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16. Abstract As part of a research project on sign retroreflectivity issues, engineers from the Texas Transportation Institute (TTI) and the Texas Department of Transportation (TxDOT) Traffic Operations Division (TRF) visited TxDOT districts and other locations to review TxDOT signing operations practices. All 25 TxDOT districts, plus the TxDOT regional warehouse in Athens and the Texas prison sign shop at the Beto Unit were visited. At each district, the team members met individually with sign crews and maintenance supervisors, sign shop staff, area engineers, district maintenance staff, district traffic staff, and the district engineer. Each visit lasted a full day and during the visit, team members discussed a wide variety of signing issues of concern to each group they met with. This report describes the general findings of the visits and the associated recommendations. The findings identified during the visit are described in Chapter 2 and address the following major areas: district relationships with Austin, signing relationships within districts, variations in district practices, sign upgrade initiative, quality of contractor sign installation, field crew challenges, signing materials and equipment, and inventory system for signing. Chapter 3 presents the recommendations associated with each of these major areas.			
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# **A REVIEW OF TxDOT SIGNING OPERATIONS**

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## **DISCLAIMER**

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The contents of this report reflect the views of the authors, who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge of the project was H. Gene Hawkins, Jr., P.E. (TX-#61509).

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## ACKNOWLEDGMENTS

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Over the course of 15 months, the authors of this report visited all 25 TxDOT districts, the regional supply center in Athens, and the prison sign shop at the Beto Unit near Palestine. During the course of those visits, the authors met with some 800 to 900 TxDOT employees to discuss signing issues. The authors wish to express their sincere gratitude to those individuals for taking time to discuss the issues and for the thoughts and suggestions offered during the discussions.

The authors would also like to thank the individuals in each district that assisted with the scheduling and arrangements for each of the visits. Without their assistance, the visits would not have been possible.

This project was conducted in cooperation with TxDOT and the FHWA.

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## CHAPTER 1

# INTRODUCTION

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Traffic signing is a critical part of the transportation system and one of the primary formal means of communicating information to road users. Signs have been a part of the transportation system since the earliest days of automobile travel and have experienced continual improvement during the twentieth century.

The Texas Department of Transportation (TxDOT) has a significant investment in traffic signs. One TxDOT research project estimated that there are somewhere between 1.5 million to 10 million signs on the state highway system<sup>1</sup>. The actual number of signs is unknown, as only a few maintenance sections have a reasonably accurate count of the signs in their section. If the midpoint of the range is used (5.75 million signs), a rough estimate of TxDOT's capital investment in traffic signs (sheeting and substrate only) is over \$600 million<sup>2</sup>, and if the total costs of the sign and installation are considered, the investment is almost \$1.5 billion<sup>3</sup>. While the amount spent on traffic signs is only a fraction of that spent on pavements and structures, traffic signs are a vital part of the transportation network and provide a valuable service to road users.

Over the last decade, there have been a number of factors that have focused greater attention on traffic signs in TxDOT. These factors include:

- In 1992, Congress passed legislation that requires the U.S. Secretary of Transportation to include minimum levels of in-service retroreflectivity for signs in the *Manual on Uniform Traffic Control Devices* (MUTCD). The Federal Highway Administration (FHWA) has published research recommendations for minimum sign retroreflectivity and is currently working to develop a proposed rule.
- In 1993, TxDOT established Type C sheeting (high intensity) as the standard sheeting for all new signs except white ones.
- A 1996 research report recommended the implementation of a sign management system as the most cost-effective means of meeting the minimum retroreflectivity levels recommended by the FHWA research<sup>4</sup>.
- In 1997, TxDOT issued the first edition of the *Sign Crew Field Book*. This document has been widely used by field crews and promoted more consistent sign placement on rural highways.
- In 1998, the TxDOT Executive Director initiated a 3-year sign upgrade program to bring all signs in compliance with current standards.

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<sup>1</sup>Hawkins, Jr., H.G., P.J. Carlson, J.B. McCaleb, and C.R. McIlroy. *Impact of Minimum Retroreflectivity Values on Sign Replacement Practices*, Research Report 1275-1, Texas Transportation Institute, College Station, Texas, October 1996, page VI-6.

<sup>2</sup>Assumes an average sign size of 9 square feet and an average cost of \$12 per square foot.

<sup>3</sup>Based on an average cost of \$250 per sign for installation. This information represents statewide bid prices in May 2001.

<sup>4</sup>Hawkins et al., page VII-8.

- Throughout the 1990s, the number and performance characteristics of sign sheeting have continually increased. This includes the introduction of several microprismatic materials that have higher retroreflectivity than the high intensity sheeting. There are also more manufacturers of high intensity sheeting. TxDOT districts have also demonstrated a willingness to experiment with different sign sheeting materials in an effort to optimize their efforts to communicate with Texas road users.
- In the late 1990s, TxDOT began to implement a sign support system that complied with National Cooperative Highway Research Program (NCHRP) 350 requirements. The FHWA requires sign supports to comply with NCHRP 350 on all roads on the National Highway System.

Research Project 0-1796, Impacts of Retroreflectivity on Sign Management, Maintenance, and Design, was established to evaluate various aspects of retroreflectivity as it relates to signs. In evaluating various sign retroreflectivity issues, the Texas Transportation Institute (TTI) researchers, in combination with staff from the TxDOT Traffic Operations Division (TRF), identified a need to visit with several districts about their signing operations practices. It is well known that every TxDOT district approaches its responsibilities differently, but the researchers did not have good information on the extent of variation in signing practices between the districts.

The initial plan was to have a team meet with TxDOT staff in 15 districts. The team for each visit would consist of one or two TTI researchers (Gene Hawkins and/or Paul Carlson) and one or two engineers from the Traffic Operations Division (Rick Collins and/or Greg Brinkmeyer). At each district, the team would visit with field personnel (sign crews and maintenance supervisors), sign shop staff, area engineers, district maintenance engineer and staff, director of transportation operations (traffic engineer) and staff, and the district engineer. The team used a list of talking points to guide the discussion (see [Appendix](#)), but allowed the group to discuss whatever issues they considered to be the most critical. Groups were segregated. With only one or two exceptions, there was no mixing of the six categories of groups at each district (field, sign shop, area engineer, maintenance, traffic, administration).

The first round of 15 district visits took place between late January and May 2000, and the visits were so informative that the team decided to visit the other 10 districts. The second round of visits took place between September 2000 and April 2001. As a result, all 25 districts were visited during a 15-month period. In addition to the districts, the team also visited the prison sign shop at the Beto Unit and the Athens regional warehouse. [Table 1](#) lists the locations visited, the dates of the visits, and the team members taking part in each visit.

For the first round of visits, the typical schedule is shown following the [table](#). For the second round, the sign shop supervisor and staff were moved to the first hour of the visit so that personnel from outlying sections would not have to travel early to be at the district by 8:00 a.m.

**Table 1. List of Districts Visited.**

District	Date Visited	TTI Staff		TxDOT-TRF Staff	
		Gene Hawkins	Paul Carlson	Rick Collins	Greg Brinkmeyer
Austin	1/27/00	✓	✓	✓	X
San Antonio	2/7/00	✓	✓	✓	✓
Houston	2/16/00	✓	✓	✓	✓
Lubbock	3/6/00	X	✓	X	✓
Childress	3/7/00	X	✓	X	✓
Amarillo	3/8/00	X	✓	X	✓
Bryan	3/23/00	✓	✓	✓	✓
Wichita Falls	4/3/00	✓	X	✓	X
Fort Worth	4/4/00	✓	✓	✓	X
Dallas	4/5/00	✓	✓	✓	X
Paris	4/6/00	X	✓	✓	X
Waco	4/27/00	✓	✓	✓	✓
Atlanta	5/8/00	✓	X	✓	X
Tyler	5/9/00	✓	X	✓	X
Lufkin	5/10/00	✓	X	✓	X
Prison Sign Shop	5/11/00	✓	✓	✓	X
Athens Warehouse	5/11/00	✓	✓	✓	X
San Angelo	9/26/00	✓	X	✓	X
Abilene	9/27/00	✓	✓	✓	X
Brownwood	9/28/00	✓	✓	✓	X
Laredo	11/28/00	✓	X	X	✓
Pharr	11/29/00	✓	X	X	✓
Corpus Christi	11/30/00	✓	X	X	✓
Yoakum	3/1/01	✓	X	✓	✓
Beaumont	3/8/01	✓	✓	✓	X
Odessa	4/25/01	X	✓	✓	X
El Paso	4/26/01	X	✓	✓	X

✓ - participated in district visit      X - did not participate in district visit  
 Sites listed in order visited.

- 8:00-9:30 sign crews and maintenance supervisors
- 9:30-10:30 area engineers
- 10:30-11:30 sign shop supervisor and staff
- 1:00-2:00 director of maintenance operations (or equivalent) and staff
- 2:00-4:00 director of transportation operations (or equivalent) and staff
- 4:00-4:30 district engineer

For each of the groups, a team member provided the same general introduction. The key points of the introduction were:

- We were doing this as part of a research project.
- We were not conducting an evaluation of the district or its personnel.
- We would not mention any person or district by name in the report.
- We would not share any comments from a group with any other group from that district.

