr>
<tr>
<td></td>
<td>Area Type:</td>
<td>rural, or</td>
</tr>
</tbody>
</table>

**Geometric Input**

- Route: LA 327 SPUR
- St Name: GARDERELN
- Railroad Co.
- Mannine: X or Spur
- Number of Tracks 1
- Dynamic Envelope: 18 ft
- Distance Between Envelope and Stop Bar: 48 ft
- Railroad Control: X Crossbucks
- X Lights/Lights/Truss
- X Gates

**Input Field Measurement**

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Queue at Start of Green</th>
<th>Last Vehicle in Envelope</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Number of Passanger Vehicles</td>
<td>Number of Single Unit Vehicles</td>
<td>Number of Tractor Trlr Vehicles</td>
</tr>
<tr>
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<tr>
<td>Average</td>
<td></td>
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</tr>
</tbody>
</table>

**Glossary and Notes**

- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trlr**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>Date</th>
<th>District</th>
<th>Time</th>
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<tr>
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<td>7/7/2003</td>
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<td>4:05 PM</td>
</tr>
<tr>
<td>TSI No.</td>
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Area Type: □ rural, or □ urban

Geometric Input

Route: LA 327 SPUR
St Name: GARDERE LN

Railroad Co. □ Mainline or Spur
Number of Tracks: 1
Distance Between Envelope and Stop Bar: 48 ft
Railroad Control: □ Crossbucks
□ Lights/Ground
□ Lights/Truss

Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trvl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Clear Envelope</th>
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</table>

Glossary and Notes

Total counts = 24; Max # of veh. = 4; Max time to clear envelope = 8 sec

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Busses
Tractor Trvl = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev. 5/02
LA 30 (NICHOLSON DR) @ LA 327 SPUR (GARDERE LN) INTERSECTION SUMMARY

Northwestern:

\[
\text{Track Clearance time} = (4 + 2n) + \text{separation time}
\]

\[
n = \frac{L}{\text{avg vehicle length}} = 66 \text{ ft} / 19 \text{ ft} = 3 \text{ vehicles}
\]

\[
\text{separation time} = 4 \text{ sec}
\]

\[
\text{Track Clearance time} = 16 \text{ sec}
\]

Marshall/Berg:

\[
\text{Track Clearance time} = t(1) + t(2)
\]

\[
t(1) = L \cdot k(j) / s = 2.84
\]

(time until the last vehicle in the blocking queue departs)

\[
L = \text{Length of the queue to be cleared (66 FT)}
\]

\[
k(j) = \text{jam density (assumed to be 240)}
\]

\[
s = \text{saturation flow rate (assumed to be 1900)}
\]

\[
t(2) = \sqrt{2(L + 2 \cdot D + W) / a} = 7.27
\]

(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)

\[
L = \text{Length of the longest design vehicle expected at the intersection (assumed to be 30ft)} \quad \text{SUV}
\]

\[
D = \text{Clearance distance on either side of the tracks (assumed to be 15 ft)}
\]

\[
W = \text{Width between the outermost rails (assumed to be 8 ft)}
\]

\[
a = \text{Acceleration rate for the design vehicle (2.5ft/sec^2)} \quad \text{SUV}
\]

\[
\text{Track Clearance time} = 10.1 \text{ sec}
\]

Field Observation:

\[
\text{Total counts} = 24; \text{ Max # of veh.} = 4; \text{ Max time to clear envelope} = 8 \text{ sec}
\]
Number of field observations under 16: 24 (denoted as \(n\))
Number of field observations equal to 16: 0
Number of field observations over 16: 0 (denoted as \(n\))

Number of usable observations: 24 \((n) + n\))

**Step 1** The Set-Up:

a. Describe the population parameter of interest.

\[T\], vehicle median time to clear dynamic envelope

b. State the null hypothesis \((H_0)\) and the alternative hypothesis \((H_a)\).

\[H_0: T = 16\]
\[H_a: T \neq 16\]

**Step 2** The Hypothesis Test Criteria

a. Check the assumptions.

The 24 field observations were independently obtained and the variable envelope clearance time is continuous.

b. Identify the test statistic to be used.

The test statistic that will be used is the number of the less frequent sign: the smaller of \(n\) \((+)\) and \(n\) \((-)\), which is \(n\) \((+)\) for this research. The test statistic \(x^n = n\).

c. Determine the level of significance.

\[\alpha = 0.05\] for a two-tailed test.

**Step 3** The Sample Evidence

a. The sample information.

\(n = 24\); the observed value of the test statistic is \(x^n = n\) = 0.

b. The test statistic.

\(x^n = n\) = 0.

**Step 4** The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.

The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \(\alpha = 0.05\) column and the \(n = 24\) row or 6.

<table>
<thead>
<tr>
<th>Number of less frequent sign</th>
<th>Reject (H_0)</th>
<th>Fail to reject (H_0)</th>
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<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Determine whether or not the calculated test statistic is in the critical region.

\(x^n\) is in the critical region (see figure above).

**Step 5** The Results

a. State the decision about \(H_a\).

Reject \(H_0\).

b. State the conclusion about \(H_a\).

The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 16 sec.
Sign Test for the Assumption that the Median Time is Equal to the

Number of field observations under 10.1: 24 (denoted as \( n(-) \))
Number of field observations equal to 10.1: 0
Number of field observations over 10.1: 0 (denoted as \( n(+) \))

Number of usable observations: 24 (\( n(-) + n(+) \))

**Step 1** The Set-Up:

a. **Describe the population parameter of interest.**
   
   \( T \), vehicle median time to clear dynamic envelope

b. **State the null hypothesis \( (H₀) \) and the alternative hypothesis \( (Hₐ) \).**

   \[
   H₀: T = 10.1 \\
   Hₐ: T \neq 10.1
   \]

**Step 2** The Hypothesis Test Criteria

a. **Check the assumptions.**
   
   The 24 field observations were independently obtained and the variable envelope clearance time is continuous.

b. **Identify the test statistic to be used.**
   
   The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( x^* = n(+) \).

c. **Determine the level of significance.**
   
   \( \alpha = 0.05 \) for a two-tailed test.

**Step 3** The Sample Evidence

a. **The sample information.**
   
   \( n = 24 \), the observed value of the test statistic is \( x = n(+) = 0 \).

b. **The test statistic.**
   
   \( x^* = n(+) = 0 \).

**Step 4** The Probability Distribution using the Classical Procedure

a. **Determine the critical region and critical values.**
   
   The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the \( n = 24 \) row or 6.

   ![Reject \( H₀ \) Fail to reject \( Hₐ \)]

   Number of less frequent sign

0 6 7

b. **Determine whether or not the calculated test statistic is in the critical region.**
   
   \( x^* \) is in the critical region (see figure above).

**Step 5** The Results

a. **State the decision about \( Hₐ \).**
   
   Reject \( H₀ \).

b. **State the conclusion about \( Hₐ \).**
   
   The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 10.1 sec.
APPENDIX N: LA 3164 (SCENIC HIGHWAY) AT CHOCTAW DRIVE
INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

<table>
<thead>
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<th>General Information</th>
</tr>
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<tbody>
<tr>
<td>Analyst: DRK</td>
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<td>District: 61</td>
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</tr>
<tr>
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</tr>
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<td>Time: 7:00 AM</td>
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<td>Area Type: <em>urban</em></td>
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</tr>
<tr>
<td>St Name: SCENIC HWY</td>
</tr>
<tr>
<td>Railroad Ctrl: <em>X</em> Crossbucks</td>
</tr>
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<td><em>X</em> Gates</td>
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<table>
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<th>Input Field Measurement</th>
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<tbody>
<tr>
<td>Queue at start of Green</td>
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<td>Last Vehicle in Envelope</td>
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<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
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| Minimum | 1 | 1 | 1 | 1 | Yes | No | 1 | 2 |
| Average | 1 | 2 | 2 | 1 | Yes | No | 1 | 2 |

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<th>Glossary and Notes</th>
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<td>Dynamic Envelope    = Typically 18 ft for 90 deg crossing, 8 ft track width plus 6 ft clearance on either side.</td>
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<tr>
<td>Single Unit Vehicles = Delivery Trucks and Busses</td>
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<tr>
<td>Tractor Trlr        = Tractor Trailer Vehicles</td>
</tr>
<tr>
<td>Nth Vehicle         = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.</td>
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<tr>
<td>Time to Clear       = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.</td>
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LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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<tr>
<th>Analyst</th>
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Geometric Input

Route: LA 3164
St Name: SCENIC HWY

Railroad Co. ____________
Mainline _______ or Spur ______
Number of Tracks 1
Dynamic Envelope ______ ft
Distance Between Envelope and Stop Bar ______ ft
Railroad Control ______ Crossbars
______ Lights/Around
______ Lights/Twiss
______ Gates

Input Field Measurement

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Maximum
Minimum
Average

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
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Tractor Trlr = Tractor Trailer Vehicles
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Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

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| Area Type: rural, or _X_ urban |

Geometric Input

Route: LA 3164
St Name: SCENIC HWY

Railroad Co.,
Mainline _X_ or Spur __________
Number of Tracks: 1
Dynamic Envelope 16 ft
Distance Between Envelope and Stop Bar 17 ft
Railroad Control: _X_ Crossbucks
_X_ Lights/Truss
_X_ Lights/Truss
_X_ Gates

Input Field Measurement

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<th>Cycle</th>
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<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
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Maximum 2 6
Minimum 1 2
Average 2 5

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
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Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
# LaDOTD Traffic Operations and Engineering
## Field Observation Method
### Railroad Preemption Worksheet

### General Information
- **Analyst:** DRK
- **District:** 61
- **Parish:** EBR
- **TSC No.:** S-178
- **Date:** 7/7/2003
- **Time:** 7:00 AM
- **Area Type:** _X_ urban

