Procedures for Establishing Speed Zones

Revised August 2015

Manual Notice: 2015-1

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Manual: *Procedures for Establishing Speed Zones*

Effective Date: August 01, 2015

Purpose

The purpose of this revision is to update information in Chapter 3 of Procedures for Establishing Speed Zones pertaining to the establishment of lower than 85th percentile speeds on sections of highways with crash rates greater than the statewide average for similar roadways. The update specifies criteria and procedures used to make this determination, and is issued as a response to a recent rule change by the Texas Transportation Commission.

Contents

The only content change made at this time, described in the paragraph above, appears on pages 3-18 and 3-19 of this manual.

Supersedes

This manual supersedes all prior editions of Procedures for Establishing Speed Zones.

Contact

For more information on the changes made to Procedures for Establishing Speed Zones, contact Brian Stanford in the Traffic Operations Division, Traffic Engineering Section by email at Brian.Stanford@txdot.gov, or by phone at (512) 416-3122.�

Archives

Past manual notices are available in a PDF archive.

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Chapter 1: Introduction

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Section 1: Overview

Purpose of Manual

The purpose of this manual is to provide the information and procedures necessary for establishing speed zones and advisory speeds on the state highway system.

Users of Manual

This manual is intended for use by entities with authority to set speed zones. It is only required to be used by the Texas Department of Transportation (TxDOT) and cities when establishing speed zones on the state highway system.

Responsibilities

The Traffic Operations Division (TRF) will:

- prepare procedures for establishing speed zones and advisory speeds
- assist districts as necessary with speed zone studies
- review and approve district recommendations for speed zoning and prepare minute orders for Transportation Commission action.

TxDOT districts will:

- conduct engineering and traffic studies associated with the establishment of speed zones and advisory speeds
- submit recommendations for speed zoning, along with results of studies to the Traffic Operations Division (TRF)
- request cities to pass ordinances establishing speed zones when necessary
- erect and maintain necessary speed limit and advisory speed signs and notify local enforcement authorities upon installation of the signs.

Cities will:

- request that the district conduct engineering and traffic studies associated with the establishment of speed zones on the state highway system, or conduct the studies themselves
- upon approval by TRF, prepare and pass city ordinances establishing speed zones.

A commissioners court of a county may by resolution request, through the local TxDOT district office, that the Texas Transportation Commission determine and declare a reasonable and safe **prima facie** speed limit lower than that established by Section 545.352 of the Transportation

Code on any part of a farm-to-market or ranch-to-market road without improved shoulders located in that county.

Section 2: Background

Basic Speed Law

Transportation Code, Chapter 545, Subchapter H, “Speed Restrictions,” contains the following sections governing speeds in the state:

- Section 545.351, Maximum Speed Requirements
- Section 545.352, Prima Facie Speed Limits (see also Transportation Code, Section 623.101, Speed Limit: for Manufactured House or House Trailer Being Towed)
- Section 545.353, Authority of Texas Transportation Commission to Alter Speed Limits
- Section 545.3531, (repealed by L 2011, Chap 259(14). eff 6/17/11)
- Section 545.3535, Authority of Texas Transportation Commission to Alter Speed Limits on Certain Roads
- Section 545.354, Authority of Regional Tollway Authorities to Alter Speed Limits on Turnpike Projects
- Section 545.355, Authority of County Commissioners Court to Alter Speed Limits (see also Transportation Code, Section 251.154, Maximum Reasonable and Prudent Speeds on County Roads)
- Section 545.356, Authority of Municipality to Alter Speed Limits
- Section 545.357, Public Hearing to Consider Speed Limits where Certain Schools Are Located
- Section 545.358, Authority of Commanding Officer of United States Military Reservation to Alter Speed Limits
- Section 545.359, Conflicting Designated Speed Limits
- Section 545.360, Duty of Texas Transportation Commission and State Board of Education to Provide Information and Assistance
- Section 545.361, Special Speed Limitations
- Section 545.362, Temporary Speed Limits
- Section 545.3625, Confidentiality of Violation Information: Fuel Conservation Speed Limit
- Section 545.363, Minimum Speed Regulations
- Section 545.364, (repealed by L. 1999, Chap. 1346(3), eff 9/1/99)
- Section 545.365, Speed Limit Exception for Emergencies; Municipal Regulation.

Collectively, these sections are referred to as the “basic speed law.” The basic speed law is founded on the belief that the majority of motorists are willing to modify their driving behavior properly, as long as they are aware of the conditions around them. Speed zone regulations are based on Section 545.351, which states in part: “An operator may not drive at a speed greater than is reasonable or prudent under the circumstances then existing.”

Prima Facie Concept

In Texas, all speed limits are considered **prima facie** limits. **Prima facie** limits are those limits that, “on the face of it,” are reasonable and prudent under normal conditions. To exceed a **prima facie** speed limit does not automatically constitute an infraction of the law, as reasonable and prudent driving behavior is, at times, possible at speeds in excess of the posted limit. However, the burden of proof of reasonable and prudent conduct under the existing conditions rests with the driver. To afford a driver this opportunity to exceed a **prima facie** speed limit recognizes the fact that any posted speed limit cannot adequately reflect the many different road conditions confronting the driver on the same highways at different times.

Authority to Set Speed Zones

The provisions of the Transportation Code, Chapter 545, Subchapter H, Section 545.353, give the Texas Transportation Commission the authority to alter maximum speed limits on highway routes both within and outside of cities, provided the *Procedures for Establishing Speed Zones* are followed and the Commission determines that the speed being established on a part of a highway system is a safe and reasonable speed for that part of the highway.

Higher Maximum Speed Limit

The Commission may establish a speed limit of:

- 75 miles per hour on any portion of the state highway system.
- 80 miles per hour on parts of Interstate Highway 10 and Interstate Highway 20 in Crockett, Culberson, Hudspeth, Jeff Davis, Kerr, Kimble, Pecos, Reeves, Sutton, and Ward counties, or
- Up to 85 miles per hour on a highway designed to accommodate travel at the speed being established.

Local Authority and TxDOT

The altering of the general statewide maximum speed limits to fit existing traffic and physical conditions of the highway constitutes the basic principle of speed zoning.

Transportation Code, Chapter 545, Subchapter H, Sections 545.355 and 545.356, give counties and cities the same authority within their respective jurisdictions. Counties with a population of more than 2.8 million and cities have the authority to establish a prima facie maximum speed limit of 75 miles per hour. The law also provides that any speed zone on highway routes in cities established by Transportation Commission minute order will supersede any conflicting zone set by city ordinance.

Except in very unusual circumstances, the zoning on state highway routes within cities should only be set by city ordinance based upon the recommendations of TxDOT. The usual practice, even for speed zones established by city ordinance, is for TxDOT to make the necessary speed studies and recommend the most appropriate zoning to the city. Cities that have a traffic engineering staff may also make speed studies on state maintained highways and recommend proper zoning. The procedure is permissible, as long as TxDOT is afforded an opportunity to review and approve the recommended city zoning.

County commissioner courts and governing bodies of incorporated cities, towns, and villages may alter maximum **prima facie** speed limits on roadways under their jurisdiction in accordance with the provision of the Transportation Code, Chapter 545, Subchapter H, Sections 545.355 and 545.356 respectively. However, alteration of maximum **prima facie** speed limits on any designated or marked roadway of the state highway system (even within the corporate limits of a city or town) typically requires an engineering and traffic investigation (as described in Chapter 3, Speed Zone Studies, of this manual) and the approval of TxDOT.

A county that increases the **prima facie** speed limit on a county road or highway is also required to conduct an engineering and traffic investigation. However, for a county road or highway outside the limits of the right-of-way of an officially designated or marked highway or road of the state highway system, the county commissioners court may declare a lower speed limit of not less than 30 miles per hour, if the commissioners court determines that the **prima facie** speed limit on the road or highway is unreasonable or unsafe.

County authority does not extend to any segment of the state highway system; however, the commissioners court of a county, by resolution, may request the Texas Transportation Commission to determine and declare a reasonable and safe prima facie speed limit that is lower than a speed limit established by Section 545.352 of the Transportation Code on any part of a farm-to-market or ranch-to-market road without improved shoulders located in that county.

The Transportation Commission shall give consideration to local public opinion and may determine and declare a lower speed limit on any part of the road without an engineering and traffic investigation, but the Transportation Commission must use sound and generally accepted traffic engineering practices in determining and declaring the lower speed limit. Sound and generally accepted engineering practices for these FM and RM roadways without improved shoulders are described in Chapter 3, Section 4, Speed Zone Design of this manual.

County Authority is different from the authority of cities, who may exercise concurrent authority subject only to commission override. In exercising their authority, cities must base any speed zones on engineering and traffic investigations, unless the roadway meets all of the following criteria:

- It is not an officially designated or marked highway or road of the state highway system.
- It is a two-lane, undivided highway or part of a highway.

If the roadway meets the above criteria, the city may declare a lower speed limit of not less than 25 miles per hour if the governing body determines that the prima facie speed limit on the highway is unreasonable or unsafe.

The authority of regional tollway authorities, regional mobility authorities, and the commanding officer of a United States military reservation to alter speed limits is addressed in Transportation Code, Sections 370.033, 545.354, and 545.358. These decision-making authorities are required to follow the speed zone procedures as adopted by TxDOT when altering, on the basis of an engineering and traffic study, speed limits on off-system turnpikes or on-system highways within the confines of a military reservation.

Value of Speed Zoning

Although comparative "before-and-after" studies indicate that speed limit signs actually have very little influence on the driver's choice of speed, speed zoning is necessary and does serve a worthwhile purpose. Realistic speed zoning will serve to protect the public and to regulate the unreasonable behavior of an individual. Having recognized that normally careful and competent actions of a reasonable person should be considered legal, the Texas Legislature has passed legislation concerning speed zoning in order to assure this protection. If a speed zone is determined by the actions of the majority of drivers on a highway, then it is hoped that speed zoning will facilitate the orderly movement of traffic by increasing driver awareness of a reasonable and prudent speed.

Properly applied speed zoning can:

- help drivers adjust their speed to the conditions
- make enforcement easier by furnishing police officers with a reasonable indication of what is excessive speed
- result in more motorists driving within the same speed range at each of the locations along the highway
- reduce the frequency and severity of crashes when accompanied by enforcement.

The Michigan Department of Transportation made a study entitled "Comparison of Speed Zoning Procedures and Their Effectiveness" dated September 1992. The following are some of the study's conclusions:

- Posting speed limits within 5 miles per hour of the 85th percentile speed has a beneficial effect, although small, on reducing total crashes but has a major beneficial effect on providing improved driver compliance. (See Chapter 3, Speed Zone Studies, for a discussion on the 85th percentile speed.)
- Posting speed limits more than 5 miles per hour below the 85th percentile speed does not reduce crashes and has an adverse effect on driver compliance.
- Speed zoning should not be used as the only corrective measure at high crash locations in lieu of other safety improvements.

- The use of radar to collect speed data appears to underestimate the 85th percentile speed by approximately 3 miles per hour.

Guidelines for Selecting Speed Limits

All authorized entities using these procedures should observe the following guidelines when selecting speed limits:

- Speed limits on all roadways should be set based on spot speed studies and the 85th percentile operating speed (see Chapter 3, Speed Zone Studies, of this manual). Legal minimum and maximum speeds should establish the boundaries of the speed limits. If an existing roadway section's posted speed limit is to be raised, the roadway's roadside features should be examined to determine if modifications may be necessary to maintain roadside safety.
- It is appropriate for posted speed limits to be based on the 85th percentile speed, even for those sections of roadway that have an inferred design speed lower than the 85th percentile speed. Posting a roadway's speed limit based on its 85th percentile speed is considered good and typical engineering practice. This practice remains valid, even where the inferred design speed is lower than the resulting posted speed limit. In such situations, the posted speed limit would not be considered excessive or unsafe.
- Arbitrarily setting lower speed limits at point locations due to a perceived shorter than desirable stopping sight distance is neither effective nor good engineering practice.
- If a section of roadway has (or is expected to have) a posted speed in excess of the roadway's inferred design speed and a safety concern exists at the location, then appropriate warning or informational signs should be installed to warn or inform drivers of the condition. Slightly shorter than desirable stopping sight distances do not present an unsafe operating condition, because of the conservative assumptions made in establishing desirable stopping sight distances. It is important to remember that any sign is a roadside object and that it should be installed only when its need is clearly demonstrated.
- New or reconstructed roadways (and roadway sections) should be designed to accommodate operating speeds consistent with the roadway's highest anticipated posted speed limit based on the roadway's initial or ultimate function.

Section 3: Factors Affecting Safe Speed

Introduction

This section discusses various factors influencing drivers and their perception of the safe speed at which to operate a vehicle. Because so many variables affect the safe operating speed of vehicles, it is not practical to consider each individually. These factors should be considered as a whole and weighed accordingly.

Design and Physical Factors of the Roadway

The design and physical factors of the roadway place a definite limitation on the safe operating speed of vehicles. These factors include:

- horizontal and vertical curves
- hidden driveways and other roadside developments
- high driveway density
- rural residential or developed areas
- lack of striped, improved shoulders.

Chapter 5, Section 2, Curves and Turns, and Chapter 5, Section 5, Descending Grades of Six Percent or Greater of this manual provides the methods that must be used to determine if a curve or an obstruction to sight distance requires an advisory speed restriction.

The effects of such factors as lane width, condition of surface, type and width of shoulders, frequency of intersections, and roadside development are not so easily measured. As a general rule, especially on tangents, these factors will be measured on the basis of prevailing speeds as determined by speed checks.

The Vehicle

The mechanical condition of vehicles and their characteristics for accelerating, decelerating, stopping, and turning definitely affect safe speeds.

The body roll angle of different makes of cars and year models of the same make also affects the safe operating speed on curves.

Braking capabilities of different vehicles, such as passenger cars, buses, and various truck-trailer combinations, are obviously different, and it would generally not be practical to post safe speeds for each group.

Normally, the posted speed will be that for the passenger car.

The Driver

The ability of different drivers varies from skillful to those who would not be able to pass an examination for an operator's license if required to take one. It would not be wise to post safe speeds for drivers at either of the two extremes of abilities, so the selection of speeds to be posted will be aimed at the ability and performance of the average driver.

Average driver ability, of course, is considered in the form of perception — reaction time in the calculation of critical approach speeds to intersections, crosswalks, and locations with limited sight distance and in determining the posting distance for signs.

Traffic

The presence of other vehicles on the highway — including those that may be entering, crossing, turning off, or parked — definitely affects critical speeds.

The frequency of pedestrians is likewise an important factor. This is especially true at intersections with limited sight distance and at approaches to crosswalks.

The speeds shall be posted for off-peak hour traffic on an average weekday for the purpose of the procedures outlined herein. This will require drivers to adjust their speeds to lower values at times of peak hour traffic at some locations.

Weather and Visibility

Speeds will normally be selected and posted for good weather conditions and dry pavement. Texas law, however, also provides for the posting of speeds for wet weather conditions.

Except in cases where the statewide maximum legal limits are posted, speeds will normally be posted on the basis of daylight speed values determined under good weather conditions.

When it can be shown that it is required during wet or inclement weather, a wet weather speed zone may be established by Transportation Commission minute order. The wet weather speed limit should be posted in addition to the regular posted speed zone. When appropriately signed, this wet weather speed limit will be effective during wet weather at any time during hours of daylight and darkness.

Accident Reconstruction Speed Limits

Transportation Code, Section 545.3561 gives municipalities and counties the authority to temporarily lower prima facie speed limits at the site of a crash investigation using vehicular accident reconstruction. The municipality or county must use a transportation engineering official with experience establishing speed limits. For a municipality, the authority applies to a highway or part of a highway in the municipality, including a highway in the state highway system. For a county, the authority does not apply to a road or highway in the state highway system.

In establishing the speed limit, the municipality or county is not required to conduct an engineering and traffic study or comply with other provisions of this subchapter. To set the temporary speed limit, the municipality or the county must:

- follow safety guidelines as developed by the department for setting regulatory construction speed limits in work zone areas,
- provide notice to the department district engineer in the district in which the accident reconstruction is occurring at least 48 hours prior to the speed reduction, and
- during the time that the accident reconstruction is being conducted, place and maintain temporary speed limit signs that conform to the Texas Manual on Uniform Traffic Control Devices (TMUTCD), temporarily conceal all other signs that permit higher speeds, and remove the temporary signs and concealments when the accident reconstruction is complete.
- Notification to the department district engineer should be documented using the Notification Speed Limit Reduction for Crash Reconstruction (TxDOT Form 2455). The form is available via hyperlink--click on the form number above--or from the Traffic Operations Division.

If a traffic lane will be closed to accommodate the reconstruction investigation, the municipality or county must follow all department rules and guidelines on lane closures.

The department may remove any temporary speed limit signs or concealments of speed limit signs that are not removed by the municipality at the conclusion of the accident reconstruction.

Chapter 2: Regulatory and Advisory Speeds

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Section 1: Application of Regulatory and Advisory Speeds

Introduction

When an engineering and traffic investigation shows that the statutory speed limits are no longer applicable for the existing conditions, the **prima facie** maximum speed limits should be altered accordingly with a speed zone.

The types of speed zones are as follows:

- regulatory
- construction
- school
- private road.

Each type of zone and its use is discussed later in this chapter.

Advisory speeds may be posted within speed zones to advise drivers of a safe operating speed to negotiate roadway features. This section discusses regulatory speeds and advisory speeds and explains their differences.

Regulatory Speeds

Regulatory speed zones should be applied only to those locations and sections of highways which are not dealt with adequately by the general statewide speed limits, and they should be indicators of the speed limitations imposed by physical and traffic conditions at such locations. Speed limits are determined by specific roadway and traffic conditions. Speed limits should not be lowered to the extent necessary for a driver to avoid a collision with a pedestrian or other motorist who is entering or crossing the highway in violation of an existing traffic regulation.