The findings from the visits are listed in [Chapter 2](#) and the recommendations are presented in [Chapter 3](#).

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## CHAPTER 2

# FINDINGS

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At the conclusion of the visits, the team members reviewed their notes and identified the key findings of the visits. These findings are presented in this chapter. The following should be considered when reviewing the list of findings:

- The classification of these as findings is based on the opinions of the team members. The inclusion of an item as a finding typically indicates that it was identified as a significant item during the discussion in several districts. However, some findings may include items that the team members believe are significant, even if they were discussed in a small number of districts. In part, this is due to the fact that the team members were not using a checklist or evaluation form in the discussions. An item might be discussed at length in one district and not even mentioned in another district.
- The team members used a list of talking points to guide the discussion in each district. However, district personnel were free to discuss any issue they felt important. As a result, not all items on the list of talking points were discussed in each district.
- The findings described herein focus upon issues that can or should be addressed on a statewide or regional basis. The report does not include any comments or findings that the team members evaluated as internal district issues.
- The findings do not identify any district or individual by name. The team members indicated the report would be prepared in this manner during the introductory comments to each group they visited with.
- The team members noticed a shift in focus in the discussions during the 15 months that the visits covered. The 3-year sign upgrade was the predominant topic of discussion in the early visits. As districts began to progress on the upgrade, it dominated less time in the discussions.
- The findings are not presented in any particular order of significance.

The findings are those that, if addressed, could have the greatest potential for improved signing operations within TxDOT. In general, they also reflect issues that were identified in a large number of districts. [Table 2](#) provides a brief summary of the findings described in this chapter.

**Table 2. Summary of Findings.**

<b>Finding</b>	<b>Summary</b>	<b>Begins on Page</b>
District Relationships with Austin	There is uncertainty among some districts over the intent of guidance provided by Austin leadership.	6
Signing Relationships within Districts	There are some differences of opinion within some districts on the emphasis that signing should receive.	8
Variations in District Practices	There are significant variations in signing practices between the districts. In many cases, these variations are necessary and appropriate.	9
Sign Upgrade Initiative	The 3-year sign upgrade initiative has been embraced by many districts as a long overdue emphasis on signing. However, some felt that the value of the upgrade could have been improved with some advance strategic planning.	10
Quality of Contractor Sign Installations	The quality of contractor installed signs often is not consistent with the quality of sign installations performed by TxDOT personnel.	11
Field Crew Challenges	There are numerous challenges facing sign crews.	15
Signing Materials and Hardware	Sign crews would benefit greatly from improved equipment.	16
DHT System for Signing	The portion of the inventory system for signing has a high potential for confusion, inefficiency, and duplication.	18

## **DISTRICT RELATIONSHIPS WITH AUSTIN**

As mentioned previously, TxDOT districts are part of a decentralized organization and tend to function on an independent basis. As such, the team members were not surprised to hear district personnel comment on the guidance provided from Austin. Some of the most common comments received included:

- In a large number of districts, the field crews feel that signing details are changed too often.
- Statewide uniformity in standards is desirable, but difficult to achieve due to statewide variations in factors such as soils, climate, and traffic conditions.
- When new standards are introduced, there is a lack of consideration for the field perspective. Many field crews indicated that they would like to have an opportunity to review changes in standards.
- The *Signs and Markings Volume* of the *Traffic Operations Manual* is not widely used by the districts. This may be partially attributed to the limited distribution of the document through all levels of TxDOT that are involved in signing operations.
- TxDOT produces a large number of documents that provide guidance on sign design, installation, operation, and maintenance. These documents include the MUTCD,



*Standard Highway Signs* book, *Sign Crew Field Book*, *Signs and Markings Volume* of the *Traffic Operations Manual*, Traffic Operations standard sheets, material specifications, and all-district memos. It is very difficult for TxDOT staff to keep abreast of all the signing information contained in these documents and their updates/revisions.

- Both the field and district personnel indicated confusion over conflicting information provided by Austin. Examples of these types of conflicts include:
  - ▶ Lack of agreement between the *Texas Manual on Uniform Traffic Control Devices* and the *Sign Crew Field Book*. By intention, the field book contains placement distances significantly greater than those in the MUTCD. In several districts, personnel were not able to distinguish that the MUTCD contains the minimum placement distances that apply to all government jurisdictions in Texas and that the field book provides placement criteria for rural highways on the TxDOT system.
  - ▶ Verbal comments made by TxDOT leadership from Austin in district visits or conferences that imply new or different standards or practices. Many cases were cited where a person (division or administration) would make a statement about needing to take some action that is not documented in a standard or all-district memo.
- Information from Austin can be interpreted in many different ways. This was repeatedly observed in how the districts interpreted the memo on the sign upgrade. Examples of how the memo was misinterpreted include:
  - ▶ How districts addressed pipe collar sign installations. The memo indicated that “the breakaway pipe collar coupling support should no longer be installed due to maintenance problems and concerns that a large percentage of field installations were performed incorrectly which, as a result, negatively affected crashworthiness.” Interpretations ranged from replace all collars to replace collars only when hit, and multiple interpretations in between.
  - ▶ Factors that were considered in the sign upgrade. Some districts focused upon all factors (sign retroreflectivity, sign post crashworthiness, sign location, sign height, and others) while other districts focused on one or two factors – e.g., upgrading the sign supports, but keeping the old sign for later replacement.
- A recent Traffic Operations Division all-districts memorandum encouraged districts to remove numerous signs. The statewide effort to reduce signs has had little impact on the total number of signs. Many TxDOT personnel commented that while some signs are being removed, a larger number of new signs are being installed.
- District visits by division staff play an important role in maintaining the relationships between the districts and divisions. Division staff cannot respond effectively to district needs without frequent travel to districts.
  - ▶ The district visits described in this report were extremely useful to TRF staff. Many of the issues identified by district personnel were addressed by TRF staff within days of hearing about it.

## SIGNING RELATIONSHIPS WITHIN DISTRICTS

In visiting the districts, the team members noticed significant differences in the perceived quality of signing within individual districts and the emphasis that signing was given within individual districts. The team members learned a great deal from the field crews (sign crews, assistant maintenance supervisors, and maintenance supervisors). In some cases, the comments from these groups were not consistent with the viewpoints of those in the district or area offices. In many cases, the field crews had a lower opinion of the quality and efficiency of signing operations compared to the engineers. In the team members' opinions, the districts with the best signing shared several common attributes. Those attributes include:

- **District Traffic Engineering Presence** – The districts with better overall signing tended to have a district traffic engineer and/or traffic engineering section with significant authority and respect. In these districts, the traffic engineer often has the final say on all signing matters. Area offices and maintenance sections rely upon the traffic engineering section to provide guidance on sign design and maintenance activities.
- **District Engineer** – The importance associated with signing activities within the district is established by the district engineer. Those districts with better signing typically had a district engineer that established signing as a district priority, provided funding for signing and sign upgrade activities, and communicated the importance of signing to personnel throughout the district.
- **Size of Budgets for Traffic Items** – Districts with better signing operations did not have to devote as many resources to items such as traffic signals and freeway management activities.
- **Area Engineer Responsibilities** – This position may be the toughest job in TxDOT.
  - ▶ It is difficult for the area engineers to keep up with the traffic signing issues in addition to all of the other areas that they are responsible for. A significant proportion of the area engineers the team visited with did not have the appropriate background or expertise to address many signing issues.
  - ▶ Area engineers that knew about signing generally had previous experience in the traffic section.
  - ▶ For most signing issues, the area engineer cannot just look up answers in the MUTCD.
  - ▶ Many area engineers were not aware of the *Sign Crew Field Book*.
- **Communication** – The communications between various portions of a district influence the quality of signing:
  - ▶ Districts with good communications and a strong working relationship between the district engineer, maintenance section, traffic section, and sign shop tended to have a higher quality of signs. This was especially apparent in the ability to use maintenance funds to support sign improvement/upgrade activities.
  - ▶ Field offices are given little or no advance notice of potential changes in standards. They learn of standard changes when it is time to implement the changes. Some of the information sent to the districts from Austin is not being communicated to the field crews. In particular, the field personnel were not aware of many of the TRF all-district memos related to signing.

