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16. Abstract

Drivers who make wrong-way entries onto freeways pose a serious risk to the safety of other motorists and themselves. Wrong-way driving often leads to head-on collisions. Wrong-way crashes are relatively infrequent but are more likely to produce serious injuries and fatalities compared to other types of crashes. Driving the wrong way on freeways has been a nagging traffic safety problem since the interstate highway system was started in the 1950s. Despite over forty years of highway design, marking, and signing improvements at freeway interchanges, the problem still persists.

Several crashes in the Texas Department of Transportation (TxDOT) Fort Worth District have brought attention to the hazard of wrong-way drivers. A search of newspaper articles revealed that the problem of wrong-way driving is not unique to Fort Worth and occurs throughout Texas. Members of the Fort Worth Traffic Management Team (TMT) identified locations with a history of wrong-way entries and assessed potential countermeasures. During this review process it was determined that research was needed to understand and develop effective countermeasures for wrong-way movements onto freeways and other restricted roads. This research provides TxDOT staff with preventative measures for reducing the frequency and severity of wrong-way entries onto freeway facilities throughout Texas.

This report documents the recommended guidelines and best practices developed during the project. The research team based the guidelines and best practices on the results of the literature review, surveys, analysis of freeway-related wrong-way crashes in Texas, and evaluation of available countermeasures. This report also provides a wrong-way entry checklist for engineers and field crews to use for reviewing wrong-way entry issues or suspected problem locations. This checklist was based on one currently used by the California Department of Transportation with some additions based on project findings.

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COUNTERMEASURES FOR WRONG-WAY MOVEMENT ON FREEWAYS: GUIDELINES AND RECOMMENDED PRACTICES

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DISCLAIMER

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- Grover Schretter, TxDOT Fort Worth District; and
- Ronnie Varnell, City of Fort Worth.

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Finally, researchers were grateful for the state DOT and TxDOT district representatives that completed the project surveys.

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LIST OF ABBREVIATIONS

Caltrans	California Department of Transportation
CFC	Contributing Factor Code
DOT	Department of Transportation
DPS	Department of Public Safety
FHWA	Federal Highway Administration
MUTCD	Manual on Uniform Traffic Control Devices
PMC	Project Monitoring Committee
PSAP	Public Safety Answering Point
RPM	Raised Pavement Marker
TMC	Traffic Management Center
TMT	Traffic Management Team
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation

CHAPTER 1. GUIDELINES AND RECOMMENDED PRACTICES FOR APPLICATION OF WRONG-WAY COUNTERMEASURES

This chapter provides the guidelines and recommended practices for application of wrong-way countermeasures and treatments. The research team developed the guidelines and recommended practices based on the results of the literature review, surveys, analysis of freeway-related wrong-way crashes in Texas, and evaluation of available countermeasures.

GUIDELINES

Guideline #1: Existing left-side exit ramps on freeways shall have reflectorized wrong-way pavement arrows installed.

The analysis of freeway-related wrong-way crashes in Texas revealed that several locations with existing left-side exit ramps experienced multiple crashes during the four-year analysis period. This confirms that left-side exit ramps in Texas, while rare, were one of the few problem location types substantiated by the analysis of wrong-way originations. Based on this information, researchers recommended that existing left-side exit ramps on freeways in Texas have the standard TxDOT reflectorized wrong-way pavement arrows (see Figure 1) installed if they are not already in place (*1*).