### Geometric Input
- **Route:** LA 3164
- **St Name:** SCENIC HWY
- **Railroad Co.:**
- **Mainline _X_ or Spur _ _ **
- **Number of Tracks:** 1
- **Dynamic Envelope:** 16 ft
- **Distance Between Envelope and Stop Bar:** 17 ft
- **Railroad Control:** _X_ Crossbucks
- **_X_ Lights/Ground
- **_X_ Lights/Truss
- **_X_ Gates

### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Number of Passanger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
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| Total counts = 24; Max # of veh. = 2; Max time to clear envelope = 9 sec |

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 8 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trlr:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
Northwestern:

Track Clearance time = \((4 + 2n) + \text{separation time}\)

\(n = \frac{L}{\text{avg vehicle length}} = \frac{35\text{ ft}}{19\text{ ft}} = 2\) vehicles

separation time = 4 sec

\[\text{Track Clearance time} = 12\text{ sec}\]

Marshall/Berg:

\(t(1) = \frac{L \cdot k(j) \cdot 2.94 \cdot s}{2.5}\) = 1.5

(time until the last vehicle in the blocking queue departs)

\(L = \text{Length of the queue to be cleared (35 FT)}\)

\(k(j) = \text{jam density (assumed to be 240)}\)

\(s = \text{saturation flow rate (assumed to be 1900)}\)

\(t(2) = \text{square root} \left(2(L + 2D + W)/a\right) = 10.37\)

(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)

\(L = \text{Length of the longest design vehicle expected at the intersection (assumed to be 50 ft)}\)

\(D = \text{Clearance distance on either side of the tracks (assumed to be 15 ft)}\)

\(W = \text{Width between the outermost rails (assumed to be 8 ft)}\)

\(a = \text{Acceleration rate for the design vehicle (1.6 ft/sec}^2\))

\[\text{Track Clearance time} = 11.87\text{ sec}\]

Field Observation:

Total counts = 24; Max # of veh. = 2; Max time to clear envelope = 9 sec
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 12 sec.

Number of field observations under 12: 24 (denoted as \( n(-) \))
Number of field observations equal to 12: 0
Number of field observations over 12: 0 (denoted as \( n(+) \))

Number of usable observations: \( 24 + 0 = 24 \)

Step 1  The Set-Up:

a. Describe the population parameter of interest.
   \( T \), vehicle median time to clear dynamic envelope

b. State the null hypothesis (H0) and the alternative hypothesis (Ha).
   \[
   H_0 : T = 12
   \
   H_a : T \neq 12
   \]

Step 2  The Hypothesis Test Criteria

a. Check the assumptions.
   The 24 field observations were independently obtained and the variable envelope clearance time is continuous.

b. Identify the test statistic to be used.
   The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( x^* = n(+) \).

c. Determine the level of significance.
   \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence

a. The sample information.
   \( n = 24 \); the observed value of the test statistic is \( x = n(+) = 0 \).

b. The test statistic.
   \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.
   The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \( x = 0.05 \) column and the \( n = 24 \) row or 6.

b. Determine whether or not the calculated test statistic is in the critical region.
   \( x^* \) is in the critical region (see figure above)

Step 5  The Results

a. State the decision about \( H_a \).
   Reject \( H_a \).

b. State the conclusion about \( H_a \).
   The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 12 sec.
LA 3164 (SCENIC HWY) @ CHOCTAW BR

Sign Test for the Assumption that the Median Time is Equal to the

Number of field observations under 11.87: 24 (denoted as \(n(-)\))
Number of field observations equal to 11.87: 0
Number of field observations over 11.87: 0 (denoted as \(n(+)\))

Number of usable observations: 24 \(n(-) + n(+)\)

**Step 1** The Setup:

a. Describe the population parameter of interest.
   \(T\), vehicle median time to clear dynamic envelope

b. State the null hypothesis \((H_0)\) and the alternative hypothesis \((H_a)\).
   
   \[
   H_0: T = 11.87 \\
   H_a: T \neq 11.87
   \]

**Step 2** The Hypothesis Test Criteria

a. Check the assumptions.
The 24 field observations were independently obtained and the variable
duration clearance time is continuous.

b. Identify the test statistic to be used.
The test statistic that will be used is the number of the less frequent sign:
the smaller of \(n(+)\) and \(n(-)\), which is \(n(+)\) for this research. The test
statistic is \(x^* = n(+)\).

c. Determine the level of significance.
   \(\alpha = 0.05\) for a two-tailed test.

**Step 3** The Sample Evidence

a. The sample information.
   \(n = 24\), the observed value of the test statistic is \(x = n(+) = 0\).

b. The test statistic.
   \(x^* = n(+) = 0\).

**Step 4** The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.
The critical value is located in the table of critical values of the sign test.
The critical value is located at the intersection of the \(n = 24\) row and the \(x^*\) 0.05 column.

\[\text{Reject } H_0 \quad \text{Fail to reject } H_0\]

Number of less frequent sign

0 \(\leq\) 6 \(\leq\) 7

b. Determine whether or not the calculated test statistic is in the critical region.
\(x^* = 0\) is in the critical region (see figure above).

**Step 5** The Results

a. State the decision about \(H_a\).
   Reject \(H_0\).

b. State the conclusion about \(H_a\).
The sample shows sufficient evidence at the 0.05 level to conclude that the
median dynamic envelope clearance time is not equal to 11.87 sec.
APPENDIX O: LA 427 (PERKINS ROAD) AT CONGRESS BOULEVARD INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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<th>Analyst</th>
<th>District</th>
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Area Type: ___ rural, or _X__ urban

Geometric Input

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<th>St Name: CONGRESS BLVD</th>
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Railroad Co. _X__ or Spur
Mainline _X__ or Spur
Number of Tracks 1
Dynamic Envelope ___18___ ft
Distance Between Envelope ___36___ ft
Railroad Control _X__ Crossbucks
_ X__ Lights/Ground
_ X__ Lights/Truss

Dynamic Envelope Distance Between Envelope and Stop Bar

Input Field Measurement

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<th>Number of Passenger Vehicles</th>
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Maximum 3 8
Minimum 2 3
Average 2 6

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trlr = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
### General Information
- **Analyst**: DRK
- **Date**: 7/16/2003
- **Time**: 4:00 PM
- **Parish**: EBR
- **TII No.**: 310
- **Area Type**: _X_ urban

### Geometric Input
- **Route**: CONGRESS BRELY
- **Railroad Co.**: _X_ or Spur
- **Mainline**: _X_ or Spur
- **Number of Tracks**: 1
- **Dynamic Envelope**: 18 ft
- **Distance Between Envelope and Stop Bar**: 36 ft
- **Railroad Crossing**: X Lights/Go
- **X Lights/Truss
- **X Other**

### Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trailer Vehicles</th>
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<th>Time to Clear Envelope</th>
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### Glossary and Notes
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Busses
- **Tractor Trailer**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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<th>Analyst</th>
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Geometric Input

Route: CONGRESS BLVD

Railroad Co. ___ Mainline, ___ Spur

Number of Tracks: ___

Dynamic Envelope: ___ ft

Distance Between Envelope and Stop Bar: ___ ft

Railroad Control: ___ Crossbucks

___ Lights/Trees

___ Gates

Input Field Measurement

<table>
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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
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Maximum: 3
Minimum: 2
Average: 3

Glossary and Notes

Total counts = 28; Max # of veh. = 3; Max time to clear envelope = 8 sec

Dynamic Envelope = Typically 18 ft for 90 deg crossing; 8 ft back width plus 6 ft clearance on either side.

Single Unit Vehicles = Delivery Trucks and Busses

Tractor Trlr = Tractor Trailer Vehicles

Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.

Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LA 427 (PERKINS RD) @ CONGRESS BLVD INTERSECTION SUMMARY

Northwestern:
Track Clearance time = \((4 + 2n) + \text{separation time}\)
n = L / \text{avg vehicle length} = 54 \text{ ft} / 19\text{ft} \approx 3 \text{ vehicles}
separation time = 4\text{sec}

Track Clearance time = 14 \text{sec}

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L'k(j)}{2.94's} = 2.32 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (54FT)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1300)

\[ t(2) = \sqrt{2(L + 2'D + W)/a} = 5 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 13Ft) PV
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (4.4ft/sec\(^2\)) PV

Track Clearance time = 7.32 \text{sec}

Field Observation:
Total counts = 28; Max # of veh. = 3; Max time to clear envelope = 8 sec
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 28 (denoted as $n(-)$)
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as $n(+)$(

Number of usable observations: 28 ($n(-) + n(+)$(

**Step 1** The Set-Up:

a. **Describe the population parameter of interest.**
   
   $T$, vehicle median time to clear dynamic envelope

b. **State the null hypothesis ($H_0$) and the alternative hypothesis ($H_a$).**
   
   $H_0: T = 14$
   $H_a: T \neq 14$

**Step 2** The Hypothesis Test Criteria

a. **Check the assumptions.**
   
   The 28 field observations were independently obtained and the variable envelope clearance time is continuous.

b. **Identify the test statistic to be used.**
   
   The test statistic that will be used is the number of the less frequent sign: the smaller of $n(+) and n(-)$, which is $n(-)$ for this research. The test statistic is $x^* = n(-)$.

c. **Determine the level of significance.**
   
   $\alpha = 0.05$ for a two-tailed test.

**Step 3** The Sample Evidence

a. **The sample information.**
   
   $n = 28$, the observed value of the test statistic is $x = n(+) = 0$.

b. **The test statistic.**
   
   $x^* = n(+) = 0$.

**Step 4** The Probability Distribution using the Classical Procedure

a. **Determine the critical region and critical values.**
   
   The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the $X = 0.05$ column and the $n = 28$ row or 8.