## VARIATIONS IN DISTRICT PRACTICES

TxDOT has a decentralized organizational structure and the team members were not surprised to find significant variation in signing practices among the districts. Examples of the different types of district variations include:

- Soil conditions require different equipment and installation procedures.
  - ▶ For example, in rock soil, it is not necessary to dig a large hole for a sign post stub. It is only necessary to drill a hole larger than the stub diameter.
  - ▶ Plastic delineators do not install easily in rocky soil conditions.
  - ▶ Sign crews need access to different types of digging equipment depending upon the type of soil conditions.
- Climate conditions require the use of different signing materials.
  - ▶ Plywood works well in West Texas where the climate is dry and the plywood does not rot.
  - ▶ In wet areas, the plywood substrate rots before the sheeting reaches the end of its service life.
  - ▶ Fiberglass reinforced plastic (FRP) posts were favored by some coastal area maintenance sections because they do not corrode in the salt air like the metal sign posts (even though the metal posts are galvanized).
  - ▶ The high winds in West Texas and the coastal areas create higher wind loads and require tighter bolt torques to keep signs from spinning on their bases. Lower bolt torques were adequate in other areas of the state.
- Differences in traffic generator signing practices creates discrepancies between many districts.
  - ▶ Differences in how districts sign generators create consistency problems for the districts. Several district personnel indicated that it made it harder for them to deny sign requests when citizens identified other locations in the state where such signing was used. This is especially problematic for those districts that try to limit traffic generator signing.
  - ▶ There are sufficient differences between districts in traffic volumes, recreational traffic, and types of generators that application of statewide traffic generator signing guidelines does not equally serve the needs of road users in all areas. For example, the most significant traffic generator in one area may not qualify for generator signing when compared to other areas of the state. But within that area, the generator may be the site that many drivers are looking for, and in fact may be one of the most popular destinations.
  - ▶ District personnel agreed that there should be statewide consistency in meeting the drivers' needs, but that the districts need flexibility in providing the infrastructure and procedures needed to meet those needs.
  - ▶ Specific generator signing situations that were consistently mentioned as challenges include signing for: public school stadiums, small universities and colleges, campgrounds, and elected officials' offices.

## SIGN UPGRADE INITIATIVE

In August 1998, the TxDOT Executive Director announced to district engineers that they had 3 years to bring the signing in their districts up to current standards. An all-districts memo on the sign upgrade was jointly issued by the Traffic Operations and Maintenance Divisions on March 1, 1999. When the district signing visits began in late January 2000, the deadline was 18 months away, and few districts had made significant progress in the field toward completion of the upgrade. When the visits finished in April 2001, the deadline was a little more than three months away and many districts were working hard to complete the upgrade.

As expected, the upgrade program generated a significant amount of discussion with all the groups in each district. The most significant comments relative to the upgrade include:

- The upgrade was viewed as a positive step toward improving signing and placing emphasis on an important part of the transportation system.
- There was a perceived lack of direction from Austin on exactly what sign items should be upgraded – sign supports, sign location, sign retroreflectivity, or other factors.
- There was a perceived lack of direction from Austin on when a sign should be upgraded. If an existing sign support was not the new hardware but was in the proper location, did it need to be replaced? If the support and sign were adequate, did the installation need to be upgraded to achieve proper height or lateral offset? Very few of the existing rural sign installations complied with the *Sign Crew Field Book*. Did the location need to be changed if all other aspects of the sign were appropriate? If the support and location were appropriate, should the sign be replaced or should it be replaced during normal nighttime inspections? As a result of the uncertainties at the district level, various districts focused on different issues. Some districts have focused on the retroreflectivity issue, some on the sign supports, some on location, and some on all aspects.
- The maintenance sections do not have the personnel to meet the upgrade demands with their own staff. Many claim that they do not have the personnel to conduct sign upgrade activities while performing routine signing activities at the same time.
- Districts are taking various approaches to the upgrade process. Some are using state forces only, some are contracting significant parts, and some are contracting only certain parts (such as sign post stubs).
- Districts that are contracting use various approaches to contract documents. There was little guidance from Austin on how to set up sign upgrade contracts. Each district has climbed its own learning curve with respect to contracting sign upgrade contracts.
- There is no statewide criteria for evaluating the progress on the upgrade. What passes as a completed upgrade on a highway in one district will not be considered complete in another district. One reason is that some districts have a central authority on when the upgrade is complete (often the district traffic section). In other districts, determination of upgrade status is left to the individual maintenance sections.
- Within the districts, progress on the upgrade was difficult to judge. In many cases, the field personnel had a different perception on the completion of the upgrade compared to the perceptions within the district.
- The emphasis on the sign upgrade has caused attention to other items to slip.

In listening to the many comments received on the sign upgrade program, the team members realized that while the sign upgrade is a positive and needed step toward improving the quality of signing, there was a lack of strategic planning for the upgrade that could have otherwise improved the results of the upgrade program. Examples of the lack of strategic planning include:

- At the time the upgrade program was announced, the Traffic Operations Division was in the process of preparing new sign support standard sheets. TRF developed the new standard sheets as part of the implementation of a new sign support system to meet the federal crashworthiness requirements. When the upgrade program was announced, the new support system had not been thoroughly field tested. Because of the upgrade program, the support system was implemented before it was fully field tested. The new standard sheets for sign mounting details (SMD sheets) were issued in December 1998, four months after the sign upgrade began. This lack of field testing may partially account for sign crew comments about the need for field review of changes in sign hardware standards.
- At the time the upgrade was announced, TRF was considering various changes in signing practices. Examples include:
  - ▶ **Fluorescent Yellow-Green School Crossing Signs** – In June 1998, the FHWA revised the national MUTCD to allow the use of fluorescent yellow-green sheeting for school and pedestrian crossing signs (the proposed rule was issued in 1996). Soon thereafter, TxDOT allowed the use of fluorescent yellow-green sheeting for school signs. Team members found that implementation of fluorescent yellow-green sheeting for school signing has been widely variable in the districts. Fluorescent yellow-green implementation could have been significantly improved if coordinated with the upgrade program.
  - ▶ **Sign Crew Field Book** – The first edition of the *Sign Crew Field Book* was issued in the spring of 1997 to the field offices. Unfortunately, it was not initially widely distributed within the district and area offices. As a result, the publication was not being used in the preparation of signing aspects for design plans until well into the sign upgrade process.
  - ▶ **Sign Sheeting Changes** – In February 2001, TRF changed the standard sheeting for white signs from engineering grade (Type A) to high intensity (Type C). Such a change would have been implemented more effectively if coordinated with the sign upgrade.
  - ▶ **Route Marker Redesign** – A previous TxDOT research project (0-1373) evaluated the potential for improving the legibility of route markers for the various classes of highways on the state system and found a significant potential for improved legibility. The sign upgrade program would have provided the ideal opportunity to implement improvements in route marker design.

## QUALITY OF CONTRACTOR SIGN INSTALLATIONS

In many districts, the field personnel commented that the quality of contractor sign installations is not consistent with TxDOT standards. It appears to be a common practice for sign crews to repair or reinstall signing shortly after the project is turned over to the state. This reduces the financial value of having contractors install signs and increases the work load on

field crews. The comments about the quality of contractor sign installations applied most often to construction projects, but they also identified problems with maintenance contracts and with sign upgrade projects. Comments also indicated that there were some contractors that did a very good job of installing signs. Some made comments that fewer of the reputable sign contractors were doing work because it was difficult for them to compete with contractors that had produced a lower quality of work.

Comments about the quality of contractor sign installations were heard most often from the sign crews and maintenance supervisor group in the districts. The problem was acknowledged by some of the other groups in various districts. When mentioned by the other groups, it was described as an inspection problem that needed to be corrected. The comments below primarily reflect the opinions of the field personnel, who are the individuals that have to correct or live with the problems created by inadequate contractor sign installations.

## **Types of Problems**

The discussions with the field personnel identified numerous types of problems that are associated with contractor sign installations. Some of the most common problems identified during the discussions are listed below. In many cases, these problems are not identified until well after a contractor is released from the job (many of these signs problems are discovered when a sign post is hit and has to be replaced).

- The wrong signs are installed.
- The signs are installed incorrectly.
  - ▶ Sign height or offset is incorrect.
  - ▶ Sign stub posts are cut off by the contractor so that they do not have to dig the hole as deep and use as much concrete. [Figure 1](#) provides an example of this type of installation.
  - ▶ The sign stub posts are driven into dirt without digging a hole. The installation is covered with a couple of inches of concrete at the top to provide the appearance of a normal installation. Such a practice is not discovered until the post is hit or the stub is pulled. [Figure 2](#) provides an example of this type of installation.
  - ▶ The slip plate of the stub base is buried below ground level or covered with dirt. Conversely, the top of stub base is too high.
  - ▶ Contractors utilize creative (non-standard) solutions to address incorrect installations. [Figure 3](#) illustrates one such example. In this case, the contractor used a double slip-base extension to raise the height of the slip plate. Other examples were also described.
- The signs are installed in the wrong location.
  - ▶ This is most often associated with a failure to use the placement guidelines in the *Sign Crew Field Book*.
- Contractor uses inadequate sign materials.
  - ▶ Sign support hardware is a cheaper version of that available through the TxDOT system. One example identified was a stub where the triangular slip plate on the stub post was not flat. As a result, it was not possible to install a sign that would not rock in the wind.



**Figure 1. Contractor 8½ inch Stub.**



**Figure 2. Contractor Partial Concrete Foundation.**

- ▶ Signs are fabricated improperly – Improper sign fabrication may include the wrong type of sheeting or substrate, incorrect sign layout, incorrect colors, or other factors.
- ▶ Contractors use lower quality concrete or use too much water. As a result, the foundation breaks when the post is hit.