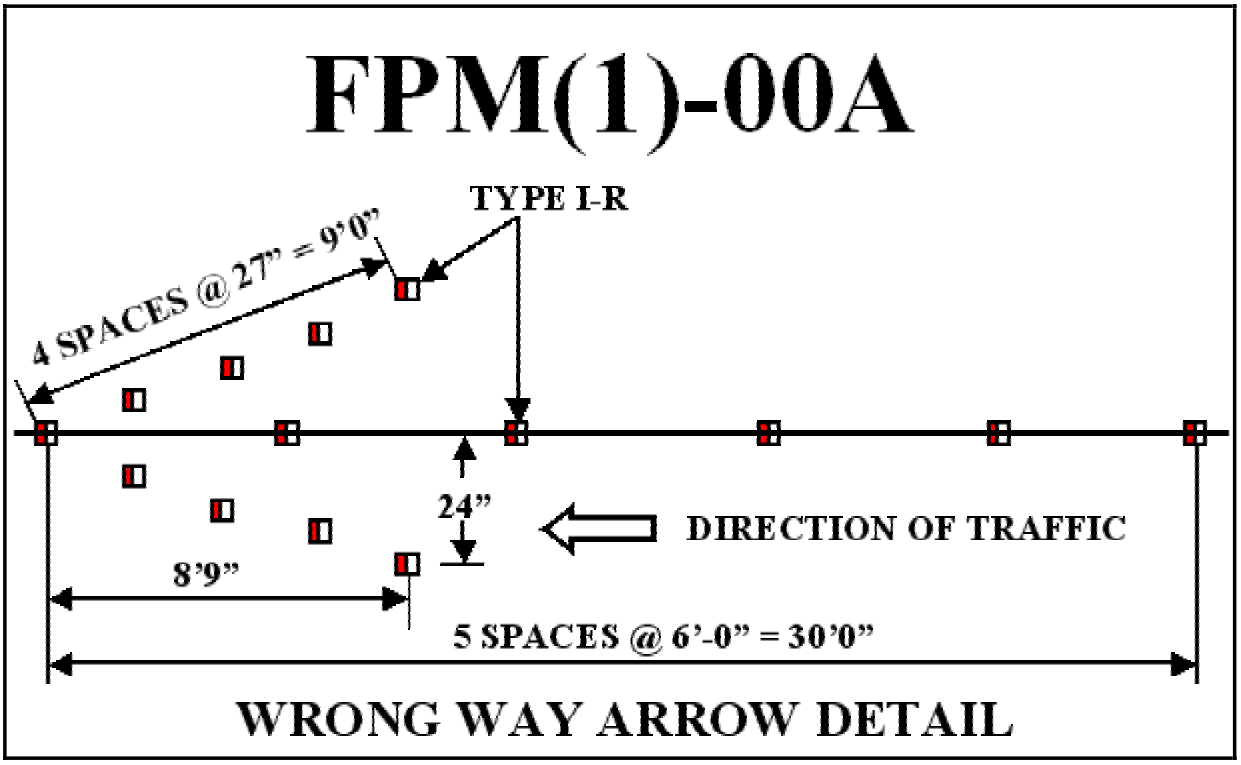

Figure 1. TxDOT Standard Wrong-Way Pavement Arrow (*1*).

Guideline #2: Left-side exit ramps on freeways should be avoided in future freeway construction.

This guideline supports previous research in California, which stated that left-hand exit ramps were obsolete and must be avoided in new construction (*2*). The basic rationale for this guideline is that drivers naturally expect to enter the freeway using a right turn and may mistakenly make this turn and travel the wrong-way onto a left-side exit ramp. Figure 2 shows how a wrong-way movement can occur at a typical left-hand exit ramp (*2*).

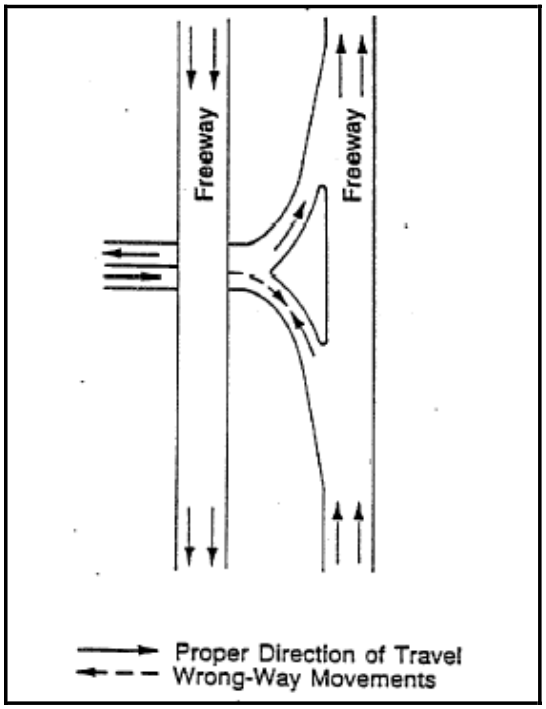

Figure 2. Proper and Wrong-Way Movements for Left-Hand Freeway Exit Ramp (*2*).

Guideline #3: Revise the Typical Standard Freeway Pavement Markings with Raised Pavement Markers Standard Plan Sheet FPM (1) – 00A.

This guideline calls for TxDOT to revise the Typical Standard Freeway Pavement Markings with Raised Pavement Markers Standard Plans Sheet FPM (1) – 00A wrong-way arrow detail from (*1*):

- "reflectorized wrong-way arrows, not to exceed two, may be placed on exit ramps"

to

- "reflectorized wrong-way arrows, not to exceed two, **should** be placed on exit ramps **for new construction and at locations with multiple wrong-way entries per year**."