   - Reject $H_a$
   - Fail to reject $H_a$

   Number of less frequent sign

0 8 9

b. **Determine whether or not the calculated test statistic is in the critical region.**
   
   $x^*$ is in the critical region (see figure above).

**Step 5** The Results

a. **State the decision about $H_a$.**
   
   Reject $H_a$.

b. **State the conclusion about $H_a$.**
   
   The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 14 sec.
Number of field observations under 7.32: 27 (denoted as n(-))
Number of field observations equal to 7.32: 0
Number of field observations over 7.32: 1 (denoted as n(+) )

Number of usable observations: 28 (n(-) + n(+) )

Step 1 The Setup:
   a. Describe the population parameter of interest.
      \[ T \text{, vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis (H0) and the alternative hypothesis (Ha).
      \[
      H_0: T = 7.32 \\
      H_1: T \neq 7.32
      \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of n (+) and n (-), which is n (+) for this research. The test statistic \( x^* = n(+) \).
   c. Determine the level of significance.
      \[ x = 0.05 \text{ for a two-tailed test} \]

Step 3 The Sample Evidence
   a. The sample information.
      \[ n = 28; \text{the observed value of the test statistic is } x = n(+) = 1. \]
   b. The test statistic.
      \[ x^* = n(+) = 1. \]

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the \( n = 28 \) row or 8.
      \[
      \begin{array}{c|c}
      \text{Reject } H_0 & \text{Fail to reject } H_0 \\
      \hline
      0 & 8 \text{ or 9} \\
      \end{array}
      \]
      Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above).

Step 5 The Results
   a. State the decision about \( H_0 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_0 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 7.32 sec.
APPENDIX P: LA 67 (PLANK ROAD) AT CHOCTAW DRIVE
INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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<th>Analyst</th>
<th>District</th>
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Area Type: ___ rural, or ☑ urban

Geometric Input

Route: LA 67
St Name: PLANK RD

Railroad Co.
Mainline ☑ or Spur ___
Number of Tracks 1
Dynamic Envelope 18 ft
Distance Between Envelope and Stop Bar 21 ft
Railroad Control ___ Crossbucks
___ Lights/Ground
___ Lights/Gates

Input Field Measurement

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<th>Last Vehicle in Envelope</th>
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Maximum 1 8
Minimum 1 5
Average 1 6

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Busses
Tractor Trlr = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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Geometric Input

Route: LA 67
St Name: PLANK RD

Railroad Co.
Mainline: X. or Spur __________
Number of Tracks 1

Dynamic Envelope: ______________ ft
Distance between Envelope and Stop Bar: __________ ft
Railroad Control: X. Crossbars
X. Lights/Ground
X. Lights/Truss
X. Gates

Distance between Envelope and Stop Bar

Input Field Measurement

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<th>Number of Passenger Vehicles</th>
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Maximum: 1
Minimum: 1
Average: 1

Glossary and Notes

Dynamic Envelope: Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles: Delivery Trucks and Buses
Tractor Trlr: Tractor Trailer Vehicles
Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information
Analyst: DRK
District: 61
Parish: EBR
T51 No.: 00087
Date: 8/13/2003
Time: 4:30 PM
Area Type: ___ rural, or ___ urban

Geometric Input
Route: LA 67
St Name: PLANK RD
Railroad Co.
Mainline X or Spur
Number of Tracks 1
Dynamic Envelope 18 ft
Distance Between Envelope and Stop Bar 21 ft
Railroad Control ___ Crossbuck
X Lights/Ground
X Lights/Truss
___ Gates

Input Field Measurement

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<th>Cycle</th>
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<th>Number of Single Unit Vehicles</th>
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Glossary and Notes
Total counts = 27; Max # of veh. = 2; Max time to clear envelope = 9 sec
Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Tril = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LA 67 (PLANK RD) @ CHOCTAW DR INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 39 ft / 19 ft = 2 vehicles
separation time = 4 sec

Track Clearance time = 12 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L \cdot k(t)}{2.94} \cdot s = 1.68 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (39 ft)
k(t) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2D + W)} = 7.27 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 30 ft)
D = Clearance distance on either side of the tracks (assumed to be 18 ft)
W = Width between the outermost rails (assumed to be 6 ft)
e = Acceleration rate for the design vehicle (2.5 ft/sec²)

Track Clearance time = 8.94 sec

Field Observation:
Total counts = 27; Max # of veh. = 2; Max time to clear envelope = 9 sec
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 12 sec.

Number of field observations under 12: 27 (denoted as n(-))
Number of field observations equal to 12: 0
Number of field observations over 12: 0 (denoted as n(+))

Number of usable observations: 27 (n(-) + n(+))

Step 1  The Setup:
   a. Describe the population parameter of interest.
      \[ T, \text{ vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis (H₀) and the alternative hypothesis (Hₐ).
      \[
      H₀: T = 12 \\
      Hₐ: T \neq 12
      \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 27 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(+) and n(-), which is n(+) for this research. The test
      statistic is \[ X^* = n(+) \).
   c. Determine the level of significance.
      \[ \alpha = 0.05 \text{ for a two-tailed test} \]

Step 3  The Sample Evidence
   a. The sample information.
      \[ n = 27, \text{ the observed value of the test statistic is } X = n(+) = 0. \]
   b. The test statistic.
      \[ X^* = n(+) = 0. \]

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \[ 0 \leq 0.05 \] column
      and the \[ n = 27 \] row or 7.

      \[ \begin{array}{cc}
      \text{Reject } Hₐ & \text{Fail to reject } Hₐ \\
      0 & 7 \ 8
      \end{array} \]

      Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \[ X^* \text{ is in the critical region (see figure above)} \]

Step 5  The Results
   a. State the decision about \[ Hₐ \]
      Reject \[ Hₐ \].
   b. State the conclusion about \[ Hₐ \]
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 12 sec.
Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 8.94 sec.

Number of field observations under 8.94: 26 (denoted as n(−))
Number of field observations equal to 8.94: 0
Number of field observations over 8.94: 1 (denoted as n(+) )

Number of usable observations: 27 (n(−) + n(+))

Step 1 The Setup:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[ H_0 : T = 8.94 \]
      \[ H_a : T \neq 8.94 \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 27 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of n (+) and n (−), which is n (+) for this research. The test statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 27 \), the observed value of the test statistic is \( x = n(+) = 1 \).
   b. The test statistic.
      \( x^* = n(+) = 1 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the n = 27 row or 7.
      \begin{tabular}{|c|c|}
        \hline
        \textbf{Reject } & \textbf{Fail to reject } \textbf{H}_0 \\
        \hline
        0 & 7 \ 8 \\
        \hline
      \end{tabular}

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_a \).
      \textbf{Reject } \textbf{H}_a
   b. State the conclusion about \( H_a \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 8.94 sec.
### General Information

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### Geometric Input

- **Route:** StName: LOBDELL BLVD
- **Railroad Co.** Mainline or Spur
- **Number of Tracks:** 1
- **Dynamic Envelope:** Distance Between Envelope and Stop Bar: 40 ft
- **Railroad Control:** Crossbucks
- **Lights/Ground:** Lights/Truss
- **Gates:**

### Input Field Measurement

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<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
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### Glossary and Notes

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Busses
- **Tractor Trlr:** Tractor Trailer Vehicles
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LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

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Maximum: 1 5
Minimum: 1 4
Average: 1 5

Glossary and Notes

- Dynamic Envelope: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
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LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
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Geometric Input

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<td>X Lights/Truss</td>
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<tr>
<td>and Stop Bar</td>
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Input Field Measurement

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<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
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Maximum: 6
Minimum: 1
Average: 4

Glossary and Notes

Total counts = 25; Max # of veh. = 1; Max time to clear envelope = 10 sec

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.

Single Unit Vehicles = Delivery Trucks and Buses

Tractor Trl = Tractor Trailer Vehicles

Nth Vehicle = The last vehicle that stops for the signal and is in or just before the Dynamic Envelope.

Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
S CHOCTAW DR @ LOBDELL BLVD INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 58ft / 19ft = 3 vehicles
separation time = 4sec

Track Clearance time = 14 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = L \cdot k(j) \cdot 2.34 \cdot s = 2.49 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (58ft)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \text{square root} \left( 2L + 2D + W \right) \cdot a = 10.37 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 50ft)
D = Clearance distance on either side of the tracks (assumed to be 18 ft)
W = Width between the outer most rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (1.6ft/sec^2)

Track Clearance time = 12.86 sec

Field Observation:
Total counts = 25; Max # of veh. = 1; Max time to clear envelope = 10 sec
Number of field observations under 14: 25 (denoted as n(−))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 25 (n(−) + n(+))

Step 1 The Setup:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[
      H_0 : T = 14 \\
      H_a : T \neq 14
      \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 25 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(−) \), which is \( n(+) \) for this research. The test statistic \( x^2 = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 25 \), the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^2 = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column and the \( n = 25 \) row or 7.
      \[
      \text{Reject } H_a \quad \quad \text{Fail to reject } H_a
      \]
      \[
      0 \quad \quad 7 \quad \quad 8
      \]
      Number of less frequent sign
   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^2 \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_a \) Reject \( H_a \)
   b. State the conclusion about \( H_a \)
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 14 sec.
Number of field observations under 12.86: 25 (denoted as n(-))
Number of field observations equal to 12.86: 0
Number of field observations over 12.86: 0 (denoted as n(+) )

Number of usable observations: 25 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H0) and the alternative hypothesis (H1).
      \[ H_0 : T = 12.86 \]
      \[ H_1 : T \neq 12.86 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 25 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n (+) and n (-), which is n (+) for this research. The test
      statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \( n = 25 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( x^* \) 0.05 column
      and the \( n = 25 \) row or 7.

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<tr>
<th>Reject ( H_0 )</th>
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</table>

   Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above).

