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Review Article

Traffic control devices for deterring wrong-way driving: Historical evolution and current practice

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HIGHLIGHTS

- A complete history of wrong-way driving TCDs in all versions of MUTCD is provided.
- Efforts made by state DOTs to aggressively attack WWD by deploying TCDs are reviewed.
- WWD TCD standards need to be revised in the next edition of MUTCD.
- Recommendations are made regarding the WWD signs and pavement marking countermeasures.

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ABSTRACT

Each year, hundreds of fatal wrong-way driving (WWD) crashes occur across the United States. Thousands of injuries are reported in crashes caused by wrong-way drivers. Traffic control devices (TCDs), i.e., signs, pavement markings, and signals, have been introduced since 1935 to combat this problem. The aim of the paper is to provide a complete history of TCDs for deterring WWD on freeways and divided highways in previous versions of the Manual on Uniform Traffic Control Devices (MUTCD) (1935–2009). A fully referenced overview of definitions, text passages, and figures of the TCDs, employed to deter WWD in all MUTCD versions, will be given to characterize the changes over time. In addition, the efforts that have been made by state department of transportation (DOT) especially over the past few years to aggressively attack WWD by deploying standard TCDs are reviewed. Finally, the paper makes conclusions and recommendations with regard to the necessity of a revision in the next edition of MUTCD for WWD TCDs. The investigation of changes and the current practice leave a trail to enable traffic engineers and policy makers to consider past decisions and their effectiveness in combating WWD, as well as providing a reference to determine whether or not their jurisdiction meets the MUTCD standards.

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1. Introduction

According to the American Traffic Safety Services Association (Zhou et al., 2014) wrong-way driving (WWD), by definition, happens when a driver, inadvertently or deliberately, drives in the opposite direction of traffic flow along a physically divided highway or its access ramps. Each year, hundreds of fatal WWD crashes occur across the United States (US) and thousands of injuries are reported in crashes caused by wrong-way (WW) drivers. According to a query of eight years of crash data (2004–2011) from the Fatality Analysis Reporting System (FARS) database, an average of 269 fatal crashes resulting in 359 fatalities occurred each year due to WWD in the US (Baratian-Ghorghi et al., 2014). This number remained quite stable, although overall fatalities and fatal crashes decreased by more than 20 percent over the eight-year period.

With respect to WWD entry points, special attention should be given to the characteristics of exit ramps and crossroad intersections, including geometric design elements, signage, pavement markings, and traffic signals (Baisyet and Stevens, 2015; Baratian-Ghorghi et al., 2015; Xing, 2013). A comprehensive literature review by Zhou et al. (2012) showed that early research on WWD countermeasures was pioneered by the California DOT (Caltrans) in the 1970s and focused mainly on improving signage, pavement marking, and geometric design. To better understand how these countermeasures have been developed and what changes have been made, it is necessary to review the efforts of past decades. An overview of the development of traffic control devices was conducted by Hawkins (1992) more than twenty years ago. Hawkins traced the evolution of the Manual on Uniform Traffic Control Devices (MUTCD). In this paper, a complete history of traffic control devices (TCDs) related to WWD avoidance, including signage, pavement marking, and traffic signals, will be discussed. This paper includes a review of all the versions of the MUTCD from 1935 to the most recent version published in 2009. In addition, the definitions, text passages, and figures relating to TCDs employed to deter WWD in previous MUTCD versions will be summarized to characterize the changes over time. This approach will help policy makers to learn from the experience of the applications in the past and better understand the implications and effects of past WWD policies.

2. Evolution of the MUTCD related to wrong-way driving avoidance

The evolution of WW traffic control device information is presented in a tabular format to speed up the comparisons between past MUTCD editions (Table 1) (AASHTO, 1935, 1942, 1948, 1961; FHWA, 1971, 1978, 1988, 2000, 2003, 2009a). This investigation of the changes within the MUTCD editions over time has highlighted its evolution and leaves a trail to enable traffic engineers and policy makers to look back at the decisions made and their effectiveness in combating WWD.

Table 1 – Evolution of WW traffic control devices in the MUTCD.

Year	Sign	Marking	Signals
1935	ONE-WAY sign	No regulations	Combination of straight-through green arrow with circular red indication
1942	–	–	Shape of arrows and indication lenses were specified in more detail
1948	DO NOT ENTER (DNE) sign	–	–
1961	One standard has changed to a recommendation	–	Prohibition of using straight-through green arrow with circular red indication Illumination of green arrow to permit straight through and prohibit making turns
1971	Modification of DNE sign WRONG-WAY (WW) sign	Transverse markings (line, word and symbol markings)	Using capitalized letters for each indication in MUTCD
1978	WW traffic control sign standards were divided into two sections: Sections 2A.31 and 2E.41	Past standard changed to option Yellow left edge line WW arrow Supplementing WW sign "WW arrow" first used	Straight-through yellow arrows were eliminated from signal faces
1988	Larger size of DNE sign	Placement of WW arrow and lane-use arrow on interchange exit/entrance ramps	–
2000	More details regarding DNE signs and WW signs	New categories of standards, guidance and options Retro-reflective raised pavement markers Lane-use arrow	Stop beacon
2003	–	–	–
2009	Relocation of WW traffic control information from "guide signs" to "regulatory signs" Lower mounting height of DNE signs and WW signs	Placement of lane-use arrow markings An arrow at the downstream end of a turn lane	Three new combinations of signal indications were prohibited