Roadway safety is an important consideration in establishing speed limits. The following factors affect roadway safety and, therefore, should be considered when establishing speed limits:

- horizontal and vertical curves
- hidden driveways and other roadside developments
- high driveway density
- crash history along the location
- rural residential or developed areas
- lack of striped, improved shoulders.

Advisory Speeds

Advisory speeds are the desirable speeds for curves, intersections, or other locations where design standards or physical conditions of the roadway restrict safe operating speeds to values less than the maximum legal speeds or posted regulatory speed limit. Figure 2-1 illustrates the use and application of warning signs with advisory speeds. For additional information on determining advisory speeds, see Chapter 5, Application of Advisory Speeds.

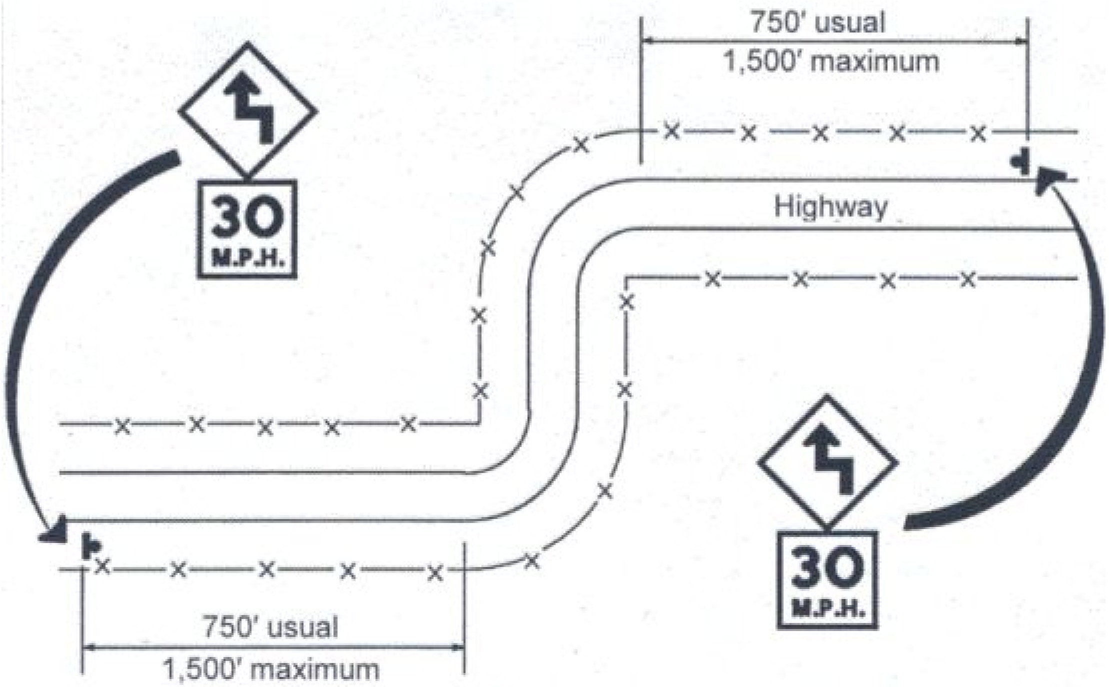

Figure 2-1. Typical applications of warning signs with advisory speeds. Note that distances shown are from the point of curvature.

Advisory Speed Sections in Regulatory Zones

If an advisory speed is located within a regulatory speed zone, it is not necessary to lower the zone speed to conform with the advisory speed. In erecting the signs, however, care should be taken not to erect a regulatory speed limit sign so near the advisory speed sign that drivers may become confused by two different speed values.

An advisory speed within a regulatory speed zone should not be posted for a value higher than the posted speed of the regulatory speed zone. Care should also be taken not to place a regulatory speed sign between an advisory speed sign and the location to which the advisory speed applies.

Regulatory Versus Advisory Speeds

Advisory speeds are determined primarily by physical and design characteristics of the roadway. The setting of regulatory speeds, while also affected by physical and design factors, is determined in large part by existing free flow traffic speeds.

A Transportation Commission minute order, city ordinance, or county ordinance is not required for advisory speed zones but is required for regulatory speed zones. Therefore, advisory speed zones are more flexible in that they can be changed without revising existing Commission minute orders or city or county ordinances.

From the standpoint of enforcement, when a regulatory speed zone has been established and signs are posted, the speed values shown on the signs are the maximum lawful **prima facie** speeds. An advisory speed sign serves to advise drivers of safe speeds that are recommended for certain roadway conditions, such as horizontal curves. It does aid the enforcement officer, however, in determining reasonable and prudent speeds. A driver might be cited for exceeding the posted value of an advisory speed zone on the grounds that they were driving at a speed that was not reasonable and prudent for the conditions existing at the time and location.

Section 2: Regulatory Speed Zones

Introduction

A regulatory speed zone is the application, by Transportation Commission minute order, city ordinance, or county ordinance, of posted legal speed limits to sections of roadway where the numerical values of these special speed limits have been determined through engineering investigations of traffic and physical conditions.

Transportation Code, Chapter 545, Subchapter H, Section 545.362 established the method whereby the statewide maximum speed limit is altered by the national maximum speed limit laws. This function is administered by the Texas Department of Transportation (TxDOT) Traffic Operations Division (TRF) through the Texas Transportation Commission. However, Section 545.362 expired by its own terms upon repeal of the national maximum speed limit.

Within Incorporated Cities or Towns

The Texas Transportation Commission has the authority to alter the speed limits on highways within the corporate limits of cities or override a speed limit set by city ordinance on such highways.

TxDOT should make studies and present recommendations to the city for their acceptance and passage of a city ordinance to establish city speed zones.

Setting of speed limits within a city by Transportation Commission minute order should only be used as a last resort. TxDOT should make every effort to secure the cooperation of the city so that speed zones will be set by city ordinance.

Highway Approaches to Incorporated Municipalities

Speed zoning of highway approaches to municipalities should find its greatest application near the cities and towns where built-up business and residence areas require speeds below the statewide maximum for safe operation.

Graduated or buffer zones may be used on approaches to cities and towns to accomplish a gradual reduction of highway speeds to the speed posted at the city limits.

Minimum Speed Limits

The need for minimum speed limits should be determined through an engineering and traffic investigation. When such a speed is justified, it should be regulated in the same manner as maximum speed limits are regulated.

Minimum speed limits are generally justified when studies show that slow moving vehicles on any part of a highway consistently impede the normal and reasonable movement of traffic to such an extent that they contribute to unnecessary lane changing or passing maneuvers.

The maximum speed limits and the need for minimum speed limits must be determined from the same speed check data. Chapter 3, Determining the 85th Percentile Speed, contains a discussion of the 85th percentile speed and minimum limits.

MINIMUM SPEED LIMIT signs (R2-4) shall be displayed in conjunction with and beneath the MAXIMUM SPEED LIMIT signs (R2-1) or as an integral sign (R2-4a).

Regulatory Speed Signs (R2 Series)

Signs for regulatory speed zones shall be from the R2 series as shown in the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) and shall be of the appropriate design — including size, text, and color. At the end of speed zones on conventional highways where the maximum legal rural speeds are permissible, an R2-1 SPEED LIMIT XX sign (or larger size sign showing those limits) should be erected in accordance with the TMUTCD. At the end of speed zones on freeways where the maximum legal rural speeds are permissible, The R2-1 SPEED LIMIT XX sign showing those limits shall be erected.

Figure 2.2 illustrates the typical location and frequency of signs for regulatory speed zones. Distances shown between speed limit signs are examples and may be greater, depending on the results of speed checks. Posted regulatory speed limits will be based on the 85th percentile, as described in Chapter 3, Determining the 85th Percentile Speed.

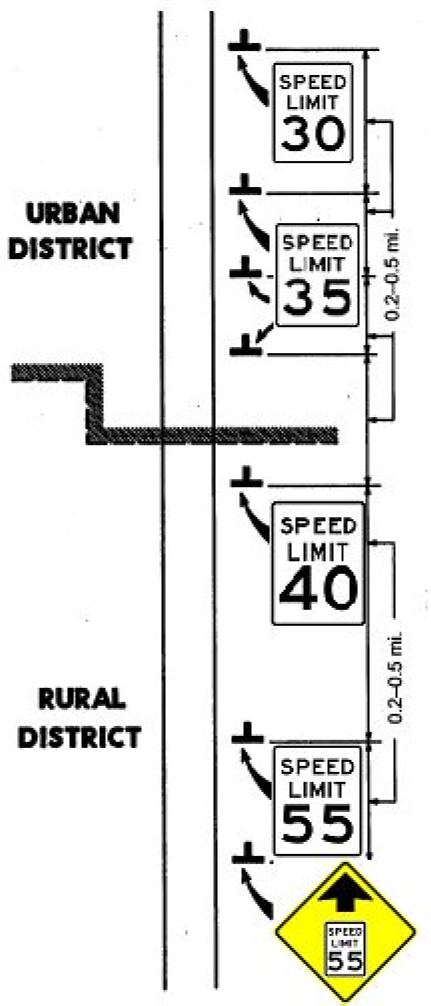

Figure 2-2. Example regulatory speed zone application showing spacing of signs transitioning from rural district to urban district and within the urban district.

Signs Within Cities and Towns

TxDOT may erect and maintain speed limit signs on highway routes within the corporate limits of cities and towns where speed limits, based on the results of an engineering and traffic investigation, are established.

Section 3: Construction Regulatory and Advisory Speeds

Introduction

Transportation Code, Section 472.022 defines barricades and warning signs and makes it unlawful to disobey their instructions. Studies have shown that in the absence of enforcement no significant differences will occur in drivers' speeds between sections signed with advisory construction speed signs and with regulatory speed signs.

Transportation Code, Section 472.022 also refers to disobedience of warning signs in construction or maintenance zones.

From the standpoint of enforcement, when a regulatory speed zone has been established and signs are posted, the speed values shown on the signs are the maximum lawful **prima facie** speeds. An advisory speed sign serves to advise drivers of safe speeds that are recommended for certain roadway conditions, such as horizontal curves. It does aid the enforcement officer, however, in determining reasonable and prudent speeds. A driver might be cited for exceeding the posted value of an advisory speed zone on the grounds that they were driving at a speed that was not reasonable and prudent for the conditions existing at the time and location.

Traffic control in work sites should be designed on the assumption that drivers will only reduce their speeds if they clearly perceive a need to do so; therefore, reduced speed zoning should be avoided as much as practicable.

Advisory Construction Speeds

Advisory speed plates (CW13-1) in conjunction with construction warning signs can often be used more appropriately than construction regulatory speed signs. The advisory speed can be altered as needed by project conditions, and several different advisory speeds can be used for varying conditions throughout the project. The advisory speed plates are intended to supplement construction warning signs advising drivers of a safe speed to drive through the section signed. See Part 6 of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) for sign detail and typical application diagrams.

Regulatory Construction Speed Zones

Regulatory construction speed limits should be used only for sections of construction projects where speed control is of major importance and enforcement is available. Regulatory construction speed signs (R2-1) must be removed during periods when they are not needed to minimize interference with traffic (see Part 6 of the TMUTCD for sign detail).

A misconception that construction speed zones are required to improve TxDOT's position in the event of a tort claim prompted the Occupational Safety Division to seek an opinion on the matter from the Attorney General's Office. The response indicated that TxDOT's best defense against a tort action would be to have strict compliance with the TMUTCD.

According to Part 6 of the TMUTCD, reduced speed zoning should be avoided as much as practicable.

Reduced speeds should only be posted in the vicinity of work being performed and not throughout the entire project.

For example, it may not be desirable to post a construction speed zone when concrete traffic barriers are used in traffic control plans, since these barriers normally provide sufficient protection for the construction workers and the traveling public. In addition, traffic control plan designs should, as much as possible, accommodate the speeds existing prior to construction. These decisions, however, require engineering judgment depending on the nature of the project and other factors which affect the safety of the traveling public and construction workers.

On sections of highway under construction, speed studies and other studies normally made in determining speeds to be posted for a regulatory speed zone are not required. In selecting the speeds to be posted, however, consideration should be given to safe stopping sight distances, construction equipment crossings, the nature of the construction project, and any other factors which affect the safety of the traveling public and construction workers.

Only those speed limits authorized by Transportation Commission minute order, city ordinance, or county ordinance are legal, and no other speed limits should be posted using regulatory speed limit signs. Construction speed zones are automatically canceled when construction is complete.

Request for Regulatory Construction Speed Zones

When a district desires construction speed zoning for projects or portions of a project outside the limits of incorporated cities, the district should prepare and submit TxDOT Form 1204, "Request for Construction Speed Zone," to the Traffic Operations Division (TRF) for review and processing for Transportation Commission action. The "Request for Construction Speed Zone" form is self-explanatory, with instructions contained on the reverse side. The form is available via hyperlink (click on the form number above) or from TRF.

Cities have the authority to establish construction speed zones within their corporate limits, and this should be encouraged, since the city will likely be responsible for enforcement. However, if a city desires the Transportation Commission to establish the zones, then the district should have a written request from the city on file.

Advisory Speed Construction Warning Plates (CW13-1)

The CW13-1 ADVISORY SPEED plate may be used in conjunction with any construction warning sign to indicate the maximum safe speed for passenger cars around a curve or through a hazardous location. It shall not be used in conjunction with any sign other than a construction warning sign, nor shall it be used alone.

The CW13-1 plate shall always be mounted on the same post with, and immediately below, the construction warning sign to which it applies.

The CW13-1 plate is classed with the construction warning signs because, when used, it is in effect a part of a construction warning sign.

Regulatory Construction Speed Limit Signs

R2-1 SPEED LIMIT signs shall be used for signing construction speed zones.

Speed limit signs shall be erected only for the limits of the section of roadway where speed reduction is necessary for the safe operation of traffic and protection of construction personnel. In most cases, this will involve only a short section of roadway where work is in progress, but in some cases, it will involve partially completed sections extending for some distance.

It is imperative that proper speed limits be posted in construction work zones. Improperly posted work zone speed limits adversely affect the flow of traffic by:

- encouraging driver disrespect for all speed limits
- endangering the driver who observes an unreasonably low posted speed limit.

The reduced speed limits are effective only within the limits where signs are erected, even though the entire length of the project may be covered by Transportation Commission minute order. Figure 2-3 shows typical signing of a construction speed zone.

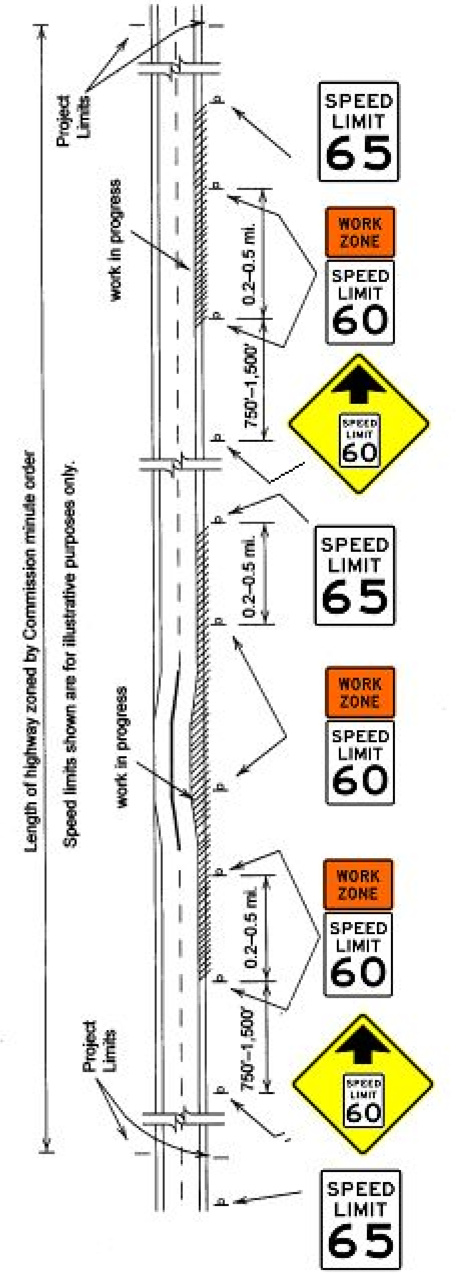

Figure 2-3. Typical construction speed zone.

Covering or Removing Temporarily Unnecessary Reduced Speed Signs

If the reduced speed limits are not necessary for the safe operation of traffic during certain construction operations or those days and hours the contractor is not working, the regulatory construction speed limit signs must be made inoperative by one of the following methods:

- moving the signs to the edge of the right-of-way and facing them away from the roadway **or**
- covering the signs when the reduced speed limits are not necessary (care should be taken, however, to delineate the sign post so it does not become an invisible obstacle at night adjacent to the roadway).

Leaving speed limit signs in place when not needed has at least three adverse effects:

- drivers ignore the signs, and by doing so, they are subject to arrest
- respect for all speed limit signs is lessened
- the law abiding driver becomes a traffic hazard by observing the reduced speed.

Signs Installed by the Contractor

Even though a contractor is allowed to furnish and/or install speed limit signs on a construction project, the engineer must see that the contractor does not erect any signs of their own design with speed limits of their choosing. **Except under the immediate direction of the engineer, the contractor has no responsibility whatsoever for the design, location, or maintenance of speed limit signs**.

Section 4: School Speed Zones

Introduction

Reduced speed limits should be used for school zones during the hours when children are going to and from school. Usually such school speed zones are only considered for schools located adjacent to highways or visible from highways.

Pedestrian crossing activity should be the primary basis for reduced school speed zones. However, irregular traffic and pedestrian movements must also be considered when children are being dropped off and picked up from school.