Step 5  The Results
   a. State the decision about \( H_0 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_1 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 12.86 sec.
## APPENDIX R: SOUTH CHOCTAW DRIVE AT MONTERREY DRIVE
### INTERSECTION DATA SHEETS

## LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
### FIELD OBSERVATION METHOD
### RAILROAD PREEPTION WORKSHEET

### General Information
- **Analyst**: DRK
- **District**: 61
- **Parish**: EBR
- **TSI No.**: C-0019
- **Date**: 7/18/2003
- **Time**: 7:00 AM
- **Area Type**: __rural, or ___ urban

### Geometric Input
- **Route**: MONTERREY DR
- **Railroad Co.**
- **Mainline**: X or Spur
- **Number of Tracks**: 1
- **Dynamic Envelope**: 18 ft
- **Distance Between Envelope and Stop Bar**: 33 ft
- **Railroad Control**: X Crossbucks
- **Lights/Ground**: X Lights/Tunnels
- **Gates**: X Gates

### Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in Nth Vehicle envelope?</th>
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| Maximum | 5                         | 5                            | 5                            | 5                            | Yes                                         | No          | 2                      | 6                     |
| Minimum | 1                         | 1                            | 1                            | 1                            | Yes                                         | No          | 2                      | 4                     |
| Average | 2.5                       | 5                            | 5                            | 5                            | Yes                                         | No          | 2                      | 5                     |

### Glossary and Notes
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Busses
- **Tractor Trlr**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
### General Information

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Date: 7/19/2003
Time: 7:00 AM

Area Type: _rural, or _urban_

### Geometric Input

- Route: MONTERREY DR
- Railroad Co.: _
- Marine: _
- X_ et Spur
- Number of Tracks: 1
- Dynamic Envelope: 18 ft
- Distance Between Envelope and Stop Bar: 33 ft
- Railroad Control: _
- X_ Crossbuck
- X_Lights/Ground
- X_Lights/Truss
- X_Gates

### Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
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### Glossary and Notes

- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Busses
- **Tractor Trlr**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

Rev 5/02
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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<th>Analyst</th>
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Geometric Input

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<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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Glossary and Notes

Total counts = 31; Max # of veh. = 3; Max time to clear envelope = 7 sec

Dynamic Envelope = Typically 18 ft for 90 deg crossing; 6 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Busses
Tractor Trl Vehicles = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
Northwestern:

\[ \text{Track Clearance time} = (4+2n) + \text{separation time} \]
\[ n = \frac{L}{\text{avg vehicle length}} = \frac{31 \text{ ft}}{19 \text{ ft}} = 3 \text{ vehicles} \]
\[ \text{separation time} = 4 \text{ sec} \]

\[ \text{Track Clearance time} = 14 \text{ sec} \]

Marshall/Berg:

\[ \text{Track Clearance time} = t(1) + t(2) \]
\[ t(1) = L \cdot k(j) / 2.94 \cdot s = 2.19 \]
(\text{time until the last vehicle in the blocking queue departs})
\[ L = \text{Length of the queue to be cleared (51 FT)} \]
\[ k(j) = \text{jam density (assumed to be 240)} \]
\[ s = \text{saturation flowrate (assumed to be 1900)} \]
\[ t(2) = \text{square root} \left( 2 \left( L + 2 \cdot D + W \right) / a \right) = 5 \]
(\text{time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection})
\[ L = \text{Length of the longest design vehicle expected at the intersection (assumed to be 19ft)} \]
\[ PV = \text{PV} \]
\[ D = \text{Clearance distance on either side of the tracks (assumed to be 15 ft)} \]
\[ W = \text{Width between the outermost rails (assumed to be 6 ft)} \]
\[ a = \text{Acceleration rate for the design vehicle (4.4ft/sec}^2 \text{)} \]

\[ \text{Track Clearance time} = 7.19 \text{ sec} \]

Field Observation:

\[ \text{Total counts} = 31; \text{ Max # of veh.} = 3; \text{ Max time to clear envelope} = 7 \text{ sec} \]
SCHOCTAW DR @ MONTERREY DR

Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 31 (denoted as n(−))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 31 (n(−) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H0) and the alternative hypothesis (Hα).
      \[ H_0 : T = 14 \]
      \[ H_α : T ≠ 14 \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 31 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(−) and n(+), which is n(−) for this research. The test
      statistic = \( x^* = n(−) \).
   c. Determine the level of significance.
      \[ \alpha = 0.05 \text{ for a two-tailed test} \]

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 31 \text{, the observed value of the test statistic is } x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the
      sign test. The critical value is located at the intersection of the
      \( n = 31 \) row and the \( 0.05 \) column.
      \[ \begin{array}{c|c|c}
          \text{Number of less frequent sign} & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
          \hline
          0 & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
          1 & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
          2 & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
          \ldots \\
          9 & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
          10 & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
        \end{array} \]
   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_0 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_α \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 14 sec.
Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 7.19 sec.

Number of field observations under 7.19: 31 (denoted as \(n(-)\))
Number of field observations equal to 7.19: 0
Number of field observations over 7.19: 0 (denoted as \(n(+)\))

Number of usable observations: 31 (\(n(-) + n(+)\))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \(T\), vehicle median time to clear dynamic envelope
   b. State the null hypothesis \((H_0)\) and the alternative hypothesis \((H_a)\).
      \[
      H_0: T = 7.19 \\
      H_a: T \neq 7.19
      \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 31 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of \(n(+)\) and \(n(-)\), which is \(n(+)\) for this research. The test statistic is \(x^* = n(+)\).
   c. Determine the level of significance.
      \[\alpha = 0.05\] for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \(n = 31\); the observed value of the test statistic is \(x^* = n(+) = 0\).
   b. The test statistic.
      \[x^* = n(+) = 0\]

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \(\alpha = 0.05\) column and the \(n = 31\) row or 9.

   b. Determine whether or not the calculated test statistic is in the critical region.
      \(x^*\) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \(H_0\).
      \[\text{Reject } H_0\]
   b. State the conclusion about \(H_0\).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 7.19 sec.
### APPENDIX S: SOUTH CHOCTAW DRIVE AT NORTH SHERWOOD FOREST BOULEVARD INTERSECTION DATA SHEETS

#### LaDOTD TRAFFIC OPERATIONS AND ENGINEERING FIELD OBSERVATION METHOD RAILROAD PREEMPTION WORKSHEET

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#### Geometric Input

- **St Name:** N SHERWOOD FOREST BLVD
- **Railroad Co.**
- **Main Line:** _X_ or Spur
- **Number of Tracks:** 2
- **Dynamic Envelope:** 36 ft
- **Distance Between Envelope and Stb Bar:** 28 ft
- **Railroad Control:** _X_ Crossbucks
- **_X_ Lights/Ground
- **_X_ Lights/Triax
- **_X_ 9 Fates

#### Input Field Measurement

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- **Maximum:**
- **Minimum:**
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#### Glossary and Notes

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trl:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

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*rev 5/02*
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

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Geometric Input

- House: St Name: N SHERWOOD FOREST BLVD
- Railroad Cn. ________________
- Mainline _X_ or Spur ________
- Number of Tracks 2
- Dynamic Envelope 36 ft
- Distance Between Envelope and Stop Bar 26 ft
- Railroad Control _X_ Crossing
  _X_ Lights/Ground
  _X_ Lights/Truss
  _X_ Gates
- Route St Name ________________
- 5 CHOCTAW DR

Input Field Measurement

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Maximum:                         7
Minimum:                         1
Average:                        3

Glossary and Notes

- Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
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- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
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# LaDOTD Traffic Operations and Engineering

**Field Observation Method**

**Railroad Preemption Worksheet**

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## Geometric Input

- House: SHERWOOD
- Forest Blvd
- Railroad Co.: _________
- Mainline or Spur: X
- Number of Tracks: 2

## Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
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<td></td>
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<td>No</td>
<td>2</td>
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</tbody>
</table>

| Maximum |                          |                             |                               |                               | Yes                             | No           | 2                     |
| Minimum |                          |                             |                               |                               | Yes                             | No           | 1                     |
| Average |                          |                             |                               |                               | Yes                             | No           | 2                     |

**Glossary and Notes**

- Total counts = 29; Max # of veh = 2; Max time to clear envelope = 8 sec
- Dynamic Envelope = Typically 18 ft for 60 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Busses
- Tractor Trl = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

_revised 9/02_
**Schoctaw Dr @ N Sherwood Forest Blvd Intersection Summary**

**Northwestern:**
Track Clearance time = \((4 + 2n) + \text{separation time}\)

\(n = L / \text{avg vehicle length} = 64 \text{ ft} / 19\text{ ft} = 3 \text{ vehicles}\)

\(\text{separation time} = 4\text{ sec}\)

Track Clearance time = 14 sec

**Marshall/Berg:**
Track Clearance time = \(t(1) + t(2)\)

\(t(1) = \frac{L \cdot k(j)}{2.94 \cdot s} = 2.75\)
(time until the last vehicle in the blocking queue departs)

\(L = \text{Length of the queue to be cleared} \ (64 \text{ FT})\)

\(k(j) = \text{jam density} \ (\text{assumed to be 240})\)

\(s = \text{saturation flowrate} \ (\text{assumed to be 1900})\)

\(t(2) = \sqrt{2(L + 2D + W/a)} = 7.27\)
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)

\(L = \text{Length of the longest design vehicle expected at the intersection} \ (\text{assumed to be 30 ft})\)

\(D = \text{Clearance distance on either side of the tracks} \ (\text{assumed to be 15 ft})\)

\(W = \text{Width between the outermost rails} \ (\text{assumed to be 6 ft})\)

\(a = \text{Acceleration rate for the design vehicle} \ (2.5 \text{ ft/sec}^2)\)

Track Clearance time = 10.02 sec

**Field Observation:**
Total counts = 29; Max # of veh. = 2; Max time to clear envelope = 8 sec
Number of field observations under 14: 29 (denoted as n(-))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+) )

Number of usable observations: 29 (n(-) + n(+))

Step 1  The Set-up:
  a. Describe the population parameter of interest.
     $T$, vehicle median time to clear dynamic envelope
  b. State the null hypothesis ($H_0$) and the alternative hypothesis ($H_a$).
     \[
     H_0: T = 14 \\
     H_a: T \neq 14
     \]

Step 2  The Hypothesis Test Criteria
  a. Check the assumptions.
     The 29 field observations were independently obtained and the variable
     envelope clearance time is continuous.
  b. Identify the test statistic to be used.
     The test statistic that will be used is the number of the less frequent sign:
     the smaller of n (+) and n (-), which is n (+) for this research. The test
     statistic $x^* = n(+)$.  
  c. Determine the level of significance.
     $\alpha = 0.05$ for a two-tailed test.