**Figure 3. Slip Base Extension.**

### **Reasons for Inadequate Sign Installations**

Various reasons were offered to explain why the quality of contractor sign installations was not consistent with that installed by TxDOT crews. Some of the most often cited are:

- Area engineer signing involvement – A noticeable proportion of area engineers indicated little interest in sign design, sign installation, or sign issues.
- Inadequate consultant expertise in sign design – Many of the consultants preparing construction plans have significant expertise in geometric design, pavement design, structural design, and the other traditional design activities. However, few have developed expertise in signing. Furthermore, the sign design portion of the plans are often not submitted until the 90 or 100 percent review stage. At that point, there is often a rush to get the plans to the letting, and the sign design does not receive the proper level of review.
- Inadequate design plans – There were multiple comments that the sign installation problems can often be traced to the design plans. Problems with design plans include:
  - ▶ Improper sign location – On construction projects, the design plans typically show the new signs to be installed in the same place that the previous signs were located. The proper level of attention is not given during the design process to determine if a sign should be relocated.
  - ▶ Old hardware standards – Many of the design plans for recent construction projects were prepared some time ago with previous sign hardware standards. The sign hardware part of the plans was not updated, and all the signs on these projects may have been installed with an older hardware system.
  - ▶ Unnecessary signs – There appears to be little in the way of engineering review on the need for specific signs. Little consideration is given to the potential for removing signs.
- Inadequate contractor experience – The team heard many comments that the contractors that bid on sign contracts (especially sign upgrade projects) did not have any previous signing experience. They required significantly greater oversight than contractors that did signing on a regular basis. Comments were made in several districts about these contractors defaulting on their contracts. In many cases, the contractors are not familiar with TxDOT sign standards.



- Hesitancy to issue change orders – Even when incorrect signing is recognized prior to project completion, there is a hesitancy to address it through change orders. Several area engineers indicated that it is more cost effective to use state forces to correct problems than to issue a change order. Field crews indicated that area engineers have this attitude because they get evaluated on the time, budget, and change orders for a project, but not on how they use their field crews to fix problems created by the contract.
- Lack of proper inspection – The inspectors on most construction projects do not deal with sign inspection issues on a daily basis. Specific sign inspection weaknesses identified in the discussions include:
  - ▶ Construction inspectors are primarily concerned with ensuring that the proper sign quantities are installed, not necessarily the quality or location (including height and lateral offset) of the installation.
  - ▶ Many inspectors do not have the background and/or training to address the details of sign installation (proper location, proper hardware, proper installation).
  - ▶ Sign materials are not inspected by Materials and Tests on maintenance contracts. On contracts where materials are inspected by Materials and Tests, the contractor may provide a sample for inspection that is not representative of the material being used on the contract.
- Relative importance of signing during project completion – Signing is typically one of the last items installed on a contract. Both the contractor and TxDOT are anxious to finish the project and may not give adequate attention to signing details.

## **FIELD CREW CHALLENGES**

Some of the most informative comments during the visits came from the sign crews and maintenance supervisors. The team members gained a strong appreciation for the difficulty of the sign crew position and the demands that they face. Typical comments related to the sign crew position include:

- Mondays are spent driving the roads and repairing damage that occurred during the weekend. This typically takes an entire day or more.
- In addition to signing activities, sign crews are responsible for many other activities, including:
  - ▶ Mailboxes – Mailboxes were one of the top complaints from the sign crews. The time devoted to mailbox installation and repair varied between districts, but some sign crews indicated it represented as much as 20 to 50 percent of their time. Some of the inefficiency in the time related to mailboxes can be attributed to the lack of coordination and planning of mailbox activities. In some areas, when a mailbox is requested, it moves to the top of the work list, even if it is located on the far side of the county.
    - Mailbox activities include installation of new mailboxes, replacement of damaged mailboxes, raising mailboxes as requested by mail carriers (to accommodate changes in vehicle height when a carrier takes over a delivery contract), removal of non-compliant mailboxes, and moving mailboxes to accommodate roadway changes (such as driveways, mailbox turnouts, etc.).

- One district has successfully used contracts for mailbox installation and maintenance.
- Other districts have implemented response policies so that mailbox installation and repair can be coordinated and accommodated on the same day of the week.
- ▶ Dead animal and debris removal – Sign crews are often called away from their primary responsibilities to remove dead animals or other debris from a roadway. The travel distance to these locations may be significant in some cases.
- ▶ Delineation – Sign crews spend a significant portion of their time installing or maintaining delineators. Many indicated that the implementation of plastic delineation has increased delineator maintenance. Specific concerns with delineator materials are described in the “Signing Materials and Hardware” section.
- Sign crews spend all day traveling in and working out of their trucks. It was not surprising that sign trucks generated a great deal of comments from the sign crews.
  - ▶ Sign crews need more input on the equipment (trucks) they get.
  - ▶ The trucks lack storage for new signs. A significant proportion of damage to new signs occurs on the sign truck during transit from the maintenance section to the installation location. This is most commonly due to the lack of specialized racks for storage signs during transit.
  - ▶ There is a lack of working area in and on the trucks.
- There is a lack of training that is specifically directed toward sign crews. Several indicated that they benefitted from meeting with sign crews from other sections and districts.
- Responding to sign vandalism is a major time commitment, particularly on Mondays and Tuesdays.
  - ▶ Sign vandalism takes various forms, including stolen signs, painted signs, and intentional sign knock-downs. Comments indicated that sign knock-downs are a popular activity in some areas. Several comments indicated that it is not unusual for every sign on a stretch of road to be knocked down during a weekend.
- Sign crews favored the new sign support system that TxDOT is currently using. They would like to see it remain constant for a period of years.

## **SIGNING MATERIALS AND HARDWARE**

The visits with personnel at the districts, the prison sign shop, and regional warehouse generated numerous comments related to the materials and equipment associated with signing operations. The most significant of these comments include:

- **Prison Recycling** – The prison is not using sanders to remove sheeting from sign blanks as they used to do. As a result, the prison is not recycling the sign blanks returned by TxDOT districts. Instead, they are selling them for scrap. Prison representatives indicated they were considering shipping old signs to a contractor so that sheeting could be removed by water blasting. The old blanks could then be returned to the prison for recycling.
- **Sign Substrates** – There were significant differences of opinion on the effectiveness of plywood and aluminum as sign substrates.

- ▶ A large number of districts (particularly those with high levels of precipitation) found that the substrate of plywood signs rotted before the sign sheeting reached the end of its service life.
- ▶ Districts in dry areas (particularly West Texas) favored the use of signs made from plywood substrates.
- ▶ Areas with high levels of vandalism problems favored signs with plywood substrates because they were not stolen as often as aluminum signs were (for recycle value).
- ▶ At least one district has minimized the use of plywood as a substrate and buys its signs with aluminum substrate on a district contract. The experience has been positive, and the sign crews like the lighter weight of the aluminum substrate signs.
- ▶ Although not part of this series of visits, three members of the team visited a major fabricator of freeway guide signs and learned that TxDOT is one of the few states in the country that still uses plywood for its signs.
- **Sheeting Warranty** – TxDOT requires sheeting manufacturers to warranty the sheeting for several years (the length of time depends upon the type of sheeting). The team was not able to identify any cases where a warranty claim was made for a sign in the field where the sheeting did not perform for the full length of the warranty period.
  - ▶ Many sign crews were even surprised to learn that there was a warranty on the sheeting.
  - ▶ TxDOT record keeping may not be adequate to provide sufficient information to file warranty claims for signs that have been in the field for several years.
  - ▶ In the sign shops, most damaged sign material is saved until there is sufficient quantity, then it is sent back to the warehouse.
- **Microprismatic Sheeting** – Most of the districts have little or no experience with microprismatic sheeting. This can be attributed to the following:
  - ▶ TxDOT sign shop cutters are not capable of cutting through microprismatic materials. They have to be cut by hand.
  - ▶ Microprismatic materials are not available through the regional warehouses. They have to be purchased directly from the vendor.
- **Sign Support System** – Shortly after the sign upgrade initiative was implemented, TxDOT-TRF implemented a new small sign support system.
  - ▶ In general, the sign support system currently used by TxDOT received favorable comments.
  - ▶ Anecdotal information provided by the sign crews indicated that some slip bases were bending instead of slipping. It is unclear whether this is a function of normal impact from a moving vehicle or the result of vandalism activities.
  - ▶ There are a lot of pipe collar coupler systems in the field. Before the 3-year upgrade initiative, some districts had upgraded all their sign supports to pipe collar systems.
- **Delineators** – Sign crews are generally unhappy with the non-metal delineator posts provided by TxDOT.
  - ▶ Plastic delineators do not stay straight over time. After one or two hits, they flop. They also flap in the wind.
  - ▶ It is too difficult to drive the plastic delineators into hard ground. A hole must be dug or a pilot hole must be drilled first.

- ▶ It is difficult for TxDOT to supply the same type of plastic delineator post from one bid to the next. As a result, field installations may be a mix-match of delineator types.