Planning

The Texas Department of Transportation (TxDOT) should make certain that all applicable traffic control devices are utilized to prevent problems in school areas. Maintaining contact with school officials can help TxDOT become aware of proposed building programs or other problems at an early stage so that solutions will be more promptly implemented. When proposed building plans are known, it may be possible to offer suggestions on access points that will prevent future problems. Also the installation of needed safety and traffic control devices can be scheduled to be in place when needed.

An engineering and traffic investigation should be conducted to determine the need for a reduced school speed limit as well as all appropriate traffic control devices to provide maximum safety.

Prompt Installation Important

Districts should initiate the installation of school speed limit signs and flashers immediately after submitting the request to the Traffic Operations Division (TRF) for Transportation Commission action. Every effort should be made to have these signs in operation as soon as practical after the minute order is approved by the Transportation Commission. If, for some reason, there is a delay in the installation of a school flasher, other static signs for school zones should be installed as soon as possible after the minute order is enacted.

Signs

Where TxDOT is responsible for signing school speed zones, the zones shall be signed with a combination of the S4-3 SCHOOL and the R2-1 SPEED LIMIT sign assembly. Flashing beacons shall also be used with the S4-4 WHEN FLASHING sign to identify the periods the school speed limit is in force. One sign, S5-1, could be used, which is a combination of these. The S5-1 SCHOOL SPEED LIMIT XX WHEN FLASHING may be used in place of the S4-3, R2-1, and S4-4. A Transportation Commission minute order, city ordinance, or county ordinance authorizing the reduced speed limit is required prior to use of these signs in school zones.

Cities should be allowed to sign school speed zones in accordance with the other options set out in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

The S4-3, R2-1 and S4-4 sign assembly with flashers shall be mounted on a permanent type mounting and placed at each zone limit of the section of highway, road, or street through which the speed limit has been reduced. The sign assembly with flashing beacons may be placed off the shoulder of the road, in the median, or overhead to face traffic entering the school speed zone. An illustration of signing for school speed zones is shown in the TMUTCD. Other types of signs used by cities should be similarly located in conformance with the TMUTCD.

Intervals of Operation

Generally, the zones indicated on the signs should be in effect only during the following specified intervals:

- from approximately 45 minutes before school opens until classes begin
- from the beginning to the end of the lunch period
- for a 30 minute period beginning at the close of school.

The intervals of operation of the flashing beacons on the school zone speed limit assembly may be extended or revised for school events as mutually agreed upon by the school district and the entity responsible for the operation of the flashing beacons. In this case, the flashing beacons should only be operated when there is an increase in vehicular activity and pedestrian traffic in and around the roadway associated with the school event.

More Information

See the TMUTCD, Part 7, for more details on school areas. For more details on the school speed zone, see Chapter 3, Section 3, “Developing Strip Maps,” under the heading: Schools.

Section 5: Private Road Speed Zones

Introduction

In addition to setting speeds on highway routes, Transportation Code, Chapter 542, Section 542.006, requires the Texas Transportation Commission to establish speed limits and erect necessary signing on private roads under certain conditions.

Eligibility Requirements

To be eligible for speed zoning, a private road must:

- be located in a subdivision that has a total of 400 or more residents or is adjacent to one or more other subdivisions that, together with the subdivision through which the road runs, have a combined total of 400 or more residents (all subdivisions included in the count must have plats filed in the deed records of a county)
- be located outside of an incorporated area
- be patrolled or scheduled to be patrolled by a law enforcement entity.

Process Initiation

The process for speed zoning private roads must be initiated by petition from the majority of property owners along the road for which zoning is requested.

Procedure

Districts receiving inquiries concerning establishment of speed zones on private roads should proceed as follows:

1. Request that the petitioners submit the names and addresses of all owners and residents of property directly abutting the portion of route to be zoned at the time the petition is delivered to the district office and indicate on this list which property owners are agreeable to having signs erected on their property.
2. Does the private road meet the eligibility requirements described earlier in this section?
   - If **yes**, continue to Step 3.
   - If **no**, return the petition, and advise the petitioners as to the reasons it does not qualify.
3. Verify the ownership of all the parcels abutting the roadway under consideration. Have a majority of the owners signed the petition?
   - If **yes**, proceed to Step 4.

- If **no**, return the petition, and advise the petitioners as to the reasons it does not qualify.

4. Determine if it is in the interest of the residents of the area and the public generally to establish speed restrictions. (The data required to determine the desirability of speed restrictions would include speed zone studies and strip maps, or other suitable plat or roadway layouts.) Also determine if any law enforcement currently does or will patrol the roadway.

5. Submit recommendation for or against the speed zoning along with results of the study to the Traffic Operations Division (TRF). NOTE: TRF will prepare the minute order to obtain Transportation Commission approval. Upon receiving Transportation Commission approval proceed to Step 6.

6. Erect the necessary signs and notify local enforcement authorities upon installation of the signs.

7. Inspect and maintain signs erected by TxDOT as necessary. (Signs placed by TxDOT are normally maintained by TxDOT.)

Petitions Rejected by the Transportation Commission. If the Transportation Commission rejects the petition, then the commission will hold a public hearing on the advisability of making the speed restrictions applicable. For more details, see Transportation Code, Section 542.006(c), (d), and (e).

Chapter 3: Speed Zone Studies

Contents:

Section 1: Overview

Engineering and Traffic Investigation

This chapter includes information concerning interim speed limits for a new or reconstructed highway and a description of how to conduct an engineering and traffic investigation as the basis for establishing a regulatory speed zone along a roadway. This investigation is commonly called a "speed zone study."

Sound and generally accepted engineering practices are an integral part of such speed zone studies and are discussed in Section 4, Speed Zone Design of this chapter.

Interim Speed Limits for New or Reconstructed Highways

An interim speed limit for a new or reconstructed highway shall be determined and posted before the highway is opened to traffic.

To set an interim speed limit, a traffic and engineering investigation will be conducted.

The traffic and engineering investigation will include a review of:

- the statuatory prima facie speed applicable to the highway
- the design speed applicable to the highway
- a trial run speed study for the highway.

To set an interim speed limit at a speed that is less than the prima facie speed applicable to the highway, a commission minute order or a city ordinance setting the interim speed limit is required.

Warning signs and advisory speed signs may be used on a highway with an interim speed limit to alert drivers to any hazards.

When traffic speeds have stabilized on a highway, an 85th percentile speed study will be conducted as discussed under Section 2 of this chapter. The interim speed limit will be used on the highway until the maximum speed for the highway is determined following the conclusion of that investigation.

Scope of Study

The speed zone study should cover the entire length of a potential zone, even though an analysis of the data may later indicate that the actual limits of the area that requires zoning are less than the limits of the potential zone.

A speed zone study consists of the following principle areas:

- determining the 85th percentile speed

- crash study
- developing of strip maps
- speed zone design
- rechecks of speed zones.

This chapter contains sections describing each of these areas.

Section 2: Determining the 85th Percentile Speed

General Concepts

The maximum speed limits posted as the result of a study should be based primarily on the 85th percentile speed, when adequate speed samples can be secured. The 85th percentile speed is a value that is used by many states and cities for establishing regulatory speed zones.

Speed checks should be made as quickly as possible, but it is not necessary to check the speed of every car. In many cases, traffic will be much too heavy for the observer to check all cars.

Theory

Use of the 85th percentile speed concept is based on the theory that:

- the large majority of drivers:
  - are reasonable and prudent
  - do not want to have a crash
  - desire to reach their destination in the shortest possible time
- a speed at or below which 85 percent of people drive at any given location under good weather and visibility conditions may be considered as the maximum safe speed for that location.

Statistical Rationale

The results of numerous and extensive “before-and-after” studies substantiates the general propriety and value of the 85th percentile criterion.

Statistical techniques show that a normal probability distribution will occur when a random sample of traffic is measured. From the resulting frequency distribution curves, one finds that a certain percentage of drivers drive too fast for the existing conditions and a certain percentage of drivers travel at an unreasonably slow speed compared to the trend of traffic.

Most cumulative speed distribution curves “break” at approximately 15 percent and 85 percent of the total number of observations (see Figure 3-1). Consequently, the motorists observed in the lower 15 percent are considered to be traveling unreasonably slow and those observed above the 85th percentile value are assumed to be exceeding a safe and reasonable speed. Because of the steep slope of the distribution curve below the 85th percentile value, it can readily be seen that posting a speed below the critical value would penalize a large percentage of reasonable drivers.

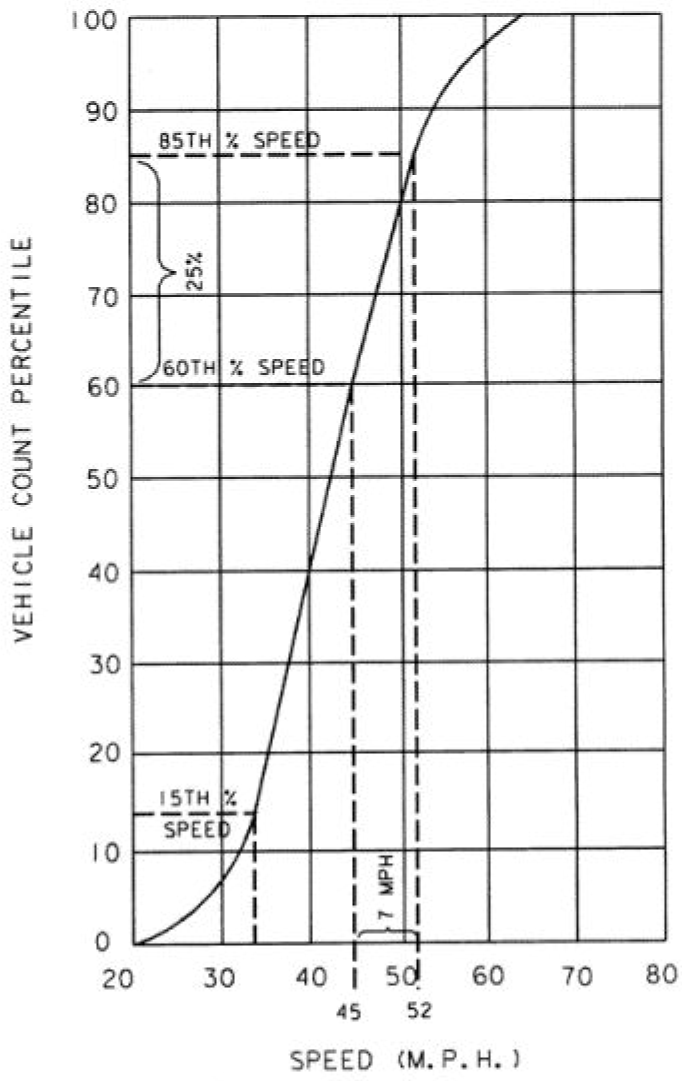

Figure 3-1. Cumulative speed distribution curve

The example illustrated in Figure 3-1 shows that a speed posted for 7 miles per hour below the 85th percentile speed would unfairly penalize 25 percent of the drivers who would otherwise be considered to be driving at a reasonable and prudent speed. Therefore, for purposes of speed zoning, the maximum posted speed should be as near as possible to the 85th percentile value, and whenever minimum speed zones are used, the minimum posted speed should be within 5 miles per hour of the 15th percentile value. (See Chapter 2, Section 2, for additional information on Minimum Speed Limits.)

Experience proves these findings valid and shows that the 85th percentile speed is the one characteristic of traffic speeds that most closely conforms to a speed limit which is considered safe and reasonable.

Speed Checks for Existing Highways

Speed checks are of prime importance, because they:

- represent the consensus of drivers as to the safe speed at a given location
- provide the basic data on which the regulatory speed zone is based.

Speed Checks for New or Reconstructed Highways

Speed checks on new or reconstructed highway sections should not be performed until it is apparent that the traffic speeds have stabilized.

Operation of Speed Check Stations

Normal speed checks should:

- be made on average week days at off-peak hours
- be made under favorable weather conditions
- include only “free floating” vehicles (see following paragraph)
- include a minimum of 125 cars in each direction at each station
- be discontinued after two hours if radar is used, or after four hours if a traffic counter that classifies vehicles by type is used — even if 125 cars have not been timed.

The vehicles checked should be only those in which drivers are choosing their own speed (“free floating”). When a line of vehicles moving closely behind each other passes the speed check station, only the speed of the first vehicle should be checked, since the other drivers may not be choosing their own speed. Cars involved in passing or turning maneuvers should not be checked, because they are probably driving at an abnormal rate of speed.

Trucks and busses should be recorded separately and should not be included as part of the 125-car total.

Location of Speed Check Stations

A complete picture of speeds in an area can only be obtained through the proper location of speed check stations. Ideally, speed checks at an infinite number of locations would be desirable; however, since this is not practical, speed check stations must be strategically located to show all the important changes in prevailing speeds.

In urban areas and on approaches to cities, speed check stations:

- should generally be located at intervals of 0.25 mile or less if necessary to insure an accurate picture of the speed pattern

- should be located midway between signals or 0.2 miles from any signal, whichever is less, to ensure an accurate representation of speed patterns
- should take into account the locality and the uniformity of physical and traffic conditions
- may be determined by trial runs through the area if volumes are too low or if a recheck of speeds is all that is needed
- should be checked midway between interchanges on the main lanes of expressways and freeways.

In rural areas, speed check stations:

- may be at intervals greater than 0.25 mile, as long as the general speed pattern is followed
- may only be necessary at each end and the middle point if the characteristics of the roadway are consistent throughout the entire section
- may be determined by trial runs through the area if the characteristics of the roadway are consistent throughout the entire section and a speed check in that section indicates that 125 vehicles cannot be checked within the two hours if radar is used, or after four hours if a traffic counter that classifies vehicles by type is used.

Measuring Speeds

Radar speed meters which operate on the radar principle are normally used for making speed checks. These devices operate from the power of an automobile battery and give direct readings of vehicle speeds in miles per hour which are accurate to within 2 miles per hour.

New technologies may be used in determining vehicular speeds for use in calculating 85th percentile speed if the measured speeds are accurate to within 2 miles per hour and the gap between vehicles is 3 seconds or greater. Examples of new technologies are counter-classifiers with the capability of classifying vehicles, determining vehicular speeds, and differentiating the gap between vehicles. These devices may include video imaging, tube counters, magnetic counters, inductive counters, etc.

Recording Measured Speeds

Use TxDOT Form 1882, “Radar Motor Vehicle Speed Field Tally Sheet,” to record tally marks beside the observed speed for each vehicle. The form is available via hyperlink (click on the form number above) or from the Traffic Operations Division.

Forms for high speed (Form 1882HS) and low speed (Form 1882LS) roads are also available via hyperlink from the Traffic Operations Division.

Figure 3-2 shows an example of a completed Field Tally Sheet.

Calculating 85th Percentile Speed

Use the following procedure to calculate the 85th percentile speed:

1. Add the tally marks as shown in the “Cumulative Total” column in Figure 3-2. Note that the marks are added from the bottom up.

2. For each “Cumulative Total” column, calculate 85 percent of the total number of vehicles checked.

Example: Figure 3-2 shows that 125 cars were counted in the northbound direction. So 85 percent would be 106 (125 x 0.85 = 106). Thus, the 106th car (counting up from the bottom) represents the 85th percentile speed.

3. Determine the speed at which the car representing the 85th percentile was traveling. Again from the northbound example in Figure 3-2, the 106th car was traveling at 48 miles per hour. Thus, 48 miles per hour is the 85th percentile speed.

On the back of the Radar Motor Vehicle Speed Field Tally Sheet there is an “85th Percentile Calculation Table,” which may be used to readily determine the 85th percentile car if the total number is between 80 and 239.

In no case shall the 85th percentile speed be interpolated between two speeds in the M.P.H. column.

After the locations of the speed check stations have been decided upon and the speed checks have been made, the 85th percentile speeds should be calculated immediately in the field. By doing so, it is possible to get an idea of what the speed curve will look like and to determine if more speed check stations are needed.

Recording the Information

Record the speed check data on the strip map as described in Section 3, Developing Strip Maps of this Chapter. The blocks shown on the strip map contain the 85th percentile speed, the speed of the fastest car checked, and the number of cars checked (reading from top to bottom in order). Show a block for each speed check location for each direction of travel measured.