Step 3  The Sample Evidence
  a. The sample information.
     n = 29; the observed value of the test statistic is $x = n(+) = 0$.
  b. The test statistic.
     $x^* = n(+) = 0$.

Step 4  The Probability Distribution using the Classical Procedure
  a. Determine the critical region and critical values.
     The critical value is located in the table of critical values of the sign test.
     The critical value is located at the intersection of the $n = 29$ row or 8.

     ![Table with critical values]

     Number of less frequent sign

  b. Determine whether or not the calculated test statistic is in the critical region.
     $x^*$ is in the critical region (see figure above)

Step 5  The Results
  a. State the decision about $H_a$.
     Reject $H_0$.
  b. State the conclusion about $H_a$.
     The sample shows sufficient evidence at the 0.05 level to conclude that the
     median dynamic envelope clearance time is not equal to 14 sec.
Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 10.02 sec.

Number of field observations under 10.02: 29 (denoted as n(-))
Number of field observations equal to 10.02: 0
Number of field observations over 10.02: 0 (denoted as n(+))

Number of usable observations: 29 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[ H_0 : T = 10.02 \]
      \[ H_+ : T \neq 10.02 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 29 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test
      statistic = \( x^+ = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \( n = 29 \), the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^+ = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the \( n = 29 \) row or 8.
      \[ \begin{array}{c|c}
          \text{Number of less frequent sign} & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
          \hline
          0 & \text{Reject } H_0 & \text{Fail to reject } H_0 \\
          8 & \text{Fail to reject } H_0 & \text{Reject } H_0 \\
          9 & \text{Reject } H_0 & \text{Fail to reject } H_0 
        \end{array} \]
   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^+ \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( H_+ \).
      \( \text{Reject } H_0 \).
   b. State the conclusion about \( H_+ \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 10.02 sec.
# APPENDIX T: SOUTH CHOCTAW DRIVE AT OAK VILLA BOULEVARD INTERSECTION DATA SHEETS

## General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>DRK</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
<td>81</td>
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<tr>
<td>Parish</td>
<td>EBR</td>
</tr>
<tr>
<td>TSI No.</td>
<td>C-202</td>
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</tbody>
</table>

### Geometric Input

- **Route:** OAK VILLA BLVD
- **St Name:** OAK VILLA BLVD
- **Location:** 30° 48' 15" N 90° 02' 20" W
- **Road:** South Choctaw Dr
- **Railroad:** 30° 48' 15" N 90° 02' 20" W
- **Railroad Co.:**
- **Mainline:** X
- **Number of Tracks:** 1
- **Dynamic Envelope:** 10 ft
- **Distance Between Envelope and Stop Bar:** 31 ft
- **Railroad Control:** X

## Input Field Measurements

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</thead>
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**Maximum:** 2 (su) 8
**Minimum:** 2 5
**Average:** 2 6

## Glossary and Notes

- **Dynamic Envelope:** Typically 13 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trlr:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information
Analyst: DRK
District: 61
Parish: EBR
TSI No.: C-202
Date: 7/17/2003
Time: 7:30 AM
Area Type: __ rural, or __ urban

Geometric Input
Route: St Name: OAK VILLA BLVD
Railroad Co.: __ Mainline, __ Spur

Number of Tracks: 1
Distance Between Envelope:
Railroad Control: __ Crossbooks, __ Lights/Ground, __ Gates

Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trk Vehicles</th>
<th>Is a Vehicle stopped in Env?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</tr>
</tbody>
</table>

Maximum: 9, 5, 7
Minimum: 2
Average: 4, 4

Glossary and Notes
Total counts = 25; Max # of veh. = 3; Max time to clear envelope = 8 sec

- Dynamic Envelope = Typically 18 ft for 60 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
- Tractor Trk Vehicles = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
S CHOTA WB @ OAK VILLA BLVD INTERSECTION SUMMARY

Northwestern:

Track Clearance time = (4 - 2n) + separation time
n = L / avg vehicle length = 49 ft / 19 ft = 3 vehicles
separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:

Preemption time = t(1) + t(2)

t(1) = L'k(j)2.94's = 2.11
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (49 FT)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(1) = \sqrt{2L'k(j)2.94's} = 10.37 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 50 ft)
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (1.8 ft/sec²)

Track Clearance time = 12.47 sec

Field Observation:

Total counts = 25; Max # of veh. = 3; Max time to clear envelope = 8 sec
Number of field observations under 14: 25 (denoted as n(−))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+) 

Number of usable observations: 25 (n(−) + n(+))

Step 1 The Set-Up:

a. Describe the population parameter of interest.
   \[ H_0: T = 14 \]
   \[ H_a: T \neq 14 \]

b. State the null hypothesis (H₀) and the alternative hypothesis (H₁).

Step 2 The Hypothesis Test Criteria

a. Check the assumptions.
   The 25 field observations were independently obtained and the variable
   envelope clearance time is continuous.

b. Identify the test statistic to be used.
   The test statistic that will be used is the number of the less frequent sign
   the smaller of n(+) and n(−), which is n(+) for this research. The test
   statistic = \[ x^* = n(+) \]

c. Determine the level of significance.
   \[ \alpha = 0.05 \] for a two-tailed test.

Step 3 The Sample Evidence

a. The sample information.
   \[ n = 25 \]; the observed value of the test statistic is \[ x = n(+) = 0 \].

b. The test statistic.
   \[ x^* = n(+) = 0 \].

Step 4 The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.
   The critical value is located in the table of critical values of the sign test.
   The critical value is located at the intersection of the \[ n = 25 \] column
   and the \[ \alpha = 0.05 \] column row 7.

   \[ \begin{array}{c|c}
   \text{Number of less frequent sign} & 0 & 7 \ \\
   \hline 
   \text{Reject } H_a & \text{Fail to reject } H_a \\
   \end{array} \]

b. Determine whether or not the calculated test statistic is in the critical region.
   \[ x^* \] is in the critical region (see figure above)

Step 5 The Results

a. State the decision about \[ H_a \]
   Reject \[ H_0 \].

b. State the conclusion about \[ H_a \]
   The sample shows sufficient evidence at the 0.05 level to conclude that the
   median dynamic envelope clearance time is not equal to 14 sec.
Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 12.47 sec.

Number of field observations under 12.47: 25 (denoted as n(-))
Number of field observations equal to 12.47: 0
Number of field observations over 12.47: 0 (denoted as n(+))

Number of usable observations: 25 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H0) and the alternative hypothesis (H1).

\[ H_0: T = 12.47 \]
\[ H_1: T \neq 12.47 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 25 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test
      statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \( n = 25 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the \( n = 25 \) row or 7.

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( H_0 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_1 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 12.47 sec.
# APPENDIX U: SOUTH CHOCTAW DRIVE AT WOODDALE BOULEVARD INTERSECTION DATA SHEETS

## LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

### General Information
- **Analyst:** DRK
- **District:** 61
- **Parish:** EBR
- **TSI No.:** 0022
- **Date:** 7/1/2003
- **Time:** 7:10 AM
- **Area Type:** _rural_ or _urban_

### Geometric Input
- **Route:** WOODDALE BLVD
- **Railroad Co.:** Mainline _X_ Spur _X_
- **Number of Tracks:** 1
- **Distance Between Envelope and Stop Bar:** 30 ft
- **Railroad Control:** Crossbuck _X_, Lights/Ground _X_, Lights/Truss _X_, Gates _X_

### Input Field Measurement

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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Queue at start of Green</th>
<th>Last Vehicle in Envelope</th>
<th>N'th Vehicle stopped in envelope?</th>
<th>Time to Clear Envelope</th>
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</thead>
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</table>

### Glossary and Notes
- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Busses
- **Tractor Trlr:** Tractor Trailer Vehicles
- **N'th Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of N'th Vehicle clears Dynamic Envelope.

*rev 5/02*
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>D.R.K.</th>
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<tr>
<td>District</td>
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<td>EBR</td>
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<td>TSI No.</td>
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| Date     | 7/14/2003 |
| Time     | 7:19 AM   |

Area Type: __rural, or __urban

Geometric Input

Route: StName: WOODDALE BLVD

Railroad Co.: x___ or Spur

Multiplier: x___

Number of Tracks: 1

Dynamic Envelope: 18 ft

Distance Between Envelope and Stop Bar: 30 ft

Railroad Control: X___ Crossbars

Lights/Ground

X___ Nth Vehicle

X___ Gates

Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Tril Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</table>

Maximum: 5
Minimum: 2
Average: 3

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.

Single Unit Vehicles = Delivery Trucks and Busses

Tractor Tril = Tractor Trailer Vehicles

Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.

Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
**General Information**

- Analyst: DRK
- District: 61
- Parish: EBR
- TSI No.: C-00022
- Date: 7/14/2003
- Time: 7:10 AM
- Area Type: □ rural, □ urban

**Geometric Input**

- Route:
  - St Name: WOODDALE BLVD
- Railroad Co.:
  - Mainline: □ Mainline, □ Spur
- Number of Tracks: 1
- Dynamic Envelope: □ 18 ft
- Distance Between Envelope and Stop Bar: □ 30 ft
- Railroad Control: □ X Crossbows
- Envelope and Stop Bar: □ X Lights/Thru
- Route:
  - St Name: SCHCCTAW DR
  - □ X Gates

**Input Field Measurement**

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<tr>
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<th>Total Number of Vehicles</th>
<th>Queue at start of Green</th>
<th>Number of Single Unit Vehicles</th>
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**Glossary and Notes**

- **Total counts = 26; Max # of veh. = 3; Max time to clear envelope = 8 sec**
- Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
- Tractor Trir = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

Rev 502
SCHOCTAW BR @ WOODDALE BLVD INTERSECTION SUMMARY

Northwestern:

Track Clearance time = \((4 + 2n) + \text{separation time}\)

\(n = \frac{L}{\text{avg vehicle length}} = \frac{48 \text{ ft}}{19 \text{ ft}} = 3 \text{ vehicles}\)

separation time = 4 sec

Track Clearance time = 14 sec

Marshall/Berg:

Track Clearance time = \(t(1) + t(2)\)

\(t(1) = \frac{L'k(j)}{2.94's} = 2.06\)

(time until the last vehicle in the blocking queue departs)

\(L' = \text{Length of the queue to be cleared} (48)\)

\(k(j) = \text{jam density} (\text{assumed to be 240})\)

\(s = \text{saturation flow rate} (\text{assumed to be 1900})\)

\(t(2) = \sqrt{2(L + 2'D + W)a} = 7.27}\)

(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)

\(L = \text{Length of the longest design vehicle expected at the intersection} (\text{assumed to be 30 ft})\)

\(D = \text{Clearance distance on either side of the tracks} (\text{assumed to be 15 ft})\)

\(W = \text{Width between the outermost rails} (\text{assumed to be 6 ft})\)

\(a = \text{Acceleration rate for the design vehicle} (2.5 \text{ ft/sec}^2)\)

Track Clearance time = 9.33 sec

Field Observation:

Total counts = 26; Max # of veh. = 3; Max time to clear envelope = 8 sec
Number of field observations under 14: 26 (denoted as n(-))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 26 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest:
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H0) and the alternative hypothesis (Ha).
      \[ H_0 : T = 14 \]
      \[ H_* : T \neq 14 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 26 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(+) and n(-), which is n(+) for this research. The test
      statistic = x* = n(+).
   c. Determine the level of significance.
      \[ \alpha = 0.05 \text{ for a two-tailed test} \]

Step 3  The Sample Evidence
   a. The sample information.
      n = 26; the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \[ x^* = n(+) = 0 \]

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the n = 26 row or 7.

      \begin{tabular}{ccc}
      0 & 7 & 8
      \end{tabular}

      Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( H_* \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_* \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 14 sec.
S CHOCTAW DR @ WOODDALE BLVD
Sign Test for the Assumption that the Median Time is Equal to the

Number of field observations under 9.93: 26 (denoted as n(-))
Number of field observations equal to 9.93: 0
Number of field observations over 9.93: 0 (denoted as n(+))

Number of usable observations: 26 (n(-) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \( H_0: T = 9.93 \)
      \( H_1: T \neq 9.93 \)
   b. State the null hypothesis (H0) and the alternative hypothesis (Ha).

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 26 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(+) and n(-), which is n(+). For this research, the test
      statistic is \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      n = 26; the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the n = 26 row or 7.

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above).

Step 5  The Results
   a. State the decision about \( H_0 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_1 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 9.93 sec.
# APPENDIX V: US 61 (AIRLINE HIGHWAY) AT SOUTH CHOCTAW DRIVE INTERSECTION DATA SHEETS

- **LaDOTD TRAFFIC OPERATIONS AND ENGINEERING**
  - **FIELD OBSERVATION METHOD**
  - **RAILROAD PREEMPTION WORKSHEET**

## General Information
- **Analyst**: DRK
- **District**: 61
- **Parish**: EBR
- **TSI No.**: 128

## Geometric Input
- **Route**: US 61
- **St Name**: AIRLINE HWY
- **Railroad Co.**: ______ or Spur: ______
- **Number of Tracks**: 1
- **Dynamic Envelope**: ______ ft
- **Distance Between Envelope and Stop Bar**: ______ ft
- **Railroad Control**: ______ Crossbucks
  - ______ Lights/Ground
  - ______ Lights/Truss
  - ______ Gates

## Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>N th Vehicle</th>
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</table>

- **Maximum**: 3
- **Minimum**: 2
- **Average**: 4

## Glossary and Notes
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trlr**: Tractor Trailer Vehicles
- **N th Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of N th Vehicle clears Dynamic Envelope.
### General Information

- **Analyst:** DRK
- **Date:** 8/12/2003
- **District:** 61
- **Time:** 4:00 PM
- **Parish:** EBR
- **TSI No.:** 120
- **Area Type:** _X_ urban

### Geometric Input

- **Route:** US 61
- **St. Name:** AIRLINE HWY
- **Railroad Co.:**
- **Multiple X or Spur:**
- **Number of Tracks:** 1
- **Dynamic Envelope:** 18 ft
- **Distance Between Envelope and Stop Bar:** 45 ft
- **Railroad Control:** _X_ Crossbucks
- **Lights/Truss:** _X_
- **Gates:**

### Input Field Measurement

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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trailers</th>
<th>Is a Vehicle Stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear</th>
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### Glossary and Notes

**Total counts = 28; Max # of veh. = 3; Max time to clear envelope = 10 sec**

- Dynamic Envelope = Typically 10 ft for 60 deg crossing, 5 ft track width plus 5 ft clearance on either side.
- Single Unit Vehicles = Delivery Trucks and Buses
- Tractor Trailers = Tractor Trailer Vehicles
- Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 9/02
US 61 (AIRLINE HWY) @ S CHOCTAW DR INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 64ft / 19ft = 3 vehicles
separation time = 4sec

Track Clearance time = 14 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = L \cdot k(j) \cdot 2.94 \cdot s = 2.75 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (64ft)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2D + W)/a} = 10.37 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 50ft)
D = Clearance distance on either side of the tracks (assumed to be 15 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (1.6ft/sec^2)

Track Clearance time = 13.12 sec

Field Observation:
Total counts = 28; Max # of veh. = 3; Max time to clear envelope = 10 sec
US61 (AIRLINE HWY) @ S CHOCTAW DR
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 14 sec.

Number of field observations under 14: 28 (denoted as n(−))
Number of field observations equal to 14: 0
Number of field observations over 14: 0 (denoted as n(+))

Number of usable observations: 20 (n(−) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      T: vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H₀) and the alternative hypothesis (H₁).
      \[ H₀: T = 14 \]
      \[ H₁: T ≠ 14 \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 20 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n(+) and n(−), which is n(+) for this research. The test
      statistic = \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3  The Sample Evidence
   a. The sample information.
      \( n = 28 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the \( n = 28 \) row or 8.
      \[ \begin{array}{c|c|c}
         \text{Reject } H₀ & \text{Fail to reject } H₀ \\
         \hline
         0 & 8 & 9
      \end{array} \]
      Number of less frequent sign
   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5  The Results
   a. State the decision about \( H₁ \).
      \( \text{Reject } H₀ \)
   b. State the conclusion about \( H₁ \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 14 sec.
US 61 (AIRLINE HWY) @ S CHOCTAW DR

Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 13.12 sec.

Number of field observations under 13.12: 28 (denoted as n(-))
Number of field observations equal to 13.12: 0
Number of field observations over 13.12: 0 (denoted as n(+))

Number of usable observations: 28 (n(-) + n(+))

Step 1 The Set-Up:
   a. Describe the population parameter of interest.
      T, vehicle median time to clear dynamic envelope
   b. State the null hypothesis (H0) and the alternative hypothesis (H1).
      
   \[
   H_0: T = 13.12 \\
   H_1: T \neq 13.12
   \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable
      envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign:
      the smaller of n (+) and n (−), which is n (+) for this research. The test
      statistic = \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 28 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \( \alpha = 0.05 \) column
      and the \( n = 28 \) row or 8.

   \[
   \begin{array}{cc}
   \text{Reject } H_0 & \text{Fail to reject } H_0 \\
   0 & 8 \ 9
   \end{array}
   \]
   Number of less frequent sign

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above)

Step 5 The Results
   a. State the decision about \( H_1 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_1 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the
      median dynamic envelope clearance time is not equal to 13.12 sec.
APPENDIX W: US 61 (SCENIC HIGHWAY) AT LA 19 (SCOTLAND AVENUE) & SWAN AVENUE INTERSECTION DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING 
FIELD OBSERVATION METHOD 
RAILROAD PREEMPTION WORKSHEET

General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>DRK</th>
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<tbody>
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<td>District</td>
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<tr>
<td>Parish</td>
<td>EBR</td>
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<tr>
<td>TSI No.</td>
<td>00112</td>
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</table>

Date: 7/24/2003
Time: 7:00 AM
Area Type: __urban, or X urban

Geometric Input

Route: LA 19
St Name: (SCOTLAND AVE) & SWAN AVE

Railroad Co.
Mainline X or Spur
Number of Tracks: 1
Dynamic Envelope 18 ft
Distance Between Envlope and Stop Bar 21 ft
Railroad Control X Crossbucks
Lights/Ground

Input Field Measurement

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<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>N th Vehicle</th>
<th>Time to Clear Envelope</th>
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Maximum: 1 5
Minimum: 1 4
Average: 1 5

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft back width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Busses
Tractor Trlr = Tractor Trailer Vehicles
N th Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of N th Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