## DHT SYSTEM FOR SIGNING







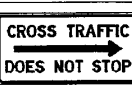
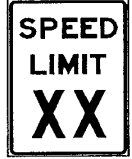
The TxDOT system for numbering signs and sign hardware (Department of Highways and Transportation (DHT) number) was a source of comments in a large number of districts. There was a high level of frustration among personnel in the various groups with how they have to track inventory items. Some of the more significant issues related to the DHT numbering system include:

- **DHT Sign Number Catalog** – A few district sign shops have developed catalogs of DHT sign numbers that they distributed to the sign crews to improve the accuracy of the sign ordering process. [Figure 4](#) illustrates one page from one of the district catalogs. In comparing the catalogs received, the team members have identified numerous inconsistencies in the DHT numbers. [Table 3](#) provides a few examples of these inconsistencies.
- **Unique Signs** – The sign shops were the most critical of the DHT system. Several of the sign shops assign a DHT number to each unique green background sign. As an example, a 48×12 inch sign with the legend “ANYTOWN 25” would have one DHT number and another sign with the legend “ANYTOWN 10” would have a different DHT number. Other sign shops are assigning DHT numbers only on the basis of the size of the green sign. For example, two green signs that are both 48×24 inches would have the same DHT number even though the legends are different. [Table 3](#) also provides an indication of how different districts assign DHT numbers to individual signs.
- **Prefabricated Signs** – Several sign shops indicated that there is duplication and redundancy in the DHT numbers for prefabricated (or face) signs ordered from the warehouse. For instance, one DHT number would be for a “Curve Right, 36×36 inch” and another DHT number would be for a “Right Curve, 36×36 inch.” The General Service Division (GSD) has been trying to eliminate some of the duplicate numbers during the time since the district visits have been completed.
- **Sign Hardware** – In at least one district, sign crews were expected to track use of every piece of hardware, including individual bolts.
- **Record Keeping** – The Daily Activity Record (DAR) used by sign crews provides space for up to six items used by a sign crew on a daily basis. However, a single sign installation may involve as many as two dozen individual pieces of equipment (concrete, stub, color, bolts, post, U-bolts, clamp, and various signs that make up an assembly). This creates a need for additional pages of records. Sign crews in some districts indicated the detail required for record keeping was extensive. Sign crews in other districts indicated it was not a problem.

Blue DHT#'S, Available From Seguin Warehouse.  
 Red DHT#'S, Order From Dist. Sign Shop.

A-1

REGULATORY SIGNS

SIGN	STD	EXPY	FRWY	MIN	SPEC	MANUAL SECT	PAGE
	R1-1 30"X30" 114890	ER1-1 36"X36" 142525	-	MRI-1 24"X24" 139732	SRI-1 48"X48" 114886	2B-4	A-1
	R1-2 36X36X36 66314	ER1-2 48X48X48 102139	FR1-2 60X60X60 114887	MRI-2 30X30X30 -	SRI-2 42X42X42 114892	2B-7	A-2
	R1-2a 21X15 150808	-	-	-	SRI-2a 30X24 143312	2B-7.1	A-3
	-	SRI-2b 30X24 156897	-	MRI-2b 36X24 -	SRI-2b 48X36 143190	2B-7.2	A-4
	R1-3 12X6	2-WAY 139703 3-WAY 139735 4-WAY 139733		-	-	2B-4	A-5
	R1-4 18X6 139734	-	-	-	-	2B-4	A-5
	R1-5R 36X18 154675	R1-5L	154676	-	SRI-5R 48X24 -	2B-4.1	A-4.1
	R2-1 24X30 5-23581 10-119423 15-142749 20-81037 25-75706 30-23179 35-23180 40-23182 45-23183 50-23184 55-23185 60-152519 65-152520 70-152469	ER2-1 36X48 30-124393 35-118167 40-62743 45-62802 50-62805 55-62811 60-155457 65-153510 70-153191	FR2-1 48X60 20-81039 25-81034 30-81025 35-81022 40-81019 45-81012 50-81009 55-23368 60-144808 65-126597 70-152335	MR2-1 18X24 -	-	2B-10	A-6

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\* Left (L) or (R) as needed.




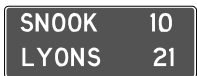
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A-3

(Rev. No. 8)

Figure 4. Example of DHT Numbering Illustration Used in One District.

**Table 3. Comparison of District DHT Sign Number Catalogs.**

Sign	Size (inches)	District A	District B	District C
 Stop R1-1	24×24	not stocked	number not provided	139732
	30×30	114890	114890	114890
	36×36	not stocked	number not provided	142525
	48×48	114886	114886	114886
 Clearance W12-2T	30×30	individual DHT no. provided for each height <sup>1</sup>	number not provided	individual DHT no. provided for each height <sup>1</sup>
	36×36		143448 <sup>2</sup>	
	48×48		143449 <sup>2</sup>	
 Destination D1 series	D1-1 variable×12 or 18	106263	(miscellaneous guide sign, various sizes)	148478
	D1-2 variable×24	133411		152124 <sup>3</sup>
 Distance D2 series	D2-1 variable×12 or 18	74269		148478
	D2-2 variable×24	140649		

Notes:

<sup>1</sup>There are 62 to 72 unique DHT numbers, depending upon the sign size and the clearance.

<sup>2</sup>The clearance height to be provided in the special instructions.

<sup>3</sup>Same DHT number used for all green guide signs of all sizes.

## OTHER FINDINGS

In addition to the findings described previously, the team also identified a number of other findings that are significant, but less detailed. Those findings are described below.

- **Sign Inventories** – On a department- or district-wide basis, TxDOT does not have any accurate data on the number of signs on the state system. The team found a small number of maintenance sections that have developed actual counts or inventories of the signs in

their sections. These inventories use several different formats, including spreadsheets (Excel), database (Access), or commercial inventory system.

- **Sign Life** – Team members were not able to identify any factual data from the districts on the life of sign sheeting and substrate.
  - ▶ Personnel in some districts claimed that signs with darker colors last only 4 to 5 years. Those near industrial areas say they get only 2 years from signs.
  - ▶ Many indicate that the quality of the plywood used as a substrate has gotten worse. Plywood is rotting through in many parts of the state before the sheeting wears out.
- **Delineation** – Delineation issues generated a great deal of discussion among many of the groups that the team members met with.
  - ▶ Personnel in a large number of districts indicated that the Texas MUTCD should be changed so that delineation is not required if raised pavement markers are used on the roadway. This is an issue because the MUTCD has a mandatory requirement for delineators on Interstate Highway curves.
- **Overhead Sign Lighting** – Sign lighting for overhead signs was discussed in several of the districts. In 1993, TxDOT-TRF issued a policy that overhead sign lights are not needed with high intensity sheeting unless other factors such as alignment or sight distance require lighting. Many of the districts like sign lighting and use it even with high intensity sheeting.
- **Supply Delivery** – During the second round of visits, several of the districts had begun to develop experience with the regional supply warehouses delivering supplies directly to the maintenance sections. With respect to signs and sign hardware, this practice appears to be working well. Some maintenance sections are maintaining longer supply on some inventory items because they only get one delivery per week and they cannot be certain that items they order will be on the delivery.
- **Fluorescent Yellow-Green Signs** – When the national MUTCD was revised in June 1998 to establish fluorescent yellow-green as an optional color sheeting for school and pedestrian signs, TxDOT restricted the use of fluorescent yellow-green to school signs. The team members found that implementation of the fluorescent yellow-green school signs has been uneven across the districts.
  - ▶ Some districts have not implemented the signs because they are not available from the regional warehouses as complete signs.
  - ▶ Early in the first round of visits, districts could not get pentagon-shaped aluminum blanks for these signs. They were covering new or old yellow signs with fluorescent yellow-green microprismatic sign faces.
  - ▶ In order to fabricate fluorescent yellow-green school crossing signs, districts order the sheeting directly from the manufacturer on a district contract. They order sign blanks through the warehouse and then fabricate the signs in the district sign shop.
  - ▶ There was uncertainty in some districts as to whether the fluorescent yellow-green sheeting can be used for other school-related signs such as the school plaque at the top of a school speed limit sign, the End School Zone sign, and the School Bus Stop Ahead sign.





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## CHAPTER 3

# RECOMMENDATIONS

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The visits to all 25 TxDOT districts identified many interesting and useful findings, the major ones of which are described in the preceding [chapter](#). Based on these findings, the team members have developed a series of recommendations for improving TxDOT signing operations. The recommendations described in this chapter address major signing recommendations that have statewide implications. Many of the minor needs and issues were addressed by the Traffic Operations Division personnel soon after returning from the various district visits. Some of the recommendations included in this chapter may already be in place to some extent, but could be implemented more thoroughly. The recommendations listed in this chapter are structured in the same categories as the findings in the previous [chapter](#).

### DISTRICT RELATIONSHIPS WITH AUSTIN

These recommendations address the manner in which information is presented to the districts by elements of TxDOT in Austin, including the administration and divisions.