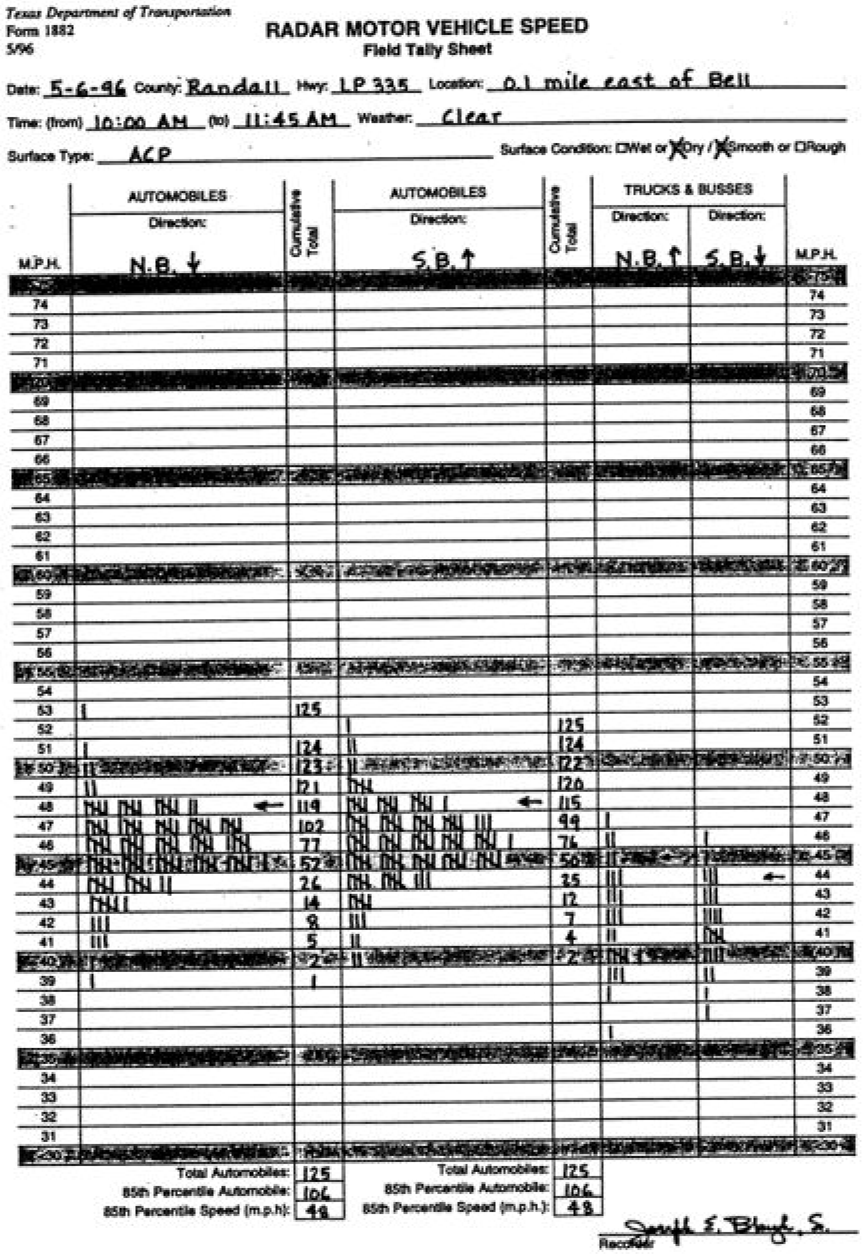

Figure 3-2. Example of completed Radar Motor Vehicle Speed Field Tally Sheet

Incomplete Data

When the data appear incomplete because of a large change in the 85th percentile speed between speed check stations or an unusually high or low 85th percentile speed at a particular point, additional speed checks should be made at new locations or repeat checks should be made at certain locations previously checked to clarify the speed picture.

Section 3: Developing Strip Maps

Strip Map Blanks

The first step in establishing a speed zone is the preparation of the strip map on which the data pertinent to the speed zone are recorded. The map should be drawn on a strip map blank. (These blanks are available from the Traffic Operations Division as a graphics file or as printed blanks.) Figure 3.3, Strip map blank (reduced in size), shows a sample strip map blank reduced in size. The blank is intended to ensure uniformity and reduce drafting work in the districts.

Scale for Strip Map

The scale used on the Road Inventory (RI-1) Highway Log Sheets is generally suitable for the strip map. In some cases, however, such as in highly developed areas, a scale of 1 inch = 300 feet is preferred. In sparsely developed rural areas, the RI-1 scale should be satisfactory. (See Figure 3.4, Typical road inventory data sheet (reduced in size), for example RI-1 sheet.)

Two different scales should not be used on the same strip map sheet. If, in zoning a long continuous section of highway, it is desirable to change the scale on the strip map, then another strip map sheet should be used for the beginning of the new scale.

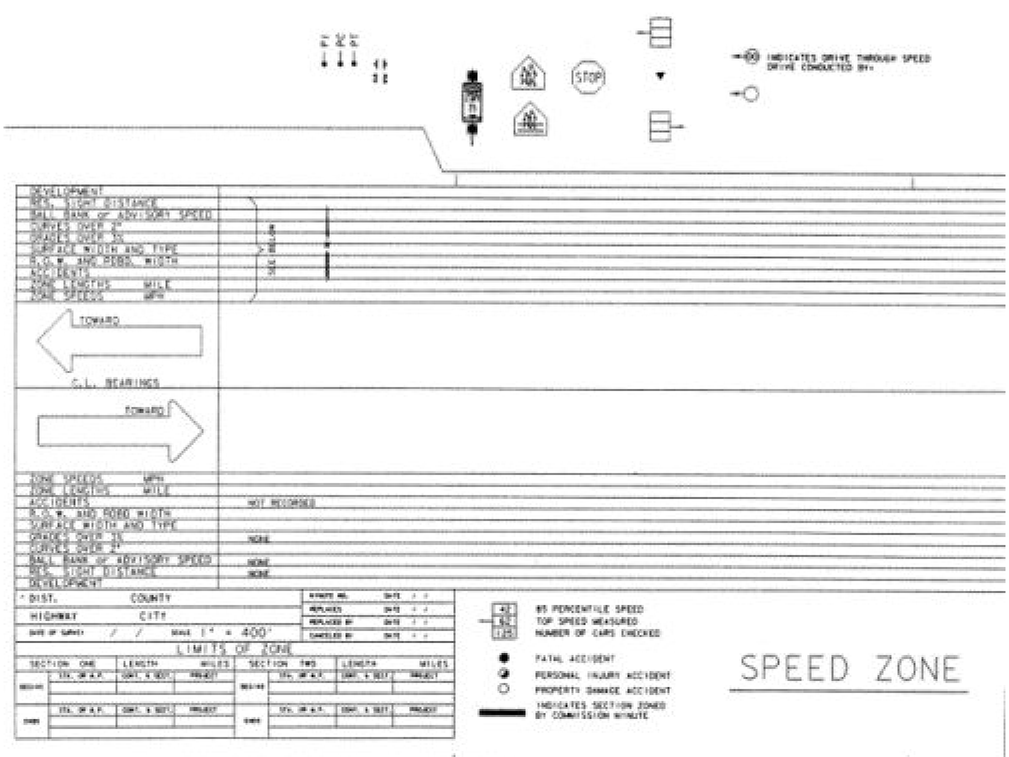

Figure 3-3. Strip map blank (reduced in size)

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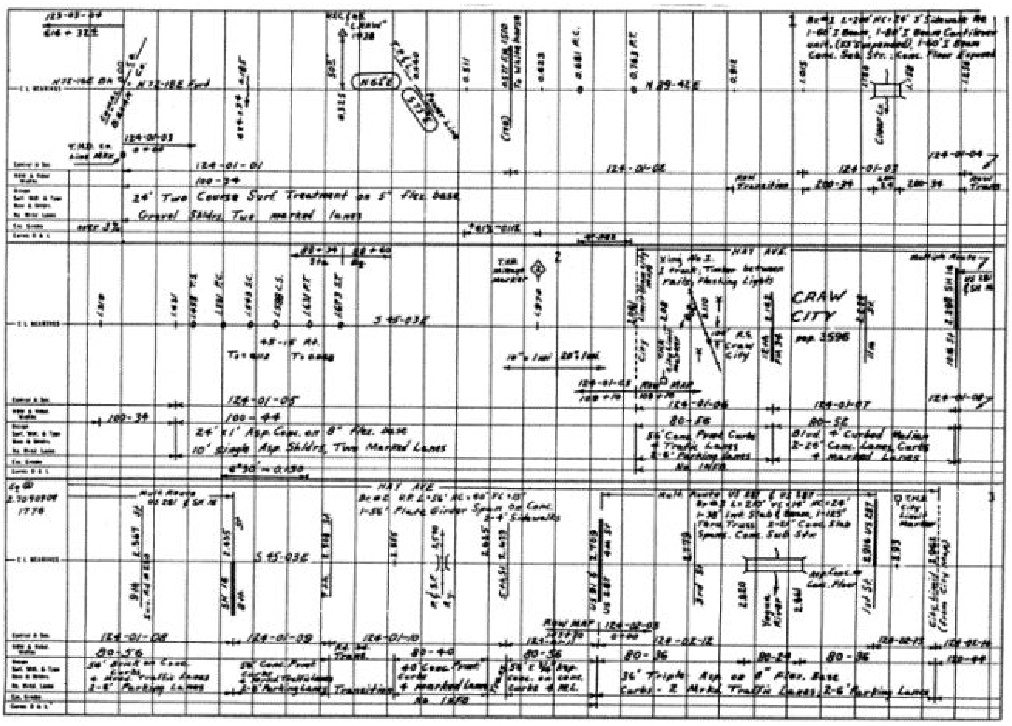

Figure 3-4. Typical road inventory data sheet (reduced in size)

Field Entry Data

The strip map should be made complete by entering field data to show road details in every aspect. The headings on the strip map blank indicate much of the required data. Figure 3-5 through Figure 3-8 show examples of how the data should be presented.

If the roadway is not divided, it is not necessary to repeat the right-of-way and roadbed width, surface width and type, grades over three percent, and curves over two degrees for both directions of travel.

In addition to the headings on the strip map blank, the following information should be shown:

Information to Show on Strip Map

Information Item	Notes
Name and highway number of the route to be zoned	• Show all names and/or highway numbers if the route has more than one name and/or highway number. • Indicate sections to be zoned by Transportation Commission minute order with a wide center line on the strip map.

Information to Show on Strip Map

Information Item	Notes
Crossroads and cross streets	• Show all names and highway numbers if the crossroads and cross streets have more than one name and carry one or more highway designations. • Show numbered highway routes by wider lines than those used for county roads and city streets.
Limits of the speed zone	Indicate reference marker and milepoint and control and section numbers. Reference markers are generally in even two-mile increments, for example: 100, 102, 104. Speed zones or distances will be measured plus or minus from the reference marker. EXAMPLE: 102+1.343
Adjoining speed zone(s) of connecting map(s)	-
Limits of any incorporated city or town	Show reference marker and milepoint and control and section numbers for these points.
Names and approximate limits of the developed area of unincorporated towns	Indicate by "beginning of developed area" and "end of developed area" under the heading, "Development" — not as "city limits."
Urban districts	• Indicate any urban district clearly under the heading "Development." • Urban district is defined in the *Texas Uniform Act Regulating Traffic on Highways* as "the territory contiguous to and including any highway or street which is built up with structures devoted to business, industry or dwelling houses, situated at intervals of less than 100 feet for a distance of 0.25 mile or more on either side."
Schools and school crossings	• Show only those schools abutting the highway. • Show location of schools. • Show all school crosswalks.
Traffic signals	Show location of existing devices to aid in proper spacing and placement of speed zone signs.
Important traffic generators	Show all factories, shopping centers/malls, and any other establishments that attract large volumes of traffic.
Ball bank readings	Show each direction of travel for all curves having a safe speed of 10 miles per hour or more below the statewide maximum speed limit.
Railroad crossings	• Indicate the number of tracks and type of grade crossing protection (crossbucks, cantilevers, crossbucks with signals, gates). • Show the name of the railroad at each crossing.
Bridges	Indicate if the roadway on the bridge is narrower than the roadway on either side of it.

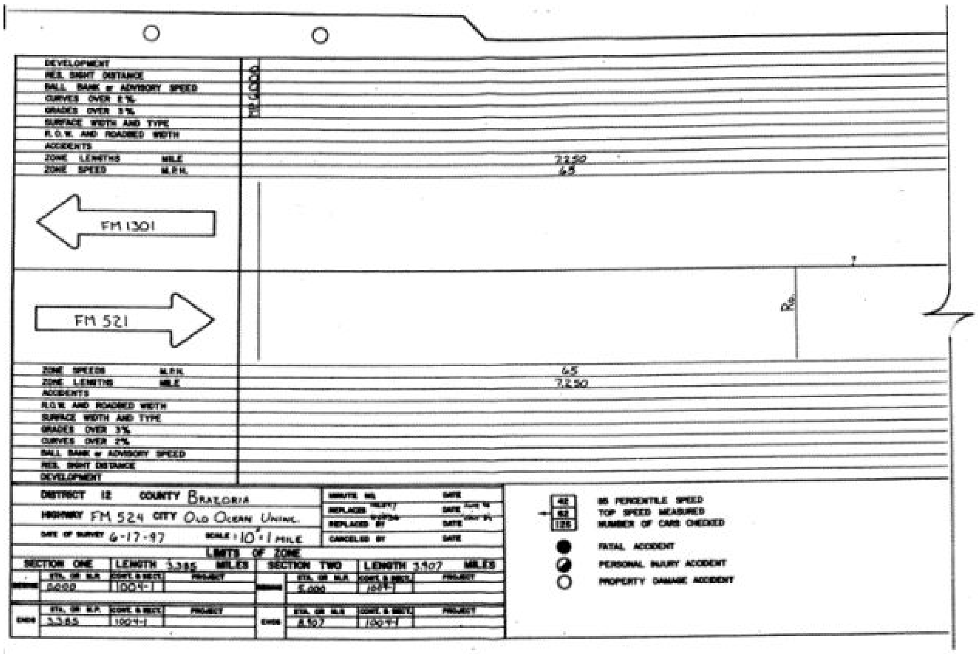

Figure 3-5. Typical speed zone through an unincorporated community (continued in Figure 3.6)

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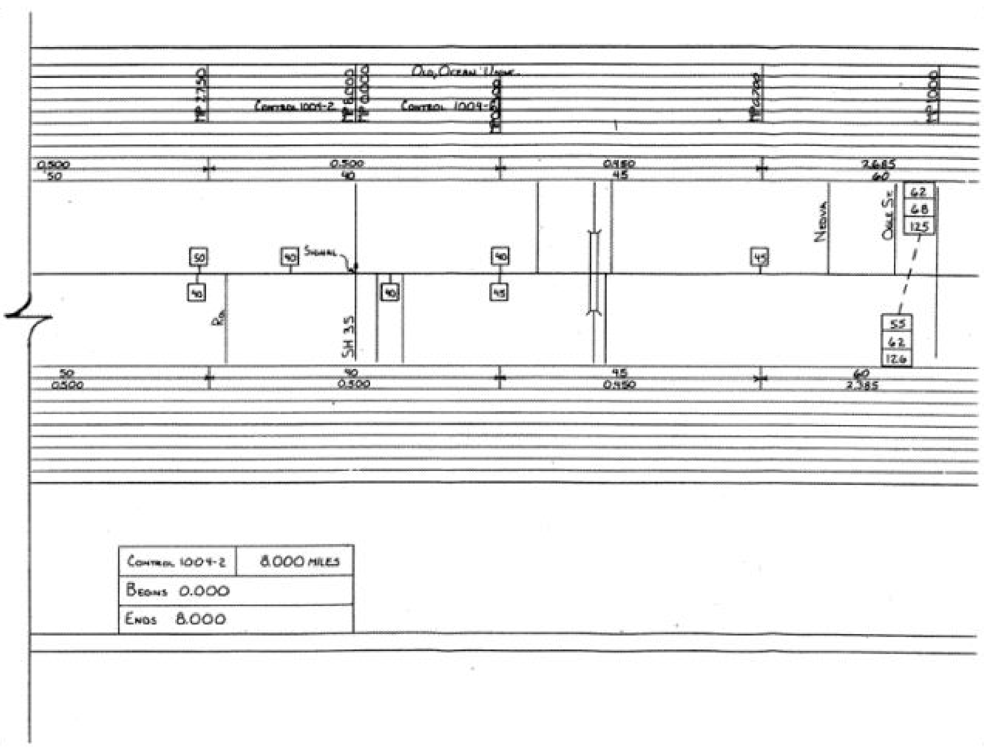

Figure 3-6. (continued from Figure 3-5). Typical speed zone through an unincorporated community

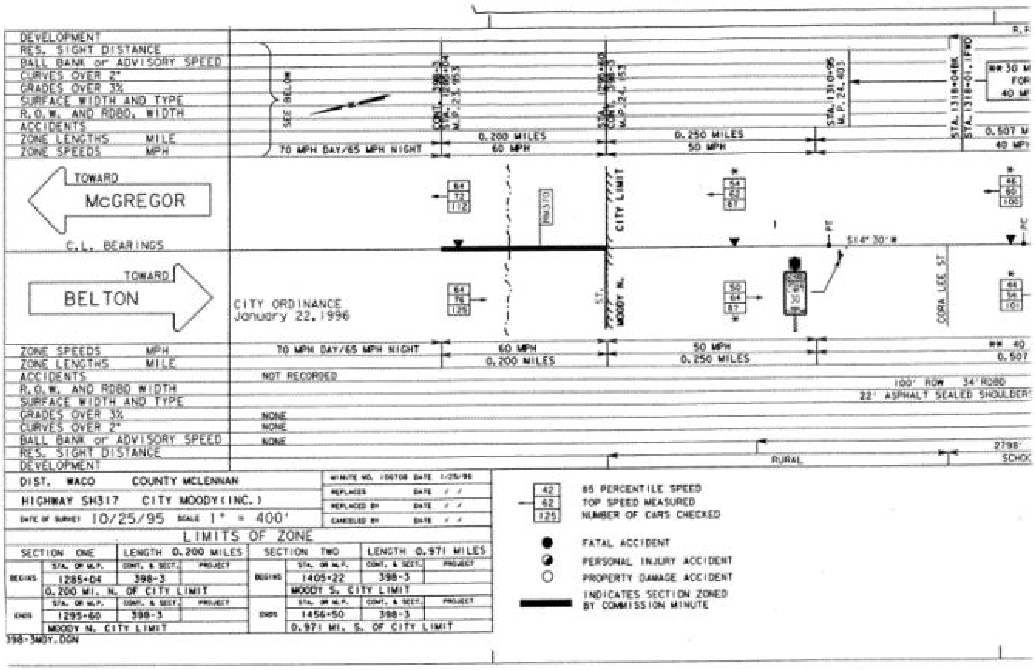

Figure 3-7. Typical speed zone on approaches to and through an incorporated area (continued in Figure 3-8)

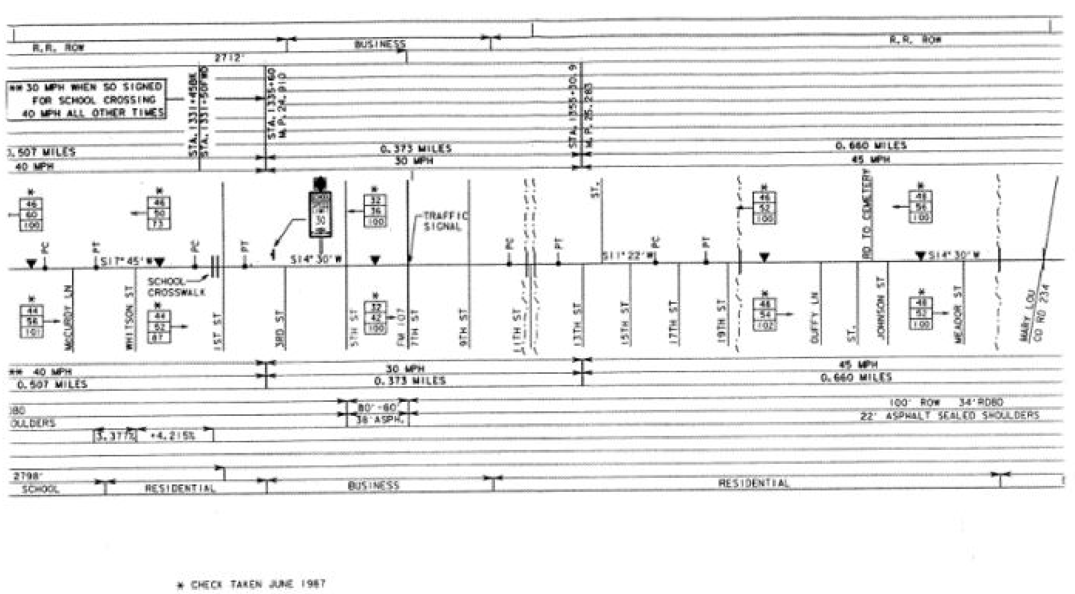

Figure 3-8. (continued from Figure 3-7). Typical speed zone on approaches to and through an incorporated area

City Limits

At locations where the study is extended into or through an incorporated city or town, the zone should be broken at the city limit, whether or not the zone speed changes. This is necessary because the speed limits inside the limits of an incorporated city or town may be established by the city government, while the speed limits outside the corporate limits of a city or town must be established by the Transportation Commission.