**General Information**

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**Geometric Input**

Route: LA 13
St Name: (SCOTLAND AVE) & SWAN AVE

Railroad Co. __________
Mainline _X_ or Spur __________
Number of Tracks: 1
Dynamic Envelope __18__ ft
Distance Between Envelope and Stop Bar __21__ ft
Railroad Control _X_ Crossbucks _X_ Lights/Ground Lights/Triax _X_ Gates

**Input Field Measurement**

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trk Vehicles</th>
<th>Is a Vehicle stopped in the envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</table>

| Maximum | 1                         | 7                           |
| Minimum | 1                         | 3                           |
| Average | 1                         | 5                           |

**Glossary and Notes**

- **Dynamic Envelope** = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles** = Delivery Trucks and Busses
- **Tractor Trk** = Tractor Trailer Vehicles
- **Nth Vehicle** = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear** = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
## General Information

<table>
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<th>Analyst</th>
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<th>District</th>
<th>Time</th>
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Area Type: _urban_

## Geometric Input

Route: LA 13  
StName: (SCOTLAND AVE) & SWAN AVE  
Railroad Co.  
Mainline _X_ or Spur _X_  
Number of Tracks: 1  
Dynamic Envelope _18_ ft  
Distance Between Envelope and Stop Bar _21_ ft

Route: US 61  
St Name: SCENIC HWY  
Railroad Control _X_ Crossbucks  
_X_ Lights/Ground  
_Gates_

## Input Field Measurement

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
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<th>Is a Vehicle stopped in the Envelope?</th>
<th>Nth Vehicle in Envelope</th>
<th>Time to Clear Envelope</th>
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Maximum: 8  
Minimum: 1  
Average: 4

## Glossary and Notes

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Busses
- **Tractor Trlr:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
**LaDOTD Traffic Operations and Engineering**

**Field Observation Method**

**Railroad Preemption Worksheet**

### General Information
- **Analyst**: DRK
- **District**: EBR
- **T&I No.**: 00112
- **Date**: 7/04/2003
- **Time**: 7:00 AM
- **Area Type**: _X_ urban

### Geometric Input
- **Route**: LA 13
- **St Name**: SCOTLAND AVE
- **Railroad Co.**: _X_ Single Rail
- **Mainline**: _X_ Single Rail
- **Spur**: _X_ Single Rail
- **Number of Tracks**: 1
- **Dynamic Envelope**: 18 ft
- **Distance Between Envelope and Stop Bar**: 21 ft
- **Railroad Control**: _X_ Crossbucks
- **Light/Truss**: _X_ Ground
- **Gates**: _X_

### Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trk Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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**Glossary and Notes**

- **Total counts**: 28; **Max # of veh.**: 2; **Max time to clear envelope**: 9 sec.
- **Dynamic Envelope**: Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles**: Delivery Trucks and Buses
- **Tractor Trk**: Tractor Trailer Vehicles
- **Nth Vehicle**: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear**: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
US 61 (SCENIC HWY) @ LA 18 (SCOTLAND AVE) & SWAN AVE INTERSECTION SUMMARY

Northwestern:
Track Clearance time = (4 + 2n) + separation time
n = L / avg vehicle length = 39 ft / 19 ft = 2 vehicles
separation time = 4 sec
Track Clearance time = 12 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = \frac{L'k(j)2.34s}{2.94} = 1.68 \]
(time until the last vehicle in the blocking queue departs)
L' = Length of the queue to be cleared (39 ft)
k(j) = jam density (assumed to be 240)
s = saturation flowrate (assumed to be 1900)

\[ t(2) = \text{square root} \left( \frac{2(L + 2D + W)}{a} \right) = 5 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 19 ft)
D = Clearance distance on either side of the tracks (assumed to be 18 ft)
W = Width between the outermost rails (assumed to be 6 ft)
a = Acceleration rate for the design vehicle (4.4 ft/sec^2)

Track Clearance time = 6.68 sec

Field Observation:
Total counts = 28; Max # of veh. = 2; Max time to clear envelope = 9 sec
US 61 (SCENIC HWY) @ LA 19 (SCOTLAND AVE) & SWAN AVE

Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 12 sec.

Number of field observations under 12: 28 (denoted as n(-))
Number of field observations equal to 12: 0
Number of field observations over 12: 0 (denoted as n(+))

Number of usable observations: 28 (n(-) + n(+))

Step 1 The Setup:
   a. Describe the population parameter of interest.
      \( T \), vehicle median time to clear dynamic envelope
   b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
      \[
      H_0 : T = 12 \\
      H_1 : T \neq 12
      \]

Step 2 The Hypothesis Test Criteria
   a. Check the assumptions.
      The 28 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign, the smaller of n (+) and n (-), which is n (+) for this research. The test statistic \( x^* = n(+) \).
   c. Determine the level of significance.
      \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence
   a. The sample information.
      \( n = 28 \); the observed value of the test statistic is \( x = n(+) = 0 \).
   b. The test statistic.
      \( x^* = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test. The critical value is located at the intersection of the \( n = 0.05 \) column and the \( n = 28 \) row or 8.

      \[
      \text{Reject } H_0 \quad \text{Fail to reject } H_0
      \]

      Number of less frequent sign

      0 8 9

   b. Determine whether or not the calculated test statistic is in the critical region.
      \( x^* \) is in the critical region (see figure above).

Step 5 The Results
   a. State the decision about \( H_1 \).
      Reject \( H_0 \).
   b. State the conclusion about \( H_1 \).
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 12 sec.
US 61 (SCENIC HWY) @ LA 19 (SCOTLAND AVE) & SWAN AVE

Sign Test for the Assumption that the Median Time is Equal to the Marshall/Berg Track Clearance Time of 6.68 sec.

Number of field observations under 6.68: 19 (denoted as \( n(-) \))
Number of field observations equal to 6.68: 0
Number of field observations over 6.68: 3 (denoted as \( n(+) \))

Number of usable observations: 28 (\( n(+) + n(-) \))

**Step 1** The Setup:

a. Describe the population parameter of interest.

\[ T, \text{ vehicle median time to clear dynamic envelope} \]

b. State the null hypothesis (H0) and the alternative hypothesis (H1).

\[ H_0 : T = 6.68 \]
\[ H_1 : T \neq 6.68 \]

**Step 2** The Hypothesis Test Criteria

a. Check the assumptions.
The 28 field observations were independently obtained and the variable envelope clearance time is continuous.

b. Identify the test statistic to be used.
The test statistic that will be used is the number of the less frequent sign: the smaller of \( n(+) \) and \( n(-) \), which is \( n(+) \) for this research. The test statistic is \( x^* = n(+) \).

c. Determine the level of significance.

\[ \alpha = 0.05 \text{ for a two-tailed test.} \]

**Step 3** The Sample Evidence

a. The sample information.

\( n = 28 \), the observed value of the test statistic is \( x = n(+) \).

\( x^* = n(+) = 9 \).

**Step 4** The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.
The critical value is located in the table of critical values of the sign test.
The critical value is located at the intersection of the \( x^* \) 0.05 column and the \( n = 28 \) row or 8.

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b. Determine whether or not the calculated test statistic is in the critical region.

\( x^* \) is in the critical region (see figure above)

**Step 5** The Results

a. State the decision about \( H_0 \)

\( \text{Reject } H_0 \)

b. State the conclusion about \( H_1 \)

The sample does not show sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 6.68 sec.
APPENDIX X: US 61/190 (RIVER ROAD) AT CASINO ROUGE ENTRANCE DATA SHEETS

LaDOTD TRAFFIC OPERATIONS AND ENGINEERING FIELD OBSERVATION METHOD RAILROAD PREEMPTION WORKSHEET

General Information

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Geometric Input

Railroad Co. ___ Mainline ___ or Spur ___
Number of Tracks: 2
Dynamic Envelope ___ ft
Distance Between Envelope and Stop Bar ___ ft
Railroad Control ___ Crossbuck ___
___ Lights/Ground ___ Lights/Truss ___ Gates

Input Field Measurement

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<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trlr Vehicles</th>
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Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Buses
Tractor Trlr = Tractor Trailer Vehicles
Nth Vehicle = The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
Time to Clear = Time from start of green until back of Nth Vehicle clears Dynamic Envelope.

rev 5/02
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information
Analyst: DRK
Date: 7/21/2003
District: 01
Time: 4:00 PM
Parish: EBR
Area Type: ___ rural, or ___ urban
TSI No.: 00312

Geometric Input
Route:
St Name: CASINO ROUGE ENTRANCE
Railroad Co.: ___
Mainline ___ or Spur ___
Number of Tracks: 2
Dynamic Envelope ___ ft
Distance Between Envelope and Stop Bar ___ ft
Railroad Control ___ Crossbucks
X Lights/Ground
X Lights/Truss

Input Field Measurement

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Maximum: 4 8
Minimum: 3 5
Average: 3 6

Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
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rev 5/02
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information

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Geometric Input

- Route: St Name: CASING ROUGE ENTRANCE
- Railroad Co.
- Mainline _X_ or Spur
- Number of Tracks: 2
- Dynamic Envelope: 26 ft
- Distance Between Envelope and Stop Bar: 63 ft
- Railroad Control: _X_ Crossbuck
- Route: US 61/190
- St Name: RIVER RD
- _X_ Lights/Signs
- _X_ Lights/Truss
- _X_ Gates

Input Field Measurement

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Maximum: 4 10
Minimum: 3 5
Average: 4 7

Glossary and Notes

- Dynamic Envelope: Typically 18 ft for 90 deg crossing, 5 ft track width plus 6 ft clearance on either side.
- Single Unit Vehicles: Delivery Trucks and Busses
- Tractor Trlr: Tractor Trailer Vehicles
- Nth Vehicle: The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- Time to Clear: Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