- Changes in signing standards, guidelines, hardware, or details should be kept to a minimum.
- When changes in signing standards, guidelines, or details are initiated by the Traffic Operations Division, notification and explanation should be distributed to all personnel involved in signing operations. The distribution should include field crews.
- Prior to implementation, changes in standards, guidelines, hardware, or details should be reviewed by a representative sample of the group(s) ultimately responsible for implementing the change. This includes review by sign crews.
- Statewide signing practices should be flexible enough to allow for differences in climate, soils, and traffic conditions.
- The Traffic Operations Division should provide some overall coordination of the various documents that address signing issues. These documents include the Texas MUTCD, *Standard Highway Signs* book, *Sign Crew Field Book*, *Signs and Markings Volume* of the *Traffic Operations Manual*, Traffic Operations standard sheets, material specifications, and all-district memos. At the minimum, there should be a short or brief overview document (such as a two-page brochure) that describes the type of material that is in each document and the audience it is intended for. This overview document should also explain the differences in values between documents (such as the minimum distances in the Texas MUTCD and the desirable distances in the *Sign Crew Field Book*). Ultimately, these documents should be available in linked electronic format. In doing so, conflicts and differences between the documents should also be resolved.
- As part of the coordination of signing documents, the Traffic Operations Division should distribute the *Signs and Markings Volume* more widely.
- All-district memos that relate to signing issues should automatically be distributed to maintenance sections and area offices, in addition to the distribution to the district.

- Major initiatives, directives, or changes in preferred practices originating from TxDOT leadership or a division should be documented in writing to improve consistency in implementation and reduce variations. Doing so also simplifies distribution of the information.
- Districts should be encouraged to seek interpretation or clarification on initiatives or directives that are not clear in intent.
- Division personnel should continue to meet with district personnel at all levels on a regular basis. This practice improves communications between Austin and the districts and helps division personnel better understand the needs of district and field personnel. These visits should include discussions with field personnel.

## **SIGNING RELATIONSHIPS WITHIN DISTRICTS**

These recommendations address how signing issues and activities are handled within the districts.

- Districts should have a strong traffic engineering presence in the district. Traffic engineering should have decision-making authority (as provided by the district engineer) on all signing issues. This should include access to the budget resources needed to meet the signing objectives established by the district engineer.
- Area engineers should have improved training in sign design and sign maintenance issues.
- Area engineers should be integrated into the communication process for signing issues.
- Area engineers should be encouraged to utilize the signing expertise and resources of the district traffic engineering section in developing plans related to signing.
- District staff should include field personnel in the review of draft standards and other documents when they are distributed to the district for review prior to implementation.
- Maintenance supervisors and sign crews should be provided with advance notice of potential changes in standards, guidelines, and practices to improve planning and resource utilization at the field level.

## **VARIATIONS IN DISTRICT PRACTICES**

These recommendations address the need for consistency in traffic generator practices between the districts.

- TxDOT needs to improve generator signing consistency across the state. If one district puts in a particular type of sign, that spreads throughout the state. There needs to be a statewide policy that accounts for the different needs of the districts, considering such factors as differences in population, traffic volumes, type of travelers, and other factors. It may be appropriate to review Appendix D of the Texas MUTCD and update or reemphasize as necessary.

## **SIGN UPGRADE INITIATIVE**

These recommendations address how lessons learned from the sign upgrade initiative should be applied to future initiatives.

- Major signing improvements should be coordinated and initiated as part of a strategic planning effort. Such a planning effort should take place on some regular interval (such as 2-4 years) and all signing changes should be incorporated into the effort. Issues that should be considered as part of the strategic effort include:
  - ▶ changes in sheeting type,
  - ▶ changes in support hardware,
  - ▶ changes in standard sheets,
  - ▶ revisions of the Texas MUTCD and other signing documents, and
  - ▶ coordination of previous all-district memorandums.
- Divisions should provide example contracting plans for projects that involve only sign upgrade or replacement. While the formal upgrade process has been completed, many districts may continue to use contractors for signing activities. Examples of contract documents would be helpful to area offices and district traffic sections.

## **QUALITY OF CONTRACTOR SIGN INSTALLATIONS**

These recommendations address how the quality of contractor sign installations might be improved.

- Improve the quality of sign inspection.
  - ▶ Use sign crews to do the sign inspection.
    - If sign crews are not used for inspection, provide sign inspection training to the inspectors.
  - ▶ Provide 100 percent inspection, particularly when concrete is poured in sign post holes.
    - If 100 percent inspection is not practical, then random sign posts should be pulled to ensure the stub is of the proper length and the proper amount of concrete is used. This practice is used successfully in at least one district.
  - ▶ Sign hardware should be stamped as part of the manufacturing process so that the manufacturer can be identified.
- As mentioned in the section “[Sign Upgrade Initiative](#),” divisions should provide districts with sample plans for signing-only contracts.
- As mentioned in the section “[Signing Relationships within Districts](#),” sign design training should be provided to area office personnel. Similar training should also be provided to consultants that prepare design plans that include signing.
- All plans that include a signing element, regardless of the source of funds, should be reviewed by the district traffic section.
- Require consultant plans to show signing and striping design prior to the 90 percent review.

## **FIELD CREW CHALLENGES**

These recommendations address means of increasing the efficiency of the work performed by sign crews.

- Austin divisions should develop guidelines and/or procedures for addressing mailboxes so that maintenance section personnel can better manage their time associated with mailbox activities. Among other things, the guidelines/procedures should:
  - ▶ Indicate that requests for mailbox installations will be honored within a set time period. For example, personnel in several districts mentioned that they set aside one day per week to conduct mailbox installation and maintenance. This practice appears to work well and allows sign crews to coordinate mailbox installations throughout the maintenance section and perform activities on one day with a minimal interruption on other signing activities.
  - ▶ Provide guidelines on prioritization of mailbox activities so that maintenance supervisors and sign crews can evaluate the urgency in addressing a mailbox request.
- Develop a proposed standard sign truck(s) that can be equipped with various equipment. The proposed design should be circulated to sign crews for review and comment. Sign trucks should include the following:
  - ▶ Have storage racks for new signs.
  - ▶ Have a boom pedestal located in the front of the sign truck bed.
  - ▶ Have an extended bumper that provides a work area at the rear of the truck.
  - ▶ Be diesel powered.
- Maintenance supervisors and sign crews should have dedicated sign training opportunities. Some districts have annual or semi-annual “sign schools” where all sign crews and maintenance supervisors meet at the district for a day to discuss signing operations. These have been very beneficial to those districts. Regional sign training activities should be conducted every 2 or so years. The Sign Crew Workshops conducted by TxDOT and TTI are one example of the type of training the sign crews would like to see more of.

## **SIGNING MATERIALS AND HARDWARE**

These recommendations address methods of improving sign materials and hardware.

- TxDOT should consider selling used sign blanks as scrap instead of returning them to the prison for recycling.
- TxDOT should consider wider use of aluminum as a sign substrate instead of plywood. In many areas of the state, the plywood substrate is rotting before the sheeting reaches the end of its service life.
- TxDOT should establish procedures that allow sign sheeting warranties to be used to replace sheeting that fails prematurely in the field. These procedures include:
  - ▶ Educating field crews about the warranties and the procedures that should be followed to make a warranty claim.
  - ▶ Ensuring that the information requirements of a warranty can be satisfied with the TxDOT process. Depending upon manufacturers requirements, the information might

- include: the fabrication date of the sign, where the sign was fabricated, the lot number for the sheeting, and the installation date for the sign.
- ▶ If TxDOT warranty procedures cannot effectively accommodate the information needs to make a warranty claim, TxDOT should evaluate whether sheeting costs could be reduced by eliminating the warranty provisions. Such an evaluation should consider the trade-offs associated with purchasing sheeting without a warranty.
  - Districts should be able to order fluorescent yellow-green school signs from the regional warehouses. This material is only available in microprismatic sheeting and has been previously purchased by the districts directly from the manufacturers.
  - TxDOT should consider making other types of prismatic sheeting available to the districts through the regional warehouses. In doing so, the following issues should be considered:
    - ▶ District sign shops should be provided with options for cutting legend from microprismatic sheeting materials.
    - ▶ Because of performance differences between the available prismatic sheeting materials, different types of microprismatic sheeting should not be used on the same sign. Identification information should be provided to the districts so that they can distinguish the different available materials.
  - TxDOT should evaluate the types of delineator posts that can be used. The evaluation should consider:
    - ▶ The ability to drive plastic posts into hard or rocky soil.
    - ▶ Deterioration and softening of plastic posts over time.
    - ▶ The desire for consistency in the types of delineator posts used at each location (round-flat-curved, white-gray, metal-plastic, etc.). If the same type of post should be used consistently at a location, the contracting process should be modified so that the posts are essentially the same from one contact to another.

## **DHT SYSTEM FOR SIGNING**

These recommendations address options for improving the numbering system used to describe various signs available through the regional warehouses and district sign shops.

- TxDOT-GSD should provide guidelines on how to assign DHT numbers to signs fabricated in the sign shops. From the sign shop perspective, the DHT number for guide signs should be based on the type of sign, but not the legend. In other words, a D2-1 sign with the legend “NEXT TOWN 25, ANY TOWN 40” should have the same DHT number as a D2-1 sign with the legend “NEXT TOWN 15, ANY TOWN 30.”
- The DHT number guidelines should also address whether the DHT number for guide signs should consider sign size. For example, should a D2-1 sign that is 48×24 have the same DHT number as a D2-1 sign that is 72×24?
- The current catalog of DHT sign numbers should be reviewed to eliminate duplicate numbers.
- TxDOT-GSD should prepare a pictorial guide illustrating DHT numbers for various types and sizes of signs. This has been done in several districts and has been very helpful to sign crews and other personnel involved in ordering and fabricating signs. [Figure 4](#) illustrates an example of one of these pages.