It is also necessary to show on the strip map the precise location of the city limit by milepoint and control section to prevent misinterpretation of the zone when the city limit is changed. The zone speed of any adjoining map should always be shown.

In the event the city limit is changed, the strip map and Transportation Commission minute order should be revised to show the new city limit.

Schools

If a reduced school speed limit is warranted, a speed zone strip map should be prepared as shown in Figure 3-7, Typical speed zone on approaches to and through an incorporated area (continued in Figure 3-8)

A regular speed zone must not change within the limits of a school speed zone, since posting of a regular SPEED ZONE sign at the point of change would prematurely terminate the school speed zone. This is due to the fact that speed limits remain fixed until a revised limit is encountered.

Speed checks provide a sound basis for selecting the proper speed limits for school zones. While it is not common practice to set speed limits significantly lower than the 85th percentile speed for regulatory speed zones, exceptions to this practice are often found at school zones.

Factual studies, reason, and sound engineering judgment, rather than emotion, should govern the final decision on the maximum deviation from the 85th percentile speed which will provide a reasonable and prudent speed limit.

It is not advisable to set a school speed limit above 35 miles per hour in either rural or urban areas. Lower school speed limits should be considered when the 85th percentile speed is below 50 miles per hour.

When the results of a speed study indicate an 85th percentile speed at or below 50 miles per hour, the reduced school speed limit should not be more than 15 miles per hour below the 85th percentile speed or normal posted speed limits. If the 85th percentile speed is 55 miles per hour, the reduced school speed limit should be 20 miles per hour below the 85th percentile speed. Any roadway with an 85th percentile speed greater than 55 miles per hour requires a buffer zone to transition down to a 35-mph speed limit.

Operation of Buffer Zones. In some cases it may be appropriate to operate the buffer zone during the same time periods as the school speed zone. This will allow motorists to travel at the higher posted speeds through both zones when the slower speeds are not necessary. An example of this would be a highway with a regular posted speed limit of 70 mph and a posted school zone speed limit of 35 mph. In this case it would be appropriate to have a school transition speed zone of 55 mph that flashes on the approach and departure side of the 35-mph school zone (see Figure 3-9). This design promotes better public relations, because people are not encouraged to violate or disrespect the law when driving through permanent transition zones that are in effect 24 hours a day. Other situations may not lend themselves to such transition zones and, therefore, should be left up to engineering judgment. The basic sign design for a school transition speed zone sign is the same as that for a regular school speed limit sign. Where TxDOT is responsible for signing school speed zones and school transition speed zones, the SCHOOL SPEED LIMIT XX WHEN FLASHING sign should be used.

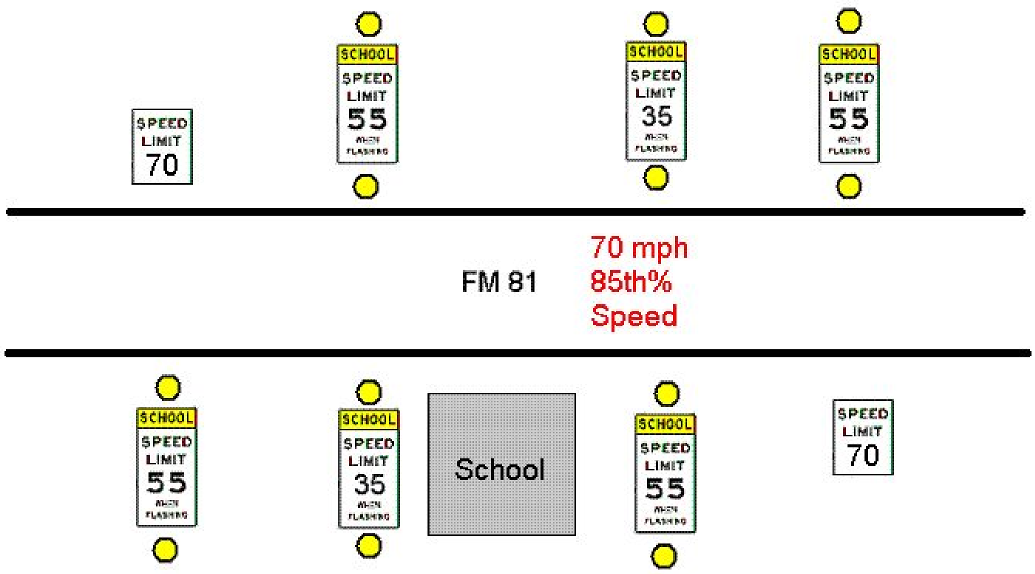

Figure 3-9. Typical school zone with flashing buffer zone

Showing Crashes on Strip Maps

At locations where recommended speed zones will be 5 miles per hour or more below the 85th percentile speed because of high crash experience, the crashes for the most recent calendar year available should be shown on the strip map. RI-1 Sheets will facilitate accurate plotting of crashes, since crash locations are coded from these sheets.

When districts submit strip maps or prints to the Traffic Operations Division (TRF) for review, TRF will obtain the crash rate for the roadway section in question as well as the statewide average crash rate for the appropriate type of roadway section and add these data to the strip map. Crash rates will be considered before lowering the zone. These data will be an important consideration in determining whether the lower zoning is justified.

Crash data need not be plotted on the strip map when proposed speed zones are within 5 miles per hour of the 85th percentile speed checks.

Section 4: Speed Zone Design

Zone Length

The length of any section of zone set for a particular speed should be as long as possible and still be consistent with the 85th percentile speeds. These zone lengths should be shown on the strip map in miles to three decimal places. Where graduated zones on the approach to the city or town are at locations where speeds fluctuate, the speed zone should generally be 0.200 mile or more.

School zones are the exception to this rule and may be as short as reasonable in urban areas, depending on approach speeds. School zones in urban areas where speeds are 30 miles per hour or less may have school zones as short as 200 to 300 feet.

Transitions

The change in speed between two adjacent zones should not normally be greater than 15 miles per hour, because the change in speed would be too abrupt for driver observance. If adjacent 85th percentile speeds show an abrupt change of more than 15 miles per hour, a transition zone of approximately 0.200 mile or more in length should be used.

Urban Areas

Texas law states that the maximum speed limit through an urban district is 30 miles per hour, unless zoned otherwise by proper authority. Therefore, a reasonable and prudent speed limit should be determined and negotiated with the city and set by city ordinance or by Transportation Commission minute order. A section of highway in this category should be speed zoned by commission minute order only if all negotiations with the city have proved unsuccessful.

Directional Differences

The 85th percentile speeds may differ considerably by direction at some locations. Such conditions are usually caused by relatively heavy development on one side of the road. Next to the development, motorists will tend to drive slower because of interference from traffic to and from the development.

On divided highways, the zone speeds should conform to the 85th percentile speed even though this may require zoning for different speeds in opposite directions.

On undivided roadways, the zones in opposite directions should be the same for enforcement purposes.

Variation from 85th Percentile

The posted speed selected is the nearest value ending in 5 or 0. The final speed limit may be lowered or raised by as much as 5 miles per hour from the 85th percentile speed or trial-run speed (if 125 cars cannot be checked during the two- or four-hour speed check) determined by the study, based on the professional judgment of the supervising engineer. Only under special conditions would the zone speed vary further from the 85th percentile. Explanations of such conditions follow.

Different Results at Adjacent Speed Check Stations. If the 85th percentile speeds for adjacent speed check stations are approximately the same, they may be averaged to determine the zone speed. Any 85th percentile speed should **not** be included in such averages if it varies more than 7 miles per hour from the speed derived from the average.

Crash Rate Greater than the Statewide Average Crash Rate for Similar Types of Roadways. When establishing a speed within an existing zone on the state highway system, the speed limit may be reduced by up to 12 miles per hour below the 85th percentile speed if the crash rate in the section of the roadway is greater than the statewide average crash rate for similar roadways. The latest speed study that has been performed on the roadway should be evaluated to determine if the information is still relevant based on the roadway traffic and characteristics. If so, then this can be used as the basis for lowering the speed limit. If the existing speed study is not valid, the district has three options:

- perform a full 85th percentile speed study
- perform an 85th percentile study at one or more locations within the segment
- perform a trial run speed study within the segment.

After determination of the 85th percentile speed, the following factors should also be considered to determine the total speed reduction up to 12 mph:

- narrow roadway pavement
- horizontal and vertical curves
- high driveway density
- lack of striped, improved shoulders
- crash history within the speed zone.

The final decision on the amount of variation should be based on the engineering judgment of the supervising engineer. Under this process, a strip map is not required. All other speed zoning rules within this manual apply for this section.

TRF will routinely provide information to the districts for roadways that meet the criteria for using this process.

Light Traffic Volumes. At locations where traffic volumes are light and 125 cars cannot be checked in the two or four hours that the speed check station is operated, the 85th percentile speed may not be reliable. Trial runs need to be made and documented in the study. ("Trial runs" are defined and explained later in this section.) Trial runs may be documented using the Summary of Trial Run for Speed Zones (TxDOT Form 1929),to supplement a strip map. (The form is available via hyperlink — click on the form number above — or from the Traffic Operations Division.) Figure 3-10, Example of completed Summary of Trial Run for Speed Zones shows an example of a completed Summary of Trial Run for Speed Zones.

Legislative or Congressional Action. Notwithstanding the volume of traffic, if legislative or congressional action results in the immediate increase in statewide maximum legal speed limits, then reasonable and prudent speed zones may be established by trial runs and engineering judgment in lieu of other speed check procedures provided in this manual. ("Trial runs" are defined and explained later in this section.) Trial runs may be documented using the Summary of Trial Run for Speed Zones (TxDOT Form 1929) instead of a strip map. (The form is available via hyperlink — click on the form number above — or from the Traffic Operations Division.) Figure 3-10, shows an example of a completed Summary of Trial Run for Speed Zones. Speed zones established through this process should be rechecked in accordance with the procedure in Section 5 of this chapter.

Provisional Traffic and Engineering Investigation Requirements. When increasing the speed limit from 70 to 75 miles per hour as authorized by the legislature, the speed zone study may be limited to the determination of the 85th percentile speed at one or more speed check locations within the established speed zone. Because the boundaries of the speed zone have been established for the 70 mile per hour zone, a strip map is not required for the increase.All other speed zoning rules within this manual apply to the provisional traffic and engineering investigations.

Additional Roadway Factors. The posted speed limit may be reduced by as much as 10 miles per hour (12 miles per hour for locations with crash rates higher than the statewide average) below the 85th percentile speed or trial-run speed (if 125 cars cannot be checked during the two- or four-hour speed check), based on sound and generally accepted engineering judgment that includes consideration of the following factors:

- narrow roadway pavement widths (20 feet or less, for example)
- horizontal and vertical curves (possible limited sight distance)
- hidden driveways and other developments (possible limited sight distance)

- high driveway density (the higher the number of driveways, the higher the potential for encountering entering and turning vehicles)
- crash history along the location
- rural residential or developed areas (higher potential for pedestrian and bicycle traffic)
- lack of striped, improved shoulders (constricted lateral movement).

Local public opinion may also be considered on farm-to-market and ranch-to-market roads without improved shoulders (Transportation Code, Section 545.3535(b)).

The final decision on the amount of variation from the 85th percentile speed for a specific roadway should be based on the engineering judgment of the supervising engineer. If additional roadway factors are used to reduce the speed limit, include the factor or factors on the speed zone strip map.

Speed limits should not be posted more than 10 miles per hour (12 miles per hour for locations with crash rates higher than the statewide average) below the 85th percentile or trial-run speed (if 125 cars cannot be checked during the two- or four-hour speed check), since unreasonably low speed limits have not been shown to be an effective way to control speeding. Allowing too great a variation would risk losing motorist respect for speed limits and traffic control devices.

Blanket Lowering of Maximum Speed Limits

A blanket lowering of maximum speed limits may be justified:

- during either state or national emergencies or disasters, such as war or energy crisis, where an authoritative study indicates that a reduction of speeds will result in a significant reduction in the consumption of fuel and energy and will promote fuel and energy conservation
- to avoid non-compliance with direct requests from the federal government to lower the statewide maximum speed limit to a speed equal to or below the national speed limit.

Trial Runs

A “trial run” is a drive through the speed zoned section of roadway at the chosen speed(s) to determine if the speeds are appropriate for the area.

After the 85th percentile speeds and zone lengths have been selected, several trial runs should be made through the area in both directions driving at the selected speeds. This should show any irregularities in the zoning which need correction.

Documentation. Trial runs may be documented using the Summary of Trial Run for Speed Zones (TxDOT Form 1929) to supplement a strip map. (The form is available via hyperlink — click on the form number above — or from the Traffic Operations Division.) Figure 3-10 Example of completed Summary of Trial Run for Speed Zones, shows an example of a completed Summary of Trial Run for Speed Zones.

Location of Regulatory Speed Limit Signs

Since speed zones are legally described to the nearest thousandth of a mile (5 feet), regulatory speed limit signs should be located within approximately 5 feet of the actual reference marker or milepoint defined in the minute order or city ordinance. Therefore the locations of regulatory speed zones tied to speed changes should be examined carefully to ensure that signs can be erected within the 5 feet variation. If adherence to the 5-feet variation is not possible, the SPEED ZONE sign should be placed as close to the actual location defined in the minute order or city ordinance as practical. For example, if the reference marker or mile point is located at an intersection, the regulatory speed limit signs should be located in accordance with standard procedures for placement of departure signing.

Texas Department of Transportation
Form 1929 (rev. 6/10/2004)

Summary of Trial Run for Speed Zones

District: ____________________

County (City — if applicable)	Highway / Control Section	Limits R = Reference Marker ST = Station MP = Milepost Begin	End	Length (miles)	Speed (miles per hour)
Kaufman	FM 741	ST83+32	93+88	0.200 mi.	65
Harris (Galveston)	IH 45 500-3	MP 0.000	1.281	1.281 mi.	60
	IH 45 100-4	MP 8.188	9.190	1.002 mi.	65
Angelina	FM 2251 2115-1	ST 55+64	285+86	4.360 mi.	60
Kimble	US 377 149-2	ST 931+00	887+44	0.825 mi.	65
Bexar	FM 2790 1741-2	MP 6.786	13.160	6.392 mi.	60
Uvalde (Concan, unic.)	SH 127 369-1	MP 0.000	1.040	1.040 mi.	60
Limestone	SH 127 369-2	ST 65+27	78+41	0.249 mi.	65
McLennan (Axtell, uninc.)	FM 1330 2675-1	ST 0+13	116+31	0.200 mi.	60
Gonzales	SH 80 287-4	MP 23.779	24.140	0.361 mi.	65
	SH 80 348-1	MP 25.156	25.202	0.046 mi.	65
Wharton	LP 183 89-10	MP 35.104	35.225	0.121 mi.	55
	LP 183 89-10	MP 37.474	37.929	0.455 mi.	60

Instructions:

- List counties (cities) in alphabetical order.
- Order highways as follows:
  1. Interstate Highways
  2. US Highways
  3. State Highways
  4. FM/RM Roads
- Show lengths up to 3 decimal places.

Figure 3-10. Example of completed Summary of Trial Run for Speed Zones

Section 5: Rechecks of Speed Zones

Introduction

Since the basic data on which speed zones are established are subject to change when conditions change, established speed zones must **not** be considered permanent.

Physical improvements to the roadway, increased roadside development, and heavy increases in traffic volumes justify a recheck of speeds to determine whether or not the 85th percentile speed has changed enough to require a change in the zone speeds.

Frequency of Rechecks

Periodic rechecks of all zones are desirable at intervals of about three to five years in urban areas regardless of roadway improvements, roadside developments, or increases in traffic volumes. Trial runs or rechecks of every third speed check station may be made.