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Geometric Input

Route: St Name CASINO ROUSE ENTRANCE
Railroad Co. __________
Mainline ___ or Spur ___
Number of Tracks 2
Distance Between Envelope and Stop Bar 88 ft
Railroad Control ___Crossbucks
___Lights/Truss
___Lights/Gates

Input Field Measurement

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Glossary and Notes

Dynamic Envelope = Typically 18 ft for 90 deg crossing, 6 ft back width plus 6 ft clearance on either side.
Single Unit Vehicles = Delivery Trucks and Busses
Tractor Trlr = Tractor Trailer Vehicles
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Time to Clear = Time from start of green until back of Nth Vehicle nears Dynamic Envelope.
LaDOTD TRAFFIC OPERATIONS AND ENGINEERING
FIELD OBSERVATION METHOD
RAILROAD PREEMPTION WORKSHEET

General Information
Analyst: DRK
District: 61
Parish: EBR
TSI No.: 00312
Date: 7/21/2003
Time: 4:00 PM
Area Type: __rural, or __urban

Geometric Input
Route: St Name: CASINO ROUGE ENTRANCE
Railroad Co.: __Mainline__ or Spur __

Number of Tracks: 2
Dynamic Envelope: __26 ft
Distance Between Envelope and Stop Bar: __68 ft
Railroad Control: __Crossbucks
St Name: RIVER RD

Input Field Measurement
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Glossary and Notes
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Tractor Trlr = Tractor Trailer Vehicles
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### General Information

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Area Type: rural, or **X** urban

### Geometric Input

- **Route:** St. Name: CASINO ROUGE ENTRANCE
- **Railroad Co.:** X or Spur
- **Number of Tracks:** 2
- **Dynamic Envelope:** 28 ft
- **Distance Between Envelope and Stop Bar:** 83 ft
- **Railroad Control:** X Crossbuck
- **Route:** US 61/190
- **St. Name:** RIVER RD

### Input Field Measurements

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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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**Maximum:** 4 6

**Minimum:** 4 6

**Average:** 4 6

### Glossary and Notes

- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicles:** Delivery Trucks and Buses
- **Tractor Trl:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
### General Information

<table>
<thead>
<tr>
<th>Analyst</th>
<th>D.R.K.</th>
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### Geometric Input

- **Route:** St Name: CASINO ROUGE ENTRANCE
- **Railroad Co.:** Mainline: X or Spur
- **Number of Tracks:** 2
- **Dynamic Envelope:** 26 ft
- **Distance Between Envelope and Stop Bar:** 88 ft
- **Railroad Control:** X Crossbucks
- **Route:** US 61/190
- **St Name:** RIVER RD

### Input Field Measurement

#### Number of Queues at Start of Green

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<tr>
<th>Cycle</th>
<th>Total Number of Vehicles</th>
<th>Number of Passenger Vehicles</th>
<th>Number of Single Unit Vehicles</th>
<th>Number of Tractor Trl Vehicles</th>
<th>Is a Vehicle stopped in Envelope?</th>
<th>Nth Vehicle</th>
<th>Time to Clear Envelope</th>
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</table>

- **Maximum:** 4
- **Minimum:** 3
- **Average:** 3

### Glossary and Notes

- **Total counts:** 24; **Max # of veh.:** 5; **Max time to clear envelope:** 10 sec
- **Dynamic Envelope:** Typically 18 ft for 90 deg crossing, 6 ft track width plus 6 ft clearance on either side.
- **Single Unit Vehicle:** Delivery Trucks and Buses
- **Tractor Trl:** Tractor Trailer Vehicles
- **Nth Vehicle:** The last vehicle that stops for the signal and is in (or just before) the Dynamic Envelope.
- **Time to Clear:** Time from start of green until back of Nth Vehicle clears Dynamic Envelope.
US 61/190 (River Rd) @ Casino Rouge Entrance Intersection Summary

Northwestern:
Track Clearance time = (4 +2n) + separation time
n = L / avg vehicle length = 95 ft / 19 ft = 5 vehicles
separation time = 4 sec

Track Clearance time = 16 sec

Marshall/Berg:
Track Clearance time = t(1) + t(2)

\[ t(1) = L\cdot k(j)2.94\cdot s = 4.12 \]
(time until the last vehicle in the blocking queue departs)
L = Length of the queue to be cleared (95 ft)
k(j) = jam density (assumed to be 240)
s = saturation flow rate (assumed to be 1900)

\[ t(2) = \sqrt{2(L + 2* D + W)/a} = 7.27 \]
(time to clear a vehicle that is stopped in the dynamic envelope that is farthest from the intersection)
L = Length of the longest design vehicle expected at the intersection (assumed to be 30 ft) SUV
D = Clearance distance on either side of the tracks (assumed to be 18 ft)
W = Width between the outermost rails (assumed to be 8 ft)
a = Acceleration rate for the design vehicle (2.5 ft/sec^2) SUV

Track Clearance time = 11.39 sec

Field Observation:
Total counts = 24; Max # of veh. = 5; Max time to clear envelope = 10 sec
Sign Test for the Assumption that the Median Time is Equal to the Northwestern Track Clearance Time of 18 sec.

Number of field observations under 18: 24 (denoted as n(−))
Number of field observations equal to 18: 0
Number of field observations over 18: 0 (denoted as n(+))

Number of usable observations: 24 (n(−) + n(+))

Step 1  The Set-Up:
   a. Describe the population parameter of interest.
      \[ T \text{, vehicle median time to clear dynamic envelope} \]
   b. State the null hypothesis (H₀) and the alternative hypothesis (Hₐ).
      \[
      \begin{align*}
      H_0 & : T = 18 \\
      H_a & : T \neq 18
      \end{align*}
      \]

Step 2  The Hypothesis Test Criteria
   a. Check the assumptions.
      The 24 field observations were independently obtained and the variable envelope clearance time is continuous.
   b. Identify the test statistic to be used.
      The test statistic that will be used is the number of the less frequent sign: the smaller of n(+) and n(−), which is n(+) for this research. The test statistic is \[ x^* = n(+) \].
   c. Determine the level of significance.
      \[ \alpha = 0.05 \text{ for a two-tailed test} \]

Step 3  The Sample Evidence
   a. The sample information.
      \[ n = 24; \text{ the observed value of the test statistic is } x = n(+) = 0. \]
   b. The test statistic.
      \[ x^* = n(+) = 0. \]

Step 4  The Probability Distribution using the Classical Procedure
   a. Determine the critical region and critical values.
      The critical value is located in the table of critical values of the sign test.
      The critical value is located at the intersection of the \[ x^* = 0.05 \] column and the \[ n = 24 \] row or 6.
      \[
      \begin{array}{c|c}
      \text{Number of less frequent sign} & \text{Reject } H_0 \text{ or Fail to reject } H_0 \\
      \hline
      0 & \text{Fail to reject } H_0 \\
      6 & \text{Reject } H_0 \\
      7 & \text{Reject } H_0 \\
      \end{array}
      \]
   b. Determine whether or not the calculated test statistic is in the critical region.
      \[ x^* \] is in the critical region (see figure above).

Step 5  The Results
   a. State the decision about \[ H_0 \].
      \[ \text{Reject } H_0. \]
   b. State the conclusion about \[ H_0 \].
      The sample shows sufficient evidence at the 0.05 level to conclude that the median dynamic envelope clearance time is not equal to 18 sec.
US 61/190 (RIVER RD) @ CASINO ROUGE ENTRANCE
Sign Test for the Assumption that the Median Time is Equal to the

Number of field observations under 11.39: 24 (denoted as n(-))
Number of field observations equal to 11.39: 0
Number of field observations over 11.39: 0 (denoted as n(+))

Number of usable observations: 24 (n(-) + n(+))

Step 1 The Set-Up:

a. Describe the population parameter of interest.
   \( T \), vehicle median time to clear dynamic envelope

b. State the null hypothesis (Ho) and the alternative hypothesis (Ha).
   \[ H_0: T = 11.39 \]
   \[ H_1: T \neq 11.39 \]

Step 2 The Hypothesis Test Criteria

a. Check the assumptions.
   The 24 field observations were independently obtained and the variable
   envelope clearance time is continuous.

b. Identify the test statistic to be used.
   The test statistic that will be used is the number of the less frequent sign:
   the smaller of n (+) and n (-), which is n (+) for this research. The test
   statistic is \( x^* = n(+) \).

c. Determine the level of significance.
   \( \alpha = 0.05 \) for a two-tailed test.

Step 3 The Sample Evidence

a. The sample information.
   \( n = 24 \); the observed value of the test statistic is \( x = n(+) = 0 \).

b. The test statistic.
   \( x^* = n(+) = 0 \).

Step 4 The Probability Distribution using the Classical Procedure

a. Determine the critical region and critical values.
   The critical value is located in the table of critical values of the sign test.
   The critical value is located at the intersection of the \( \alpha = 0.05 \) column
   and the \( n = 24 \) row or 6.

b. Determine whether or not the calculated test statistic is in the critical region.
   \( x^* \) is in the critical region (see figure above)

Step 5 The Results

a. State the decision about \( H_1 \).
   Reject \( H_1 \).

b. State the conclusion about \( H_1 \).
   The sample shows sufficient evidence at the 0.05 level to conclude that the
   median dynamic envelope clearance time is not equal to 11.39 sec.
VITA

DeeAngela R. Kenon was born December 20, 1972, in Peoria, Illinois, a mid-size city in the heart of Illinois. She obtained her Bachelor of Science in Civil Engineering in 1996 from the University of Illinois at Urbana-Champaign. In 1996, she began her employment with the Louisiana Department of Transportation and Development (LADOTD). Today, she is still with the Department in the area of traffic engineering. With the help of the LADOTD and the support of her family and friends, she joined the master’s program at Louisiana State University in 2001, specializing in transportation engineering. She anticipates receiving her degree in May of 2004.