This revision would make the installation of wrong-way pavement arrows a more standard practice, particularly at known or suspected problem locations.

Guideline #4: Repair deficient wrong-way pavement arrows and make their maintenance a priority, particularly in the urban districts of Dallas/Fort Worth, Houston, and San Antonio.

TxDOT's standard wrong-way pavement arrow is comprised of raised pavement markers (RPMs), which create good visibility and reflectivity at night. The use of RPMs also can be a maintenance concern because they are often run over, especially on high-volume exit ramps in urban areas. Field inspections by the research team revealed that wrong-way pavement arrows sometimes had markers missing or were very worn in appearance (see Figure 3 and Figure 4). In some cases, all of the RPMs that were part of the wrong-way arrow had been lost and only the black epoxy was left on the pavement (Figure 5). Researchers believe that it is important to repair deficient wrong-way pavement arrows and make their maintenance a priority, particularly in the urban districts of Dallas/Fort Worth, Houston, and San Antonio. Researchers based the singling out of these three districts on the crash analysis, which found that approximately 60 percent of all the freeway-related wrong-way crashes occurred in the urban districts of Dallas/Fort Worth, Houston, and San Antonio.

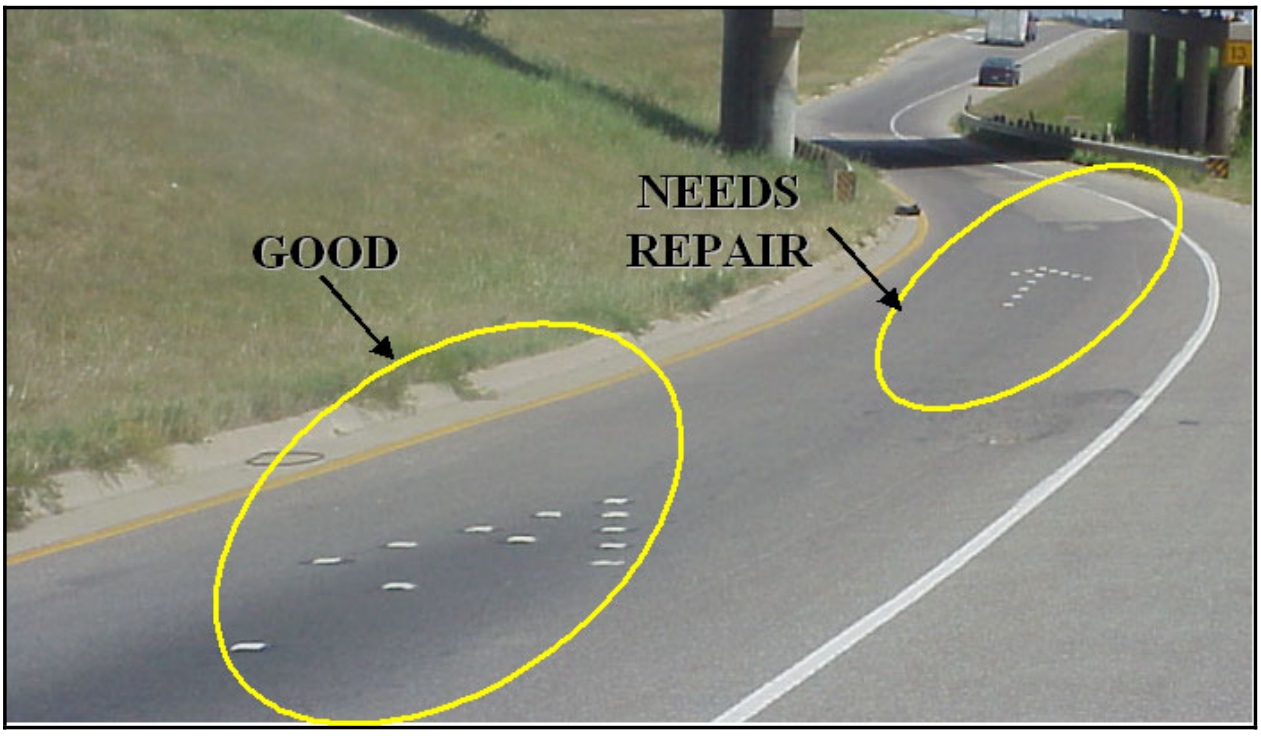

Figure 3. Wrong-Way Arrows on Left-Hand Exit Ramp.