In rural areas, rechecks are desirable at intervals of five to ten years. In many instances, trial runs may be sufficient.

If the speed checks or trial runs indicate a need for revision of the zone, rechecks of speeds should be made at all speed check stations for that particular section and a revised strip map made and submitted.

Procedure

In preparing a revised strip map, the original tracing on file with the Traffic Operations Division may be obtained and used where all data, other than speed check data shown thereon, are current. **A strip map containing out-of-date information should be considered obsolete**.

New strip maps should be prepared when physical improvements of the roadway have been made or when changes in roadside development have occurred since the original strip map was prepared even though the speed checks and zone speeds may not change.

Section 6: Environmental Speed Limits

Introduction

An environmental speed limit is a speed limit created by the Texas Transportation Commission at the request of the Texas Commission on Environmental Quality (TCEQ) for the purpose of meeting federal air-quality standards. The TCEQ is the state air-pollution control agency and is the principal authority in the state on matters relating to the quality of the state's air resources.

Existing Environmental Speed Limits

Existing environmental speed limits created at the request of the TCEQ may be retained on the state highway system until such time as the TCEQ advises the department in writing that the speed limit is unnecessary and a speed study performed for the area finds that the existing environmental speed zone is not reflective of the 85th percentile speed as determined by procedures detailed in this manual.

New Environmental Speed Limits Prohibited

As per Transportation Code, §545.353(j), no new environmental speed limits may be created on the state highway system.

Chapter 4: Speed Zone Approval

Contents:

Section 1: Overview

Introduction

Speed zones on the state highway system, including turnpikes under TxDOT's authority, may be set by Transportation Commission minute order or by the city, depending on the circumstance (as shown in the following table).

Authority to Set Speed Zones on State Highway System (including on turnpikes under TxDOT's authority)

If the speed zone is...	Then it is established by...
outside a city	Transportation Commission minute order
inside a city	city ordinance or resolution or Transportation Commission minute order

This chapter covers the speed zone approval process for each of these circumstances.

Regional Mobility Authorities and Regional Tollway Authorities

This chapter does not cover the speed zone approval process for turnpikes under the control of a regional mobility authority (RMA) or regional tollway authority (RTA). An RMA is an authority created under Transportation Code, Chapters 361 or 370, at the request of one or more counties and authorized by the Transportation Commission for the purpose of constructing, maintaining, and operating transportation projects. An RTA is an authority created under Transportation Code, Chapter 366, consisting of two or more counties for the purpose of acquisition, design, financing, construction, operation, and maintenance of a turnpike project or system.

Speed zone approval for roadways under the control of RMAs or RTAs are set according to the conditions outlined in the following two tables.

Authority to Set Speed Zones on Turnpikes under Control of an RMA

If the speed zone is...	Then it is established by...
outside a city	RMA order
inside a city	city ordinance or RMA order

Authority to Set Speed Zones on Turnpikes under Control of an RTA

If the speed zone is...	Then it is established by...
outside a city	RTA order
inside a city	city ordinance or RTA order

Section 2: Approval Process

Outside an Incorporated City

If the strip map contains only zones outside of incorporated city limits (to be set by Transportation Commission minute order), the district should send two prints or an electronic version of the strip map to the Texas Department of Transportation (TxDOT) Traffic Operations Division (TRF) for review. When TRF and the district have reached agreement on the proposed speed limits, TRF will write the necessary commission minute order. Prints required by the district should be made prior to submitting original tracings, mylars, or computer prints to TRF.

Within an Incorporated City

If the strip map contains only zones within the corporate limits of a city, the district should send two prints or an electronic version of the strip map to TRF for review. When TRF and the district have reached agreement on the proposed zones, the district should then request the city to pass an ordinance establishing the speed zones. After receiving the ordinance from the city, the district should retain the original strip map and ordinance for its use.

Adjacent Portions Within and Outside an Incorporated City

If a strip map submission contains adjacent altered speed zones situated both within and outside the corporate limits of a city, the district should send two prints or an electronic version of the strip map to TRF for review. When TRF and the district have reached agreement on the proposed zones, the district should then request the city to pass an ordinance establishing the zones within the city limits and TRF will write the necessary commission minute order. If there is an immediate need to post the speeds set by ordinance, signs may be installed for these zones prior to receiving a commission minute order on the adjacent section, as long as the city zone and adjacent existing rural zones are compatible.

Speed Zones Unacceptable to a City

Although TxDOT has the authority to alter the speed limits on highways within the corporate limits of cities or override a speed limit set by city ordinance on such highways, it is intended that studies be made and recommendations be presented to the city for their acceptance and passage of a city ordinance to establish city speed zones. TxDOT should make every effort to have reasonable speed limits established.

In the event that a city will not accept the zones within its corporate limits as submitted by the district, and it is not possible to reach an agreement with the city on reasonable and prudent speed limits, then the district should prepare one strip map showing the city's preference and one strip map showing TxDOT's recommendation. Both strip maps should be submitted to TRF along with the district's request for Transportation Commission action for making one of the zones effective.

When the commission minute order has been passed, the district should send a copy of the minute order, along with a copy of the strip map, to the city.

The setting of speed limits within a city by commission minute order should only be used as a **last resort**; TxDOT should make every effort to secure the cooperation of the city so that the zones will be set by city ordinance.

Filing of Strip Maps

The original strip map tracings for rural roads and those within incorporated cities and towns where the Transportation Commission established the zones are kept on file at TRF. If additional copies of the strip map or the commission minute order are desired, they may be obtained from TRF.

Transportation Commission Minute Order

After the Transportation Commission passes a minute order establishing a regulatory speed zone, the TxDOT administration will send copies of the minute order to the district.

Chapter 5: Application of Advisory Speeds

Contents:

Section 1: Overview

Introduction

A discussion of the following types of advisory speeds is included in this section:

- curves and turns
- intersections
- narrow and one-lane bridges
- descending grades of six percent or greater
- dips
- exit ramps.

Advisory Speed Sign Posting

The W13-1 ADVISORY SPEED sign may be used in conjunction with any warning sign to indicate the maximum safe speed for passenger cars around a curve or through a hazardous location. **It must not be used in conjunction with any sign other than a warning sign, nor shall it be used alone.**

The W13-1 sign shall always be mounted on the same post with and immediately below the warning sign to which it applies.

Figure 5-1 shows typical warning and advisory speed signing applications.

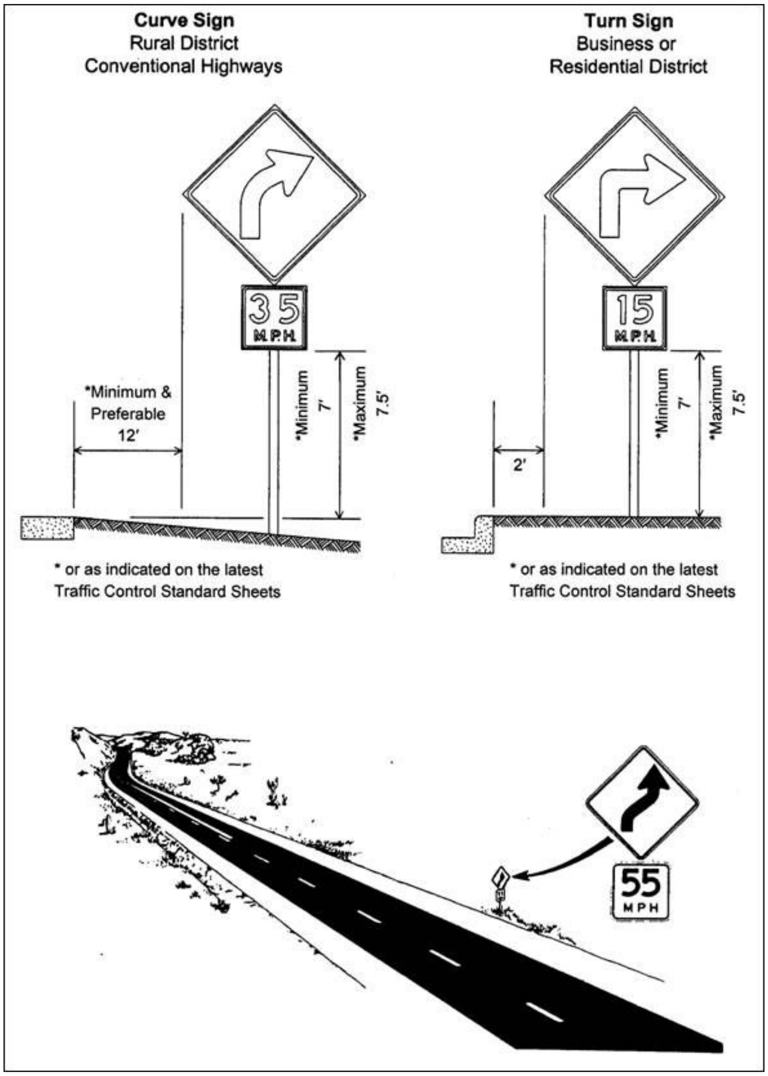

Figure 5-1. Typical height and location of warning and advisory speed signs

Section 2: Curves and Turns

Introduction

Warning signs are intended to improve curve safety by alerting the driver to a change in geometry that may not be apparent or expected. These signs notify drivers of the change through the use of one or more curve warning signs identified in the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD). Drivers may also be notified of the need to reduce their speed through the use of a W13-1 ADVISORY SPEED plaque.

When one or more warning signs are used at a horizontal curve, the curve advisory speed and other curve related traffic control devices should be checked periodically to ensure that they are appropriate for the prevailing conditions. Changes in the regulatory speed limit, curve geometry, or crash history may justify the conduct of an engineering study to reevaluate the appropriateness of the existing signs and posted advisory speed.

Objective

An important objective in horizontal curve signing is having a uniform and consistent display of advisory speed on curves of similar geometry, character (e.g., sight distance, intersection presence, etc.), and road surface condition. As stated in the TMUTCD, "uniformity of the meaning of traffic control devices is vital to their effectiveness" (Section 1A.02). It further describes the benefits of uniformity in the following statement.

> "Uniformity of devices simplifies the task of the road user because it aids in recognition and understanding, thereby reducing perception/reaction time. Uniformity means treating similar situations in a similar way." (Section 1A.06).

The uniform application of a traffic control device allows drivers to develop an expectation that leads to the correct interpretation of device message. In this manner, a uniformly applied advisory speed will be more likely to be understood and respected by drivers.

Research indicates that the historically inconsistent use of curve warning signs, especially those with an advisory speed plaque, may have lessened the average motorist's respect for the message the signs convey. On familiar highways, drivers have come to learn that they can comfortably exceed the advisory speed for most curves. The concern is that these drivers may occasionally travel on roadways that are less familiar to them and where the advisory speed is posted at the maximum safe speed. These drivers may find themselves traveling too fast for conditions and experience uncomfortable side forces. In extreme cases, they may lose control of the vehicle and slide off the roadway.

Methods to Establish Curve Warning Advisory Speeds

Three methods for establishing curve warning advisory speeds are described in this section. Any one of the following three methods can be used to determine the curve advisory speed.

- Direct Method,
- Global Positioning System (GPS) Method, and
- Design Method.

Issues with Ball-Bank Indicator. Historically, the ball-bank indicator has been used to establish the curve advisory speed. However, this device is susceptible to forces that are not a result of road curvature (e.g., bounce due to rough pavement, jerk due to steering corrections, slip due to variation in pavement friction supply, etc.). These forces come and go while traveling along the curve and cause the ball-bank indicator to produce readings that can vary randomly by several degrees. All too often, one of these random peak readings is mistakenly used as the basis for determining the advisory speed. This characteristic of the ball-bank indicator is one reason that advisory speed is not uniform among curves of similar geometry. For this reason, the three methods described in this section are not based on a specific threshhold ball-bank reading (e.g., 10 degrees). The methods are based on the same criteria and will provide a uniform and consistent display of advisory speed among curves, regardless of which method is used. For all three methods, the advisory speed is defined as the average speed of free-flowing trucks.

Steps for implementing each method are described later in this section. The **Direct Method** is based on the field measurement of curve speed. The **GPS Method** is based on a single-pass survey using a GPS receiver and software to compute the curve radius and deflection angle. The **Design Method** is useful when the radius and deflection angle are available from as-built plans.

Compliance Period. In order to allow the districts ample time to acquire the necessary equipment to perform one of the three methods described in this section, the ball-bank method may be used to determine the advisory speed of curves until January 1, 2013. The steps for determining the advisory speed using a ball-bank indicator will remain in this section until the compliance date of January 1, 2013 has passed. After that date, curve advisory speed signs installed on the state highway system shall be established by one of the methods described in this section. All existing curve advisory speed signs shall be verified to be in compliance with any one of the three methods described in this section (and changed if necessary) by a target compliance date of January 1, 2015.

Direct Method

The Direct Method is based on the field measurement of vehicle speeds on the subject curve. The procedure for implementing the Direct Method consists of three steps. During the first step, speed measurements are taken in the field. During the second step, the measurements are used to compute the advisory speed. During the last step, the recommended advisory speed is confirmed through a field trial run. Each of these steps is described in the remainder of this subsection.

Step 1: Field Measurements. Measure the speed of 125 or more free-flowing passenger cars at about the middle of the curve in one direction of travel. Normal speed checks should be discontinued after two hours if radar is used or after four hours if a traffic counter that classifies vehicles by type is used even if 125 cars have not been timed. A free-flowing vehicle will be at least 3 seconds behind the previous vehicle. A radar speed meter can be used for this purpose.

Repeat the measurements for the opposing direction of travel if the road is divided or if conditions suggest the need for separate consideration of each curve travel direction. When two or more curves are separated by a tangent of 600 feet or less, one sign should apply for all curves. However, each curve should be surveyed separately in this step.

Compute the arithmetic average of the measured speeds for each direction of travel at each curve studied. Also, compute the 85th percentile speed for each direction and curve.

Step 2: Determine Advisory Speed. Multiply each of the average speeds from Step 1 by 0.97 to obtain an estimate of the average truck speed for each direction of travel. The advisory speed for each direction of travel is then computed by first adding 1.0 mph to the corresponding average and then rounding the sum down to the nearest 5 mph increment. This technique yields a conservative estimate of the advisory speed by effectively rounding curve speeds that end in 4 or 9 up to the next higher 5 mph increment, while rounding all other speeds down. For example, applying this rounding technique to a curve speed of 54, 55, 56, 57, or 58 mph yields an advisory speed of 55 mph.

When two or more curves are separated by a tangent oof 600 ft. or less, one sign should apply for all curves. However, each curve should be evaluated separately in this step. The advisory speed plaque should show the value for the curve having the lowest advisory speed in the series.

Step 3: Confirm Speed for Conditions. During this step, the appropriateness of the advisory speed determined in Step 2 is evaluated. As an initial task, the need for an advisory speed plaque is checked. A representative 85th percentile on tangent sections of the roadway is needed for this check. It can be measured using the procedure described in Step 1 or estimated from the regulatory speed limit. If it is measured, the point of measurement should be at least 8 seconds travel time from any curve in either direction. The 85th percentile tangent speed and the 85th percentile curve speed (from Step 1) are used with Figure 5-2 to determine the need for an advisory speed plaque.

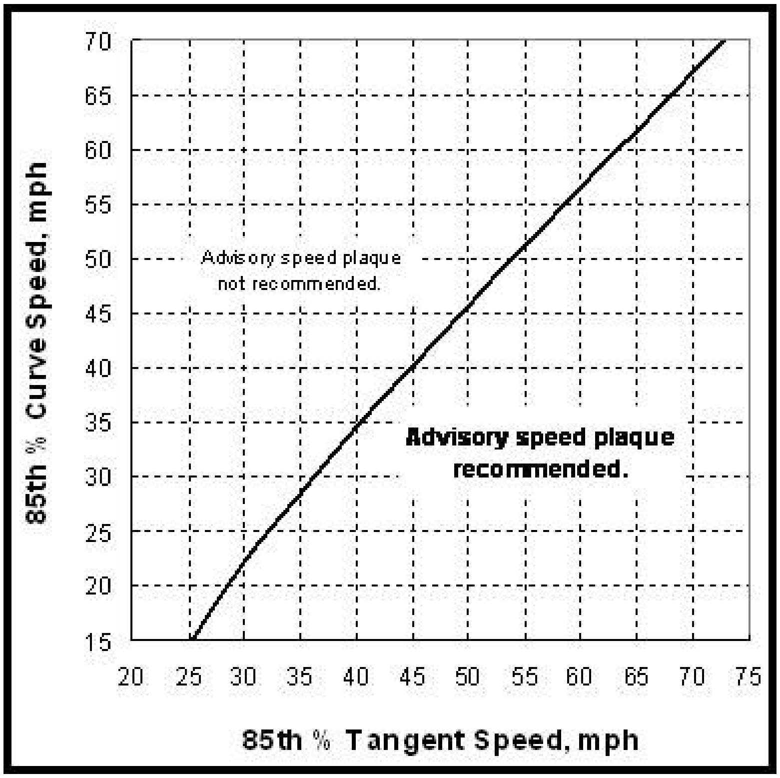

Figure 5-2. Guidelines for determining the need for an advisory speed plaque.

A second task involves a field evaluation of curve conditions. The evaluation includes consideration of the following factors.

- driver approach site distance to the beginning of the curve,
- visibility around the curve,
- unexpected geometric features within the curve, and
- position of the most critical curve in a sequence of closely spaced curves.

The unexpected geometric features noted in the third bullet may include:

- presence of an intersection,
- presence of a sharp crest curve in the middle of the horizontal curve,
- sharp curves with changing radius (including curves with spiral transitions),
- sharp curves after a long tangent section, and
- broken back curves.

A final task involves a test run through the curve while traveling at the advisory speed determined in Step 2. The engineer may choose to adjust the advisory speed or modify the warning sign layout based on consideration of the aforementioned factors. The advisory speed for one direction of travel through the curve may differ from that for the other direction.