- Ultimately, TxDOT-GSD should consider revising the DHT numbering scheme so that it utilizes a combination of the sign codes used in the MUTCD (such as R1-1 for a Stop sign) and the size of the sign. The current scheme requires the use of two parallel numbering schemes (DHT numbers for ordering and MUTCD numbers for design). For example, a Right Curve sign could have a DHT number of W01-02R, 36×36, or something similar. A similar system is used by the Ohio DOT for their signs.
- Before making any changes in the DHT system, TxDOT should seek input from sign crews, maintenance supervisors, and sign shop supervisors on a potential system.

## **OTHER FINDINGS**

These recommendations address other issues that are not in one of the major categories of findings.

- TxDOT should consider revising the Texas MUTCD so that delineation is not required on Interstate Highway curves if retroreflective raised pavement markers are used.
- TxDOT-TRF should provide the districts with specific information on which school signs can use the fluorescent yellow-green sheeting.
- TxDOT should continue the practice of shipping signing supplies directly from the regional warehouses to the maintenance sections.

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## APPENDIX

# LIST OF DISCUSSION ITEMS

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The pages in this appendix represent the talking points the team used to generate discussion with each of the groups in the districts. Not every issue was addressed in each district.

### **SIGN CREWS AND MAINTENANCE SUPERVISORS**

- Sign Upgrade Process
  - ▶ How is sign upgrade process going?
  - ▶ What are your district's objectives for upgrading signs?
  - ▶ What is being replaced/upgraded? (bases, couplers, signs below 7 ft, etc.)
- Sign Support Hardware
  - ▶ Are you having problems with any type of sign support?
  - ▶ Are you removing coupler connections?
  - ▶ How do you like the Poz-Loc support system?
  - ▶ Do you set the Poz-Loc base in concrete?
  - ▶ Are you having any problems with repeat uses of Poz-Loc systems?
  - ▶ How do you like the Texas Universal system?
  - ▶ Any installation problems?
  - ▶ Are you using the prefabricated goalpost or T's?
  - ▶ Do you have any problems with sign clamps?
- Sign Materials
  - ▶ Are you getting all the signs you need?
  - ▶ Are you having problems getting any sign hardware?
  - ▶ Do you think high intensity should be used for white signs?
- Sign Installation
  - ▶ Are you using a neoprene washer between the bolt and sign face?
  - ▶ When do you call Digtess/One call (or other) before digging a sign post hole?
- Sign Crew Truck
  - ▶ What features would you like to see on your sign truck?
    - Auger
    - Bucket
    - Crane/boom
- Contractor Sign Installation
  - ▶ To what extent are you having to replace contractor sign installations when a construction project is turned over to the state?
  - ▶ Would you be willing to do any of the following to minimize replacement activities:
    - Review plans during design process?
    - Conduct sign inspections during construction?
  - ▶ How well are construction inspectors inspecting contractor sign installations?

- Administration and Communication
  - ▶ How much explanation is provided on changes in practice?
  - ▶ Have you ever been shown any crash test videos?
  - ▶ How many are on a sign crew?
  - ▶ What happens in situations where more than one sign man is needed for a particular job? How frequently does this occur?
  - ▶ Do you keep a diary of sign installation, maintenance, and related activities?
- Sign Documents
  - ▶ Which of the following do you have and which do you use?
    - *Sign Crew Field Book*
    - Texas MUTCD
    - Traffic Control Standard Sheets
    - *Signs and Markings Volume of the Traffic Operations Manual*
    - *Standard Highway Sign Designs for Texas*
    - Others
  - ▶ How often do you use these documents?
  - ▶ If you do not use any of these documents, why?
- Night Inspection
  - ▶ How often are you conducting nighttime inspections?
  - ▶ Who conducts the inspection?
  - ▶ How many people are on a team when conducting the inspection?
  - ▶ What type of vehicle are you conducting the inspection in?
  - ▶ How fast do you drive when conducting the inspection?
  - ▶ How do you identify which signs to replace when you do inspections? (list, spray paint, sticker)
- Delineators
  - ▶ What kind of delineator posts are you using?
  - ▶ Have you had any problems with a particular type of delineator?
  - ▶ Do you have guidelines for placement and which type do you use where?
- Mailboxes
  - ▶ Any problems with mailboxes?
- Sign Replacement
  - ▶ Have you ever measured the retroreflectivity of a sign with an instrument?
  - ▶ Are plywood signs lasting as long as they used to?
  - ▶ Have budget constraints restricted sign replacement activities?
- Sign Warranty Replacement
  - ▶ Have you ever made a warranty claim when replacing a sign that failed before it should have?
- Sign Life
  - ▶ How long are your signs lasting in the field?
  - ▶ What are the primary factors that cause signs to need replacement?
  - ▶ What can be done to increase the life of signs?
- Recycling
  - ▶ What do you do with old sign blanks?



- Vandalism
  - ▶ How much of a problem is vandalism?
  - ▶ What are the most common forms of vandalism?
  - ▶ What have you done to combat vandalism, if anything?
- Sign Maintenance Traffic Control
  - ▶ What type of traffic control do you use when maintaining/installing signs?
  - ▶ Is this adequate?

## AREA ENGINEERS

- Sign Upgrade Process
  - ▶ How is sign upgrade process going?
  - ▶ What are your district's objectives for upgrading signs?
  - ▶ What is being replaced/upgraded? (bases, couplers, signs below 7 ft, etc.)
  - ▶ How are you paying for the sign upgrade?
  - ▶ Are you contracting out some upgrade activities?
- Politics
  - ▶ How often do you put up signs that are the result of political pressure? (signs that would not otherwise be installed)
  - ▶ Are you involved in the political decision-making process?
  - ▶ How does your district engineer respond to political pressure for signs?
- Sign Design
  - ▶ What is the area engineers' role in sign design?
  - ▶ When designing a road rehabilitation, do you just put signs back where they were?
  - ▶ Do you have anyone from the Maintenance Section review sign portions of design plans during the design process?
- Sign Documents
  - ▶ Which of the following do you use in the sign design process?
    - *Sign Crew Field Book*
    - Texas MUTCD
    - Traffic Control Standard Sheets
    - *Signs and Markings Volume of the Traffic Operations Manual*
    - *Standard Highway Sign Designs for Texas*
    - Others
  - ▶ How often do you use these documents?
  - ▶ If you do not use any of these documents, why?
- Night Inspection
  - ▶ How frequently are nighttime sign inspections conducted?
  - ▶ Are you involved in the nighttime sign inspections?
- Contractor Sign Installation
  - ▶ How good of a job are construction inspectors doing when inspecting signs on construction projects?
  - ▶ Are contractors installing signs in accordance to TxDOT standards?
  - ▶ To what extent are you having to replace contractor sign installations when a construction project is turned over to the state?

- Sign Administration
  - ▶ How are citizen requests for new signs handled?
  - ▶ Do work orders for new signs go through your Area Office?
  - ▶ How many people should be on a sign crew?
  - ▶ How often do you meet with the sign crews?
- Sign Life
  - ▶ How long are your signs lasting in the field?
  - ▶ What are the primary factors that cause signs to need replacement?
  - ▶ What can be done to increase the life of signs?
- Vandalism
  - ▶ How much of a problem is vandalism?
  - ▶ What are the most common forms of vandalism?
  - ▶ What have you done to combat vandalism, if anything?
- Pavement Markings
  - ▶ How is the Area Office involved in pavement marking activities?
- Sign Materials
  - ▶ Are field crews getting all the signs they need?
  - ▶ Are field crews having problems getting any sign hardware?
  - ▶ Do you think high intensity should be used for white signs?
- Sign Installation
  - ▶ Are sign crews provided with all the equipment they need to install signs in an efficient manner?
- Delineators
  - ▶ Have you had any problems with a particular type of delineator?
- Mailboxes
  - ▶ Any problems with mailboxes?
- Sign Replacement
  - ▶ Have budget constraints restricted sign replacement activities?

## **SIGN SHOP PERSONNEL**

- Sign Upgrade Process
  - ▶ How is sign upgrade process going?
  - ▶ How is the upgrade affecting the sign shop?
- Sign Materials
  - ▶ Is the quality of signs received from the prison acceptable? (wrinkled faces)
  - ▶ What do you do with unacceptable prison signs?
  - ▶ Which regional warehouse do you work through?
  - ▶ Do you have any problems getting sign materials from the regional warehouse?
  - ▶ Have you had any experience with prismatic sheeting?
  - ▶ What type of material are you using for white signs?
- Sign Shop Administration
  - ▶ Who do you answer to - maintenance or traffic?
  - ▶ Is this an appropriate arrangement?
  - ▶ Do you get to decide the amount of sign inventory you carry?