Figure 4. Wrong-Way Arrow with Missing Raised Pavement Marker.

Figure 5. Wrong-Way Arrow with all Raised Pavement Markers Missing.

Guideline #5: Consider the use of lowered DO NOT ENTER and WRONG WAY signs mounted together on the same post to address alcohol and nighttime problem locations.

TxDOT standard wrong-way signing involves the use of gatepost sets of DO NOT ENTER and WRONG WAY signs mounted at the standard mounting height (i.e., distance from ground to bottom edge) of 7 feet for urban signs and 5 feet for rural signs (see Figure 6). Several states, most notably California, have used lowered DO NOT ENTER, WRONG WAY, and ONE WAY signs as an effective countermeasure for deterring wrong-way entries onto freeway facilities. The lowered mounting height was based on the following:

- avoids sight restrictions,
- more visible at night because they are in the path of low beam headlights (wrong-way crashes and entries are more problematic in dark light conditions), and
- potentially more visible to impaired drivers because they tend to drive with their eyes low looking for visual cues from the pavement (a significant portion of wrong-way crashes involve impaired drivers).

Figure 6. TxDOT Typical Gatepost Signing with the DO NOT ENTER and WRONG WAY Signs Mounted at Standard MUTCD Mounting Height.

The analysis of wrong-way crashes in Texas revealed that almost 61 percent had some influence of alcohol and/or drugs cited by the investigating officer. This is a significantly higher proportion than for other types of crashes and points to driver influence being a primary contributor to the majority of freeway-related wrong-way crashes. Furthermore, approximately 80 percent of the wrong-way crashes in Texas happened at night (i.e., dark light conditions). Both of these findings suggest that lowered DO NOT ENTER, WRONG WAY, and ONE WAY signs like

those used in California (see Figure 7 and Figure 8) should be considered to address the problems of alcohol-involvement and darkness in creating wrong-way crashes.

Figure 7. Lowered DO NOT ENTER/WRONG WAY Sign Package Used in California.

Figure 8. Lowered One Way and Turn Restriction Signs in California.

Some of the issues that need to be addressed while considering implementation issues with lowered DO NOT ENTER and WRONG WAY signs:

1. Crashworthiness – The survey revealed that there have been no crash testing or other analyses to support the safety of lowered sign mounting height. This is potentially a

barrier to implementation in Texas and crash tests would likely need to be performed to assess the performance and safety of a lowered DO NOT ENTER/WRONG WAY sign package.

2. Financial – There are a number of financial issues associated with using lowered signs. The first is that the Federal Highway Administration does not pay for lowered signs because they do not meet the *Manual on Uniform Traffic Control Devices* (MUTCD) standard. Caltrans uses state funds to pay for all of their DO NOT ENTER sign packages. Texas has a high number of exit ramp, frontage road, and divided highway locations that would be potential sites for retrofitting with lowered signs.

3. Design – The Georgia and Virginia DOTs have adopted the California standards (i.e., the bottom of the lower DO NOT ENTER and WRONG-WAY package placed two feet (0.6 m) above the edge of pavement. TxDOT could adopt the California standards or consider research on alternative designs using different materials (e.g., plastic signs, metal posts instead of wood posts, etc.).

RECOMMENDED PRACTICES

Recommended Practice #1: Coordinate with the primary 911 public safety answering points to share information on reports of wrong-way movements on freeway facilities.

This recommended practice can take one of the following two approaches:

- Approach #1 – Coordinate with the 911 public safety answering point (PSAP) representatives as the research team did by receiving a list of wrong-way driving reports on a monthly basis. TxDOT would likely receive more cooperation from 911 representatives than what the research team experienced. The monthly lists could be used to track areas and corridors where wrong-way movements have occurred and could be compared with historical crash data.

- Approach #2 – TxDOT Traffic Management Centers (TMCs) in the urban areas (i.e., Austin, Dallas, Fort Worth, El Paso, Houston, and San Antonio) share information with the 911 PSAP in real-time. Further research would be needed to develop protocols and procedures for TMC operators on how to respond to wrong-way driving reports (e.g., what, if any, type of warning should be given to motorists traveling in the correct direction in the vicinity of the wrong-way driver.

The research team recommends that TxDOT initially take Approach #1 and work towards Approach #2 as the relationships develop with the PSAP representatives.