GPS Method

The GPS Method is based on the field measurement of curve geometry. The geometric data are then used with a speed prediction model to compute the average speed of trucks. This speed then becomes the basis for establishing the advisory speed.

The procedure for implementing the GPS Method consists of three steps. During the first step, measurements are taken in the field while traveling along the curve. During the second step, the measurements are used to compute the advisory speed. During the last step, the recommended advisory speed is confirmed through a field trial run. Each of these steps is described in the remainder of this section.

To ensure reasonable accuracy in the model estimates using this method, the curve deflection angle should be 6 degrees or more. A curve with a smaller deflection angle will rarely justify curve warning signs or an advisory speed plaque.

Equipment. The equipment used includes the following:

- GPS receiver,
- electronic ball bank indicator (optional), and
- laptop computer.

The GPS receiver is used to estimate curve radius and deflection angle. The electronic ball bank indicator is optional, and is used to estimate superelevation rate. If an electronic ball-bank indicator is not used, then superelevation rate will need to be estimated using other means.

The computer is used to run the Texas Roadway Analysis and Measurement Software (TRAMS) program. This program is designed to monitor the GPS receiver and the electronic ball-bank indicator while the test vehicle is driven along the curve. After the curve is traversed, TRAMS calculates curve radius and superelevation rate from the data streams. Advisory speed and traffic control device selection guidelines can be determined using the radius and superelevation rate estimates with the Texas Curve Advisory Speed (TCAS) spreadsheet. The TRAMS software, TCAS spreadsheet, and a TRAMS Installation Manual are available from the Traffic Operations Division (TRF).

Installation. The following activities must be completed the first timeTRAMS is installed on the computer. More details are provided in the TRAMS Installation Manual.

- Install the driver for the GPS receiver.
- If the electronic ball-bank indicator is used, an adapter may be needed to convert the RS-232 connection into a USB connection. Install the driver for this adapter.
- Install TRAMS (a copy of TCAS will also be installed in the TRAMS file directory).

Equipment Setup. The following activities must be completed prior to using the equipment to establish the advisory speed for one or more curves.

Mount the GPS receiver and electronic ball-bank indicator (if used) on the dashboard in a fixed position. These devices should not be able to move during the test runs. Figures 5-3 abd 5-4 show the devices mounted on the dashboard and secured using adhesive tape.

Figure 5-3. Equipment setup in test vehicle-laptop positioning.

Figure 5-4. Equipment setup in test vehicle-GPS positioning.

If an electronic ball-bank indicator is used, activate its auto-leveling feature with the test vehicle parked on level pavement. Do this under the same vehicle loading and tire inflation conditions that will be present during the test runs.

With the laptop on, click on the TRAMS icon to launch TRAMS. TRAMS will initially connect with the two devices. It will then present the main panel, as shown in Figure 5-5.

Verify that TRAMS is receiving valid data from the GPS receiver. Information about the status of this device is located in the upper right corner of the main panel, as shown in Figure 5-5. A red circle indicates invalid (bad) data. A green circle indicates valid (good) data.

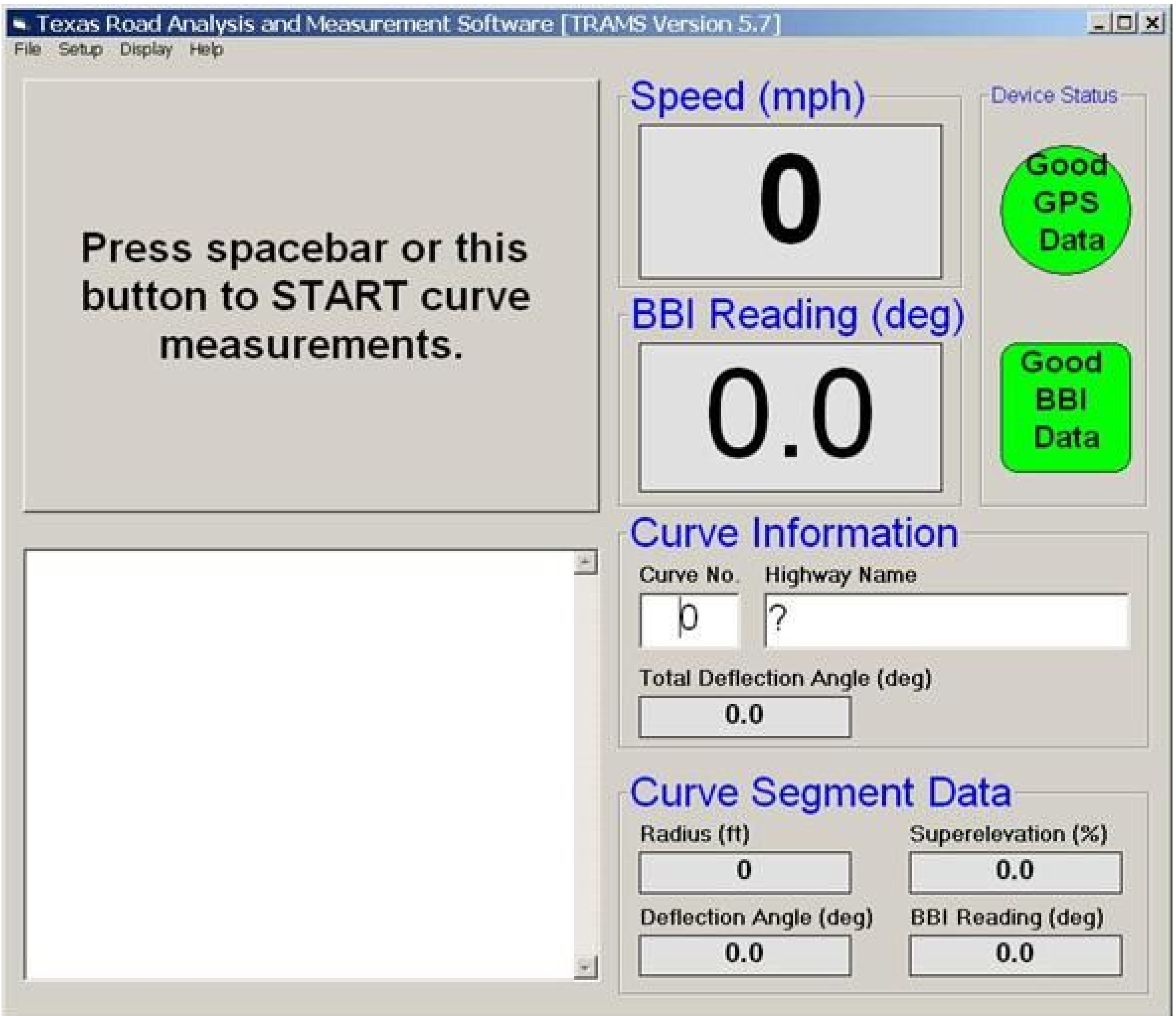

Figure 5-5. TRAMS main panel.

If the electronic ball-bank indicator (BBI) is used, verify that TRAMS is receiving valid data from it. A red square indicates invalid (bad) data. A green square indicates valid (good) data.

If valid data are not being received by one or both of the devices, check the following conditions:

- Are the devices turned on and properly connected to the laptop computer?
- Is the GPS receiver blocked from obtaining good satelite reception? Structures (bridges, garage roofs, buildings, etc.) or dense tree coverage may make it difficult to maintain GPS reception.
- Has TRAMS been configured with the proper port numbers for the devices? This can usually be accomplished by selecting the "Automatic" mode in the Configure Devices panel (from the main panel, select File, Configuration Settings, Configure Devices). If used, the electronic ball-bank indicator ("Reiker Device") must also be enabled in this panel (i.e., select Enabled in the Rieker box).

- If any settings are changed in the Configure Devices panel, the Save Configuration File option should be selected to save all settings to the file (in which case they will be loaded and used each time TRAMS is launched).

Step 1. Field Measurements. Before beginning a test run, enter the curve number and highway name in their respective fields provided on the main panel (see Figure 5-5).

Repeat the measurements for the opposing direction of travel if the road is divided or if conditions suggest the need for separate consideration of each curve travel direction. When two or more curves are separated by a tangent of 600 ft. or less, one sign should apply for all curves. However, each curve should be surveyed separately in this step.

Speed Limit. If the 85th percentile tangent speed is not known, note the regulatory speed limit on the roadway where the curve is located. The speed limit can subsequently be used in TCAS to estimate the 85th percentile tangent speed.

Test Run Speed. The following rules-of-thumb should be considered when selecting the test run speed.

- The test run speed should be at least 10 mph below the existing curve advisory speed provided that the resulting test run speed is not less than 15 mph.
- If superelevation rate is being measured, test runs should be conducted at 45 mph or less, with slower speeds considered desirable in terms of yielding more accurate estimates of superelevation.

In general, a slower test run speed will improve accuracy in measurement by minimizing tire slip and allowing the driver to track the curve accurately.

Measurement Procedure. The following task sequence describes the field measurement procedure as it would be used to evaluate one direction of travel through the subject curve. Measurement error and possible differences in superelevation rate between the two directions of travel typically justify repeating this procedure for the opposing direction. Only one test run should be required in each direction.

1. When the test vehicle is 1 or 2 seconds travel time in advance of the beginning of the curve, press the space bar or click the large button on the TRAMS main panel. This action will start the data collection process. Precise location of the beginning of the curve is not required. A reasonable estimate of its location, based on the analyst’s judgement, will suffice.

2. While driving through the curve, track the centerline of the roadway as carefully as possible. This process will provide an accurate survey of the intended travel path. The analyst should avoid “cutting the corner” of sharp curves. The analyst should also avoid letting the vehicle drift to the outside of the lane while traveling along the curve.

3. When the test vehicle is 1 or 2 seconds travel time beyond the end of the curve, press the space bar or click the large button a second time to stop recording curve data. Precise

location of the end of the curve is not required. A reasonable estimate of its location, based on the analyst’s judgement, will suffice.

Save the File. When asked whether a curve report file should be saved, indicate “Yes” by pressing Enter (or clicking on the Yes button). Alternatively, indicate “No” if it is believed that the curve was not accurately measured during the test run (e.g., the driver did not accurately track the curve, or the data recording was not started and stopped at the appropriate times). CAUTION: If the curve has the same number as a curve that was previously evaluated, the new file will overwrite the file from the previous curve.

Optional Check When Superelevation Rate is Measured. At the conclusion of the test run, the 95th percentile error range for superelevation rate is provided in the curve report file. It can be checked to confirm that the estimated value is reasonably precise. If this range exceeds 3 percent, repeat the test run at a lower speed. If the aforementioned test-run-speed rules-of-thumb were followed, then this check should not be needed.

The curve report file can be accessed from the main panel by selecting File, Open Curve Report, and selecting the appropriate “log” file. The file will be named “Curve-XX-Rpt. Log,” where XX will be replaced by the curve number entered on the main panel before the start of the test run. Once the file is selected, select Open and the file will be opened in Notepad, a text editor provided with Windows®.

Step 2. Determine Advisory Speed. Two options are available for determining the advisory speed. One option is based on a review of the survey data in the field. The second option is based on a review of the survey data in the office, following the survey of all curves of interest.

When two or more curves are separated by a tangent of 600 ft. or less, one sign should apply for all curves. However, each curve should be evaluated separately in this step.The advisory speed plaque should show the value for the curve having the lowest advisory speed in the series.

Option 1: In-Field Determination. This option is performed in the field. The data from the most recent test run is exported directly to TCAS. This action is accomplished from the main panel by selecting File, Export to TCAS. At this point, TCAS will load. The analyst will need to click on the “Import TRAM Data” button in TCAS to import the test run data into TCAS. This button is shown in the upper left corner of Figure 5-6. The analyst will also need to enter the 85th percentile speed in TCAS in the second to last row of the Input Data section. Alternatively, the analyst can enter the speed limit in the Alternate Input Data section and let TCAS compute an estimate of 85th percentile speed.

As shown in Figure 5-6, TCAS allows the entry of data for up to six test runs, one column for each test run. The imported data are always placed in the same TCAS column (i.e., the left column). If the analyst wants to save any data in this column, then he or she should copy and paste the data to another column in TCAS (or another spreadsheet) and save the file. Exit TCAS (and Excel) after importing and evaluating the data for a given curve.

CURVE ADVISORY SPEED WORKSHEET						
General Information						
District:		**Curve Data Source:**		**Date:**	November 16, 2009	
Highway:		Known curve geometry		**Analyst:**		
Input Data						
Click button to read TRAMS data: Import TRAMS data	**Curve Identification Number**					
Curve deflection, left or right						
Compass heading 1, degrees						
BBI reading of superelevation, degrees						
Deflection of ball for superelevation reading, left or right						
Speed when recording the BBI reading of superelevation, mph	0	0	0	0	0	0
Curve length, ft						
Compass heading 2, degrees						
Survey method (partial or full)						
Regulatory speed limit, mph						
Estimate of 85th% tangent speed, mph						
Alternate Input Data *(if data are entered here, they will be used instead of estimates from the data above)*						
85th% tangent speed, mph						
Total curve deflection angle, degrees						
Curve deflection angle, degrees						
Superelevation rate, percent						
Curve radius, ft						
Advisory Speed						
Survey method (partial or full)						
Total deflection angle, degrees	0	0	0	0	0	0
Curve deflection angle, degrees	0.0	0.0	0.0	0.0	0.0	0.0
Curve radius, ft						
Degree of curvature, degrees						
Curve path radius, ft						
Superelevation rate, percent						
Average tangent speed, mph						
Unrounded advisory speed, mph						
Rounded advisory speed, mph						

Figure 5-6. TCAS main panel.

Option 2: In Office Determination. This option is performed back in the office. The curve report file for each curve is opened in Notepad and printed by selecting File, Print. There is one report for each unique curve number entered in TRAMS. The data on a report is typed into TCAS and the appropriate advisory speed determined. Instructions for opening a curve report file were provided in the previous step.

Step 3: Confirm Speed for Conditions. During this step, the appropriateness of the advisory speed determined in Step 2 is evaluated. The activities conducted during this step are the same as those discussed in Step 3 of the Direct Method, except that the need for an advisory speed plaque is checked using the information in the Traffic Control Device Guidance Section of TCAS.

Design Method

The Design Method is based on the use of curve geometry data obtained from files or as-built plans. This method is suitable for evaluating newly constructed or reconstructed curves because the data are available from construction plans.

The procedure for implementing the Design Method consists of three steps. During the first step, curve geometry data are obtained from files or plans. During the second step, the measurements are used to compute the advisory speed. During the last step, the recommended advisory speed is confirmed through a field trial run, if or when the curve exists. Each of these steps is described in the remainder of this subsection.

Step 1: Obtain Curve Geometry. Consult the appropriate files to obtain the radius, deflection angle, and superelevation rate for the curve. If the curve is circular, the "total curve deflection angle" is equivalent to the "curve deflection angle," as used in TCAS. The total curve deflection angle equals the deflection angle in the two intersecting tangents.

If spiral transition curves are included in the design, obtain the radius and superelevation rate data for the central circular curve. The total curve deflection angle is the same as defined in the previous paragraph. The curve deflection angle represents the deflection angle of the central circular curve.

If compound curvature is used in the design, obtain the radius and superelevation rate data for the sharpest component curve. The total curve deflection angle is the same as defined in the first paragraph. The curve deflection angle represents the deflection angle of the sharpest component curve.

Obtain the aforementioned data for both directions of travel if the road is divided or if conditions suggest the need for separate consideration of each curve travel direction. When two or more curves are separated by a tangent of 600 ft. or less, one sign should apply for all curves. However, data for each curve should be obtained in this step.

Step 2: Determine Advisory Speed. The data obtained in Step 1 are entered in TCAS in the section titled Alternate Input Data. If a reasonable estimate of the 85th percentile tangent speed is not available, the speed limit can be used in TCAS to estimate the 85th percentile tangent speed.

NOTE: The drop-down list at the top of the spreadsheet should be set to "Known Curve Geometry."

When two or more curves are separated by a tangent of 600 ft. or less, one sign should apply for all curves. However, each curve should be evaluated separately in this step. The advisory speed plaque should show the value for the curve having the lowest advisory speed in the series.

Step 3: Confirm Speed for Conditions. During this step, the appropriateness for the advisory speed determined in Step 2 is evaluated. The activities conducted during this step are the same as those discussed in Step 3 of the Direct Method except that the need for an advisory speed plaque is checked using the information in the Traffic Control Device Guidance section of TCAS.

Ball-Bank Method

The steps for determining the advisory speed using a ball-bank indicator will remain in this section until the compliance date of January 1, 2013 has passed.

The speed to be posted will be based on results obtained from test runs in a vehicle equipped with either a mechanical ball-bank indicator (see Figure 5-7) or an electronic accelerometer, not the calculated value. (See following discussion of “Calculated Speed.”)