- Communication
  - ▶ Have you had any contact with other sign shops?
  - ▶ Do you provide any additional services to sign crews beyond sign fabrication?
- Sign Fabrication
  - ▶ Do you use any document other than the *Standard Highway Signs*?
  - ▶ What computer program do you use? (Trafficked)
  - ▶ What type of cutter(s) do you have and how many?
  - ▶ Can your cutters cut prismatic sheeting?
  - ▶ Have you had any problems with materials during sign fabrication?
  - ▶ Do you screen signs?
- Recycling
  - ▶ What do you do with old sign blanks?
- Large Green Guide Signs
  - ▶ Who makes large green guide signs? (sign shop or contractor)
  - ▶ Does the sign shop have the capability to make large green signs?
  - ▶ What is the quality of large green signs from contractors?
  - ▶ What type of sheeting do you use for route markers mounted to guide signs?
- Sign Life
  - ▶ How long are your signs lasting in the field?
  - ▶ What are the primary factors that cause signs to need replacement?
  - ▶ What can be done to increase the life of signs?
- Vandalism
  - ▶ How much of a problem is vandalism?
  - ▶ What are the most common forms of vandalism?
  - ▶ What have you done to combat vandalism, if anything?
- Sign Warranty Replacement
  - ▶ Have you ever made a warranty claim when replacing a sign that failed before it should have?

## **MAINTENANCE ENGINEER AND STAFF**

- Sign Upgrade Process
  - ▶ How is sign upgrade process going?
  - ▶ What are your district's objectives for upgrading signs?
  - ▶ What is being replaced/upgraded? (bases, couplers, signs below 7 ft, etc.)
- Sign Materials
  - ▶ Do you think high intensity should be used for white signs?
- Sign Administration
  - ▶ Who do the sign crews answer to?
  - ▶ How is the working relationship between maintenance and traffic?
  - ▶ Where is the sign shop located in the district organizational chart?
  - ▶ Is this an appropriate location?

- Sign Installation
  - ▶ Are the sign crews getting the materials they need?
  - ▶ Are you having problems with any type of sign support?
  - ▶ Are you removing coupler connections?
  - ▶ How do you like the Poz-Loc support system?
  - ▶ How do you like the Texas Universal system?
  - ▶ Do you have any problems with sign clamps?
- Contractor Sign Installation
  - ▶ To what extent are your crews replacing contractor sign installations when a construction project is turned over to the state?
  - ▶ How well are construction inspectors inspecting contractor sign installations?
- Night Inspection
  - ▶ How often are you conducting nighttime inspections?
  - ▶ Who conducts the inspection?
- Sign Life
  - ▶ How long are your signs lasting in the field?
  - ▶ What are the primary factors that cause signs to need replacement?
  - ▶ What can be done to increase the life of signs?
- Tort
  - ▶ Are you aware of any (non-work zone) lawsuits in which signing was a primary factor?
- Politics
  - ▶ How often do you put up signs that are the result of political pressure? (signs that would not otherwise be installed)
  - ▶ Are you involved in the political decision-making process?
  - ▶ How does your district engineer respond to political pressure for signs?
- Vandalism
  - ▶ How much of a problem is vandalism?
  - ▶ What are the most common forms of vandalism?
  - ▶ What have you done to combat vandalism, if anything?
- Sign Lighting
  - ▶ Are you turning sign lights off?
  - ▶ Approximately how many are turned off (%)?
  - ▶ How do you determine where to turn off sign lights?
  - ▶ Have you received complaints about turning off sign lights?
  - ▶ Do you perceive a significant costs savings by turning off sign lights?
- Pavement Markings
  - ▶ What type of marking materials do you use?
  - ▶ Do you have a district striping truck? If so, what is it used for? What part of the organization does it respond to? (maintenance or traffic)
  - ▶ What kind of life do you get from markings? How often do you replace markings?
  - ▶ Do you use RPMs? If so, at what spacings?
- Delineators
  - ▶ Have you had any problems with a particular type of delineator?
- Mailboxes
  - ▶ Any problems with mailboxes?

## **DIRECTOR OF TRANSPORTATION OPERATIONS AND STAFF**

- Sign Upgrade Process
  - ▶ How is sign upgrade process going?
  - ▶ What are your district's objectives for upgrading signs?
  - ▶ What is being replaced/upgraded? (bases, couplers, signs below 7 ft, etc.)
- Sign Administration
  - ▶ Do you have any idea how many signs are in your district? If so, how do you know?
  - ▶ Would you like to implement a computerized sign management system?
  - ▶ Who do the sign crews answer to?
  - ▶ How is the working relationship between maintenance and traffic?
  - ▶ Where is the sign shop located in the district organizational chart?
  - ▶ Is this an appropriate location?
- Sign Installation
  - ▶ Are the sign crews getting the materials they need?
  - ▶ Are you having problems with any type of sign support?
  - ▶ Are you removing coupler connections?
  - ▶ How do you like the Poz-Loc support system?
  - ▶ How do you like the Texas Universal system?
  - ▶ Do you have any problems with sign clamps?
- Sign Materials
  - ▶ Do you think high intensity should be used for white signs?
- Sign Lighting
  - ▶ Are you turning sign lights off?
  - ▶ Approximately how many are turned off (%)?
  - ▶ How do you determine where to turn off sign lights?
  - ▶ Have you received complaints about turning off sign lights?
  - ▶ Do you perceive a significant cost savings by turning off sign lights?
- Sign Life
  - ▶ How long are your signs lasting in the field?
  - ▶ What are the primary factors that cause signs to need replacement?
  - ▶ What can be done to increase the life of signs?
- Night Inspection
  - ▶ How often are you conducting nighttime inspections?
  - ▶ Who conducts the inspection?
- Contractor Sign Installation
  - ▶ To what extent are your crews replacing contractor sign installations when a construction project is turned over to the state?
  - ▶ How well are construction inspectors inspecting contractor sign installations?
- Tort
  - ▶ Are you aware of any (non-work zone) lawsuits in which signing was a primary factor?
- Politics
  - ▶ How often do you put up signs that are the result of political pressure? (Signs that would not otherwise be installed)
  - ▶ Are you involved in the political decision-making process?

- ▶ How does your district engineer respond to political pressure for signs?
- Environmental Issues
  - ▶ Are there activist groups that are commenting on sign-related activities? (sign lighting, aesthetic appearances, other)
- Delineation
  - ▶ On horizontal curves, how do you decide whether to use additional delineation beyond pavement markings? For instance: RPMs, post-mounted delineators, chevrons, or large arrow panels. Are these devices coordinated in any consistent manner throughout your jurisdiction? Do you think they should be?
  - ▶ Have you had any problems with a particular type of delineator?
- Pavement Markings
  - ▶ What type of marking materials do you use?
  - ▶ Do you have a district striping truck? If so, what is it used for? What part of the organization does it respond to? (maintenance or traffic)
  - ▶ What kind of life do you get from markings? How often do you replace markings?
  - ▶ Do you use RPMs? If so, at what spacings?
- Vandalism
  - ▶ How much of a problem is vandalism?
  - ▶ What are the most common forms of vandalism?
  - ▶ What have you done to combat vandalism, if anything?
- Mailboxes
  - ▶ Any problems with mailboxes?

## **DISTRICT ENGINEER**

- Sign Upgrade Process
  - ▶ How is sign upgrade process going?
  - ▶ What are your district's objectives for upgrading signs?
  - ▶ What is being replaced/upgraded? (bases, couplers, signs below 7 ft, etc.)
- Sign Administration
  - ▶ Do you have any idea how many signs are in your district? If so, how do you know?
  - ▶ Would you like to implement a computerized sign management system?
  - ▶ How is the working relationship between maintenance and traffic?
  - ▶ Where is the sign shop located in the district organizational chart?
  - ▶ Is this an appropriate location?
- Sign Installation
  - ▶ Are the sign crews getting the materials they need?
  - ▶ Are you removing coupler connections?
- Sign Materials
  - ▶ Do you think high intensity should be used for white signs?
- Sign Lighting
  - ▶ Are you turning sign lights off?
  - ▶ Have you received complaints about turning off sign lights?
- Sign Life
  - ▶ What are the primary factors that cause signs to need replacement?

- Contractor Sign Installation
  - ▶ To what extent are your crews replacing contractor sign installations when a construction project is turned over to the state?
  - ▶ How well are construction inspectors inspecting contractor sign installations?
- Tort
  - ▶ Are you aware of any (non-work zone) lawsuits in which signing was a primary factor?
- Politics
  - ▶ How often do you put up signs that are the result of political pressure? (signs that would not otherwise be installed)
  - ▶ Are you involved in the political decision-making process?
  - ▶ How does your district engineer respond to political pressure for signs?
- Environmental Issues
  - ▶ Are there activist groups that are commenting on sign-related activities? (sign lighting, aesthetic appearances, other)
- Delineation
  - ▶ Have you had any problems with a particular type of delineator?
- Pavement Markings
  - ▶ How much are you spending on pavement markings?
  - ▶ What problems are you aware of with respect to pavement markings?
- Vandalism
  - ▶ How much of a problem is vandalism?
- Mailboxes
  - ▶ Any problems with mailboxes?