Recommended Practice #2: Implement inductive loops or other detectors on exit ramps in future construction.

Installation of inductive loops or other detectors on exit ramps during future construction, particularly on urban freeways, would allow for the implementation of wrong-way detection and warning systems. In addition to wrong-way application, the detectors could also be used for other purposes such as traffic counts and detection of queues before they spill back onto the freeway mainlanes. The detector installation would be relatively inexpensive when done as part of major freeway reconstruction projects.

Recommended Practice #3: Utilize the wrong-way entry checklist for reviewing wrong-way entry issues and suspected problem locations.

The wrong-way entry checklist contained in Chapter 2 is designed for engineers and field crews to use for reviewing wrong-way entry issues or suspected problem locations. The research team based the checklist on one currently used by Caltrans with some additions and modifications based on project findings.

CHAPTER 2. WRONG-WAY ENTRY CHECKLIST

TEXAS WRONG-WAY ENTRY ANALYSIS PROCEDURES

This document was developed for TxDOT engineers and field crews to use for reviewing wrong-way entry issues or suspected problem locations. The research team based the checklist on one currently used by Caltrans (*2*) with some additions and modifications based on project findings. The checklist was developed as part of the 0-4128 Countermeasures for Wrong-Way Movement on Freeways research project performed by the Texas Transportation Institute.

STEP 1: Review pertinent Department of Public Safety (DPS) crash reports.

Obtain copies of the original ST-3 crash reports from the DPS or local police agencies to have the officer's crash diagram and narrative of events. The best screening variable for wrong-way crashes is contributing factor code (CFC) 71 (*wrong way – one way road*). Some of the crash reports with CFC 71 will not be freeway-related crashes.

STEP 2: Analyze crash reports to determine wrong-way entry locations.

The information contained in the crash diagram and narrative is the best way to determine where the wrong-way entry occurred. Review the diagram and narrative and try to determine the location where the wrong-way entry occurred.

Other tools such as recent aerial photographs and online maps can be useful in determining wrong-way entry locations. The analyst should use the aerial photographs to review ramps, cross roads, and median openings approximately three miles upstream (can be less in urban and more in rural areas) from the actual location of the wrong-way crash.

STEP 3: Perform field inspections.

Field investigation of ramps located within three miles may also be necessary to inspect the condition of signing and marking. Field inspection should occur during both daylight and dark conditions, particularly if the crash occurred at night. Using proper safety procedures, inspectors should get out of the vehicle and view the scene from the wrong-way driver's perspective. Use the WRONG-WAY ENTRY CHECKLIST – FIELD INSPECTION SHEET to complete the field inspection.

STEP 4: Make recommendations.

Any recommendations for improvements that result from the field investigation should verbally be communicated to a management level engineer. Do not initially put these recommendations in writing to prevent tort liability.

WRONG-WAY ENTRY CHECKLIST
FIELD INSPECTION SHEET

Inspector name: _____

Location description: _____
_____
_____

Crash Report ID Number: _____

Table 1. Signing Checklist

Sign	Check if	Yes	No	Comments
DO NOT ENTER	Present in minimum quantity			
	Visible from entry decision point			
	Mounted at standard MUTCD height			
	Night time visibility is sufficient			
	High intensity sheeting			
	In good repair and free of graffiti			
WRONG WAY	Present in minimum quantity			
	Mounted at standard MUTCD height			
	Night time visibility is sufficient			
	High intensity sheeting			
	In good repair and free of graffiti			
ONE-WAY	Present at the location			
	Supplement to DO NOT ENTER sign			
TURN RESTRICTION SIGNS	NO RIGHT TURN			
	NO LEFT TURN			
	NO U-TURN			
	KEEP RIGHT			
	DIVIDED HIGHWAY			

Table 2. Pavement Markings Checklist

Pavement Marking	Check if	Yes	No	Comments
WRONG-WAY ARROWS	Present at the location			
	RPMs in arrow in good condition			
	Thermoplastic arrow in good condition			
RED-CLEAR MARKERS	Present on the freeway main lanes			
	In good condition			
OTHER MARKINGS	Elephant tracks (turning guide lines)			
	Stop lines at end of exit ramp			
	Other: _____			
	Other: _____			
	Other: _____			

Other items to review and note include:

- Location of nearby businesses (particularly bars)
- Geometry near the wrong-way entry point that might be confusing (driveways, islands, etc.)
- Any other factors that the inspector feels might contribute to wrong-way movements

REFERENCES

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