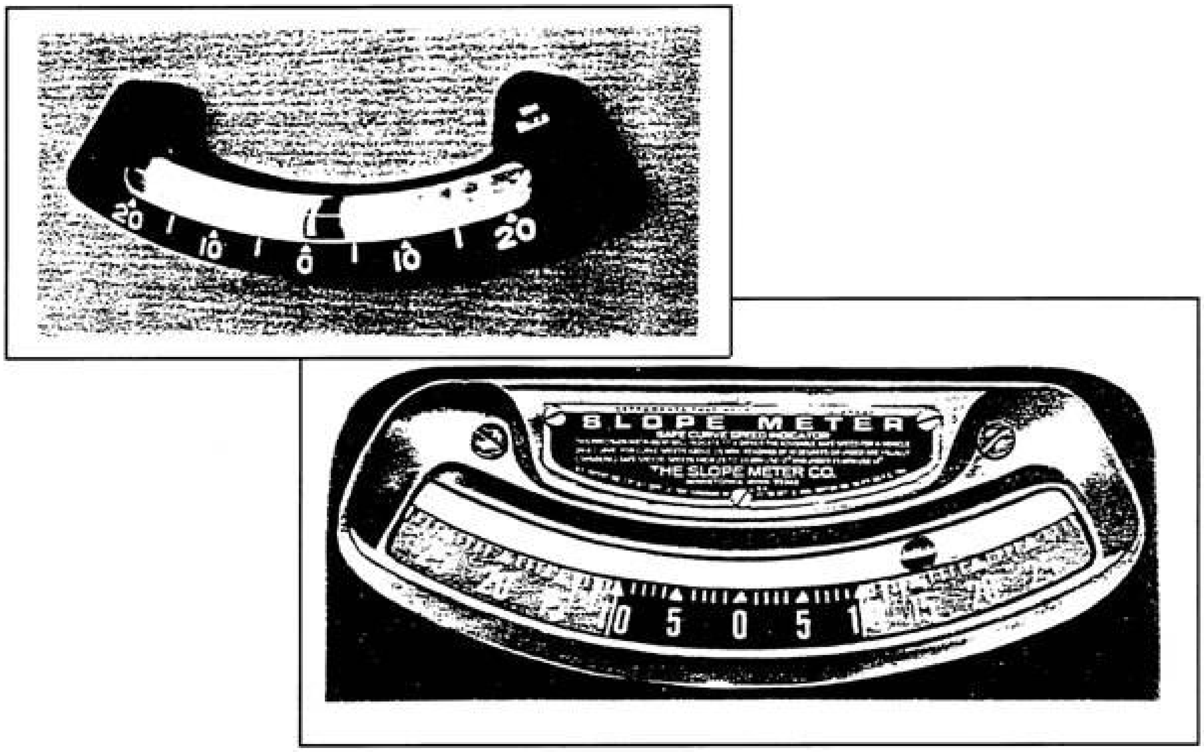

Figure 5-7. Two types of ball-bank indicators.

Calculated Speed

For curves and turns, the calculated speed is to be used as a guide for making the initial test run and as a check on the speed obtained by the use of the mechanical or electronic bank indicator. The calculated speed is not, however, to be used as the sole basis for selecting the posted speed. (See “Selecting Speed for Posting” at the end of this section for additional discussion.)

Calculate the design speed of the curve under consideration using the formula

$$V = \sqrt{15R(e+f)}$$

where:

V = vehicle speed in miles per hour

R = radius of curve in feet

e = rate of roadway superelevation in feet per foot

f = side friction factor with value depending on speed as follows:

	If the speed is:	**then the sidefriction factor is:**
	• 35 mph or greater	0.15
	between 20 and 35 mph	0.18
	20 mph or less	0.31

Selection of Car and Mounting of Bank Indicator

Select an average passenger car for making the test runs and mount the bank indicator on the center line of the dash. Suitable metal strap mountings can be made on which to mount the indicator, as shown in Figure 5-8. The metal strap holding the right side of the indicator on dash mountings should be slotted and a thumb nut provided so the steel ball can be adjusted to the zero degree position by raising or lowering the right side of the indicator. If there is any doubt about the selection of an average car, a bank indicator should be mounted on three different makes or year models for a check.

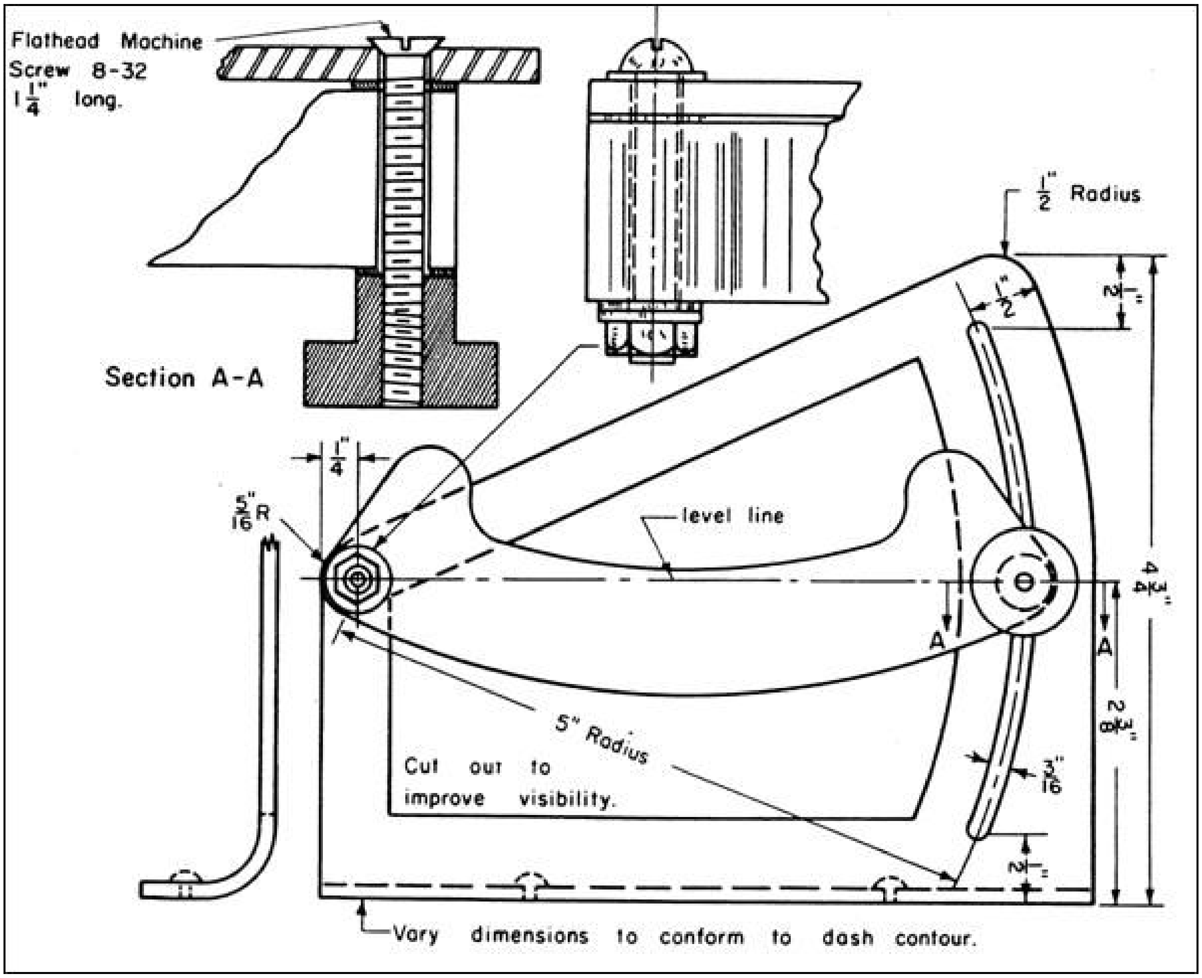

Figure 5-8. Suggested mounting for ball-bank indicator on dash.

Before Conducting Test Runs

To ensure proper operation of the bank indicator, it is critical that the following steps be taken before conducting test runs

- Inflate all tires to the uniform pressure used during speedometer calibration.
- Calibrate the test vehicle's speedometer (see following procedure)
- Zero the bank indicator (see following procedure).

Calibrating Speedometer

It is essential that speedometers be calibrated accurately so that advisory speeds will be uniform throughout the state.

Calibrate the speedometer for recording of speed. The accuracy of the odometer for recording distance should be checked against a measured distance. Calibration for speed can be done easily with a radar speed meter or by timing the car over a measured distance. The speedometer should be checked for each 5 mph interval over 20 mph, and several test runs should be made for each speed so that an average value may be obtained.

Zeroing the Bank Indicator

The bank indicator must be adjusted to the zero reading before test runs are conducted. This must be done with the car straddling the center line of the pavement on a tangent section to give the effect of a flat level surface and the driver and recorder in the same position in which they will ride during the test runs.

It is essential that the driver and recorder be in the same position when the bank indicator is set to the zero reading as they will be when test runs are made, because a shift in the load is reflected in a change of the indicator reading.

Conducting Bank Indicator Test Runs

The curve should be driven at the calculated speed described previously on the initial run. If the calculated speed is not available, the curve should be driven at an estimated speed approximately 5 miles per hour slower than that which the driver feels they can maintain throughout the entire length of the curve.

Each succeeding run should be made at a speed 5 miles per hour greater than the preceding run until the bank indicator reading reaches:

- 10 degrees for speeds of 35 mph or more
- 12 degrees for speeds of 25 and 30 mph
- 14 degrees for speeds of 20 mph or less.

On each test run, the driver should reach the test run speed at a distance of at least 0.25 mile from the beginning of the curve and maintain this speed throughout the entire length of the curve. The path of the car throughout the curve should be maintained as nearly as possible in the center of the right hand lane.

Test runs should be made in each direction on each curve.

On each of the speeds of the test runs, the observer must carefully note the position of the ball throughout the length of the curve and record the maximum deflection in degrees. The readings should be interpolated as closely as possible to the nearest degree.

Alternate Ball-Bank Indicator Test Run Method

An alternate procedure, intended to minimize the number of test runs required to determine the speed for which the curve is to be posted, is as follows:

1. Drive the car at a speed of 5 miles per hour around the curve, staying as nearly as possible in the center of the right hand lane, and record the maximum deflection of the ball-bank indicator in degrees. Record the reading of the ball-bank indicator as plus if the deflection of the ball is to the right on a right hand curve and to the left on a left hand curve. The reading of the ball-bank indicator should be recorded as minus if the deflection of the ball is to the left on a right hand curve and to the right on a left hand curve.
2. Drive around the curve at a constant speed that can be maintained without acceleration or deceleration and without driving outside the right hand traffic lane. Record the maximum deflection of the ball-bank indicator and the speed at which the curve was driven.
3. Compute the maximum safe speed for the curve by solving the following formula for V2:

$$V_2 = \frac{V_1}{\sqrt{\frac{\theta_1 + (\pm\varphi)}{\theta_2 + (\pm\varphi)}}}$$

where:

q_1 = maximum ball-bank indicator reading as recorded in Step 2

q_2 = 10° for 35 mph and greater **or**

12° for speeds of 21 through 34 mph **or**

14° for 20 mph and less

φ = ball-bank indicator reading as recorded in Step 1

V_1 = vehicle speed in miles per hour at which q1 was recorded in Step 2

V_2 = calculated safe speed in mph for which curve is good.

4. Drive around the curve, staying in the right-hand lane, at the calculated speed V_1 without acceleration or deceleration as a check on measurements and computations. The ball-bank indication recorded at speed V_1 should then be:
   - 10° for speeds of 35 mph or more

- 12° for speeds of 25 and 30 mph
- 14° for speeds of 20 mph or less.

Selecting Speed for Posting

Remember, the speed to be posted shall be based on the results obtained from test runs with the ball-bank indicator (described later in this section), **not the calculated value**.

The posted speed shall be a multiple of 5 miles per hour.

In selecting the speed to be posted, care should be taken that the calibrated speed for any given speedometer reading is used rather than the speedometer reading itself. As a final check, the posted speed is aimed at the highest value that will permit the average car to travel around the curve in its own lane without causing an uncomfortable side throw to its passengers. **The speed to be posted on the curve should not be reduced arbitrarily below that determined by the procedures provided in this section.**

When there is a reverse curve or a series of three or more curves, the advisory speed sign shall show the value for the curve having the slowest safe speed in the series.

Section 3: Intersections

Introduction

Advisory zones may be posted at intersections such as traffic circles designed for an operating speed less than the speed of the approaches, and intersections with restricted sight distances that require a reduction in speed for safe operation.

View Obstructions

For intersections having view obstructions, trial runs should be conducted to determine the safe and reasonable speed for the area. This speed may be posted as an advisory speed below a warning sign to warn motorists of the limited sight distance.

Section 4: Narrow and One-Lane Bridges

Introduction

Narrow bridges with clear width between curbs less than 18 feet but more than 16 feet, and one lane bridges with clear width between curbs of 16 feet or less may require advisory speeds. As a rule, advisory speed zones should be applied for such structures when horizontal or vertical sight distance restrictions on the approaches require a reduction of approach speeds for safe operation. Advisory speeds of this type are intended to eliminate the element of surprise.

Placement of Signs

The normal location of the W5-2 NARROW BRIDGE or W5-3 ONE LANE BRIDGE signs, under which a W13-1 ADVISORY SPEED sign would be mounted, is specified in the latest edition of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) (Table 2C-4). The signs may be located at a greater distance in advance of the bridge if necessary to allow sufficient time and distance for deceleration and may be repeated at the point where the structure first comes into view.

Section 5: Descending Grades of Six Percent or Greater

Introduction

Where vehicles may attain a speed in excess of that required for a safe stopping distance or in excess of that required for safe travel around curves at the bottom or within the limits of the grade, the posting of an advisory speed may be prudent.

Determining Minimum Sight Distances

The minimum horizontal and vertical sight distances on descending grades of 6 percent or greater should be determined either by field measurements or by calculations from the plans.

Calculation

Using the minimum sight distance as the safe stopping distance, the critical speed should be calculated from the formula

$$d = \frac{V^2}{30(0.4 \pm g)} + 2.93V$$

where:

d = sight distance for safe stopping distance in feet

V = the velocity in miles per hour

g = percent of grade (in decimal form) divided by 100.

If a Curve is Involved

If a curve is within the limits of or at the bottom of such a grade, the advisory speed for the curve should be determined by the procedure found in Section 2 of this chapter, Curves and Turns

The speed to be posted should be the lower of the two speeds found for providing a safe stopping distance and that for safe travel around the curve.

Section 6: Dips, Bumps, and Exit Ramps

Dips and Bumps

An advisory speed may be desirable where a depression or bump in the road profile is sufficiently abrupt to create a hazardous condition, cause discomfort to passengers, cause a shifting in cargo, or deflect a vehicle from its true course when crossed at speeds prevailing on the approaches.

The speed to be posted for dips or bumps should be determined by trial runs. It should be the highest speed that will enable a vehicle to travel over the dip or bump without considerable discomfort to passengers, without causing a shifting of cargo, or without causing a deflection of a vehicle from its true course.

Exit Ramps

The Exit Speed or Ramp Speed signs (W13-2 and W13-3) are intended for use where engineering investigations of roadway, geometric, or operating conditions show the necessity of advising drivers of the maximum recommended speed on a ramp.

Appendix A: Forms

Introduction

This appendix lists the forms described in this manual and provides on-line links to them. Copies of these forms may also be obtained from the Traffic Operations Division (TRF).

Forms Pertaining to Speed Zones

TxDOT Form Number	Form Name	# of Pgs.	Described in
1204	Request for Construction Speed Zone	2	Chapter 1, Accident Reconstruction Speed Limits Chapter 2, Request for Regulatory Construction Speed Zones
1882 1882LS 1882HS	Radar Motor Vehicle Speed Field Tally Sheet (with 85th Percentile Calculation Table on back)	2	Chapter 3, Recording Measured Speeds
1929	Summary of Trial Run for Speed Zones	1	Chapter 3, Speed Zone Design
2455	Notification Speed Limit Reduction for Crash Reconstruction	2	Chapter 1, Accident Reconstruction Speed Limits

Appendix B: Glossary

The following words and terms, when used in this manual, have the following meanings, unless the context clearly indicates otherwise.

Commission — The Texas Transportation Commission.

control measure — Any measure specifically identified and committed to in the applicable state implementation plan.

district — A geographical area managed by a district engineer, in which the Texas Department of Transportation (TxDOT) conducts its primary work activities.

emissions reduction measure — A measure designed to reduce emissions from on-road vehicles.

farm-to-market (FM) or ranch-to-market (RM) road — A road shown in the records of the Commission to be a farm-to-market or ranch-to-market road.

may — Auxiliary verb used to indicate a permissive condition.

National Ambient Air Quality Standards (NAAQS) — Federal air quality standards established by the Environmental Protection Agency (EPA) to protect public health and welfare. NAAQS have been established for ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, particulate matter, and lead.

nonattainment county or nonattainment area — A county or counties in an air quality control region (area) for which a designated pollutant exceeds the National Ambient Air Quality Standards (NAAQS) for the pollutant as designated pursuant to 42 USC §7407.

shall — Auxiliary verb used to indicate a mandatory condition.

should — Auxiliary verb used to indicate an advisable but not mandatory condition; however, any reason for not following the instruction must be supported by sound engineering judgment.

State Implementation Plan (SIP) — The plan prepared by the Texas Natural Resources Conservation Commission as required by 42 USC §7410 to attain and maintain air quality standards. An approved SIP is the implementation plan, or most recent revision of this plan, which has been approved or promulgated by the Environmental Protection Agency.

Texas Manual on Uniform Traffic Control Devices (TMUTCD) — The manual, and any revisions, adopted by the commission as required under Transportation Code, §544.001.

Texas Commission on Environmental Quality (TCEQ) — The state air pollution control agency, which is the principal authority in the state of Texas on matters relating to the quality of the state's air resources.

Traffic Engineering Section (TE) — A section in the Traffic Operations Division whose primary responsibility relates to traffic engineering.

Traffic Operations Division (TRF) — The division within the Texas Department of Transportation, headquartered in Austin, whose primary responsibility relates to traffic operations.

transportation conformity — A requirement for §176(c) of the Federal Clean Air Act. EPA's transportation conformity rule (40 CFR Parts 51 and 93) and the Texas transportation conformity rule (30 TAC §114.260) contain the detailed requirements. Transportation conformity requires nonattainment and maintenance areas to demonstrate that estimated on-road mobile source emissions from metropolitan transportation plans (MTPs), transportation improvement programs (TIPs), and transportation projects conform to the purpose of the SIP, meaning that they will not cause or contribute to violations of air quality standards or delay timely attainment.