

# Traffic Control Devices at Horizontal Curves

A data-driven approach to creating MUTCD guidelines

**NCHRP** NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM



Paul Carlson  
Brad Brimley  
Gene Hawkins



Scott Himes  
Frank Gross  
Hugh McGee



# Current MUTCD guidelines



**Table 2C-5. Horizontal Alignment Sign Selection**

Type of Horizontal Alignment Sign	Difference Between Speed Limit and Advisory Speed				
	5 mph	10 mph	15 mph	20 mph	25 mph or more
Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5), and Combination Horizontal Alignment/Intersection (W10-1) (see Section 2C.07 to determine which sign to use)	Recommended	Required	Required	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended	Required	Required	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended	Required	Required	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required	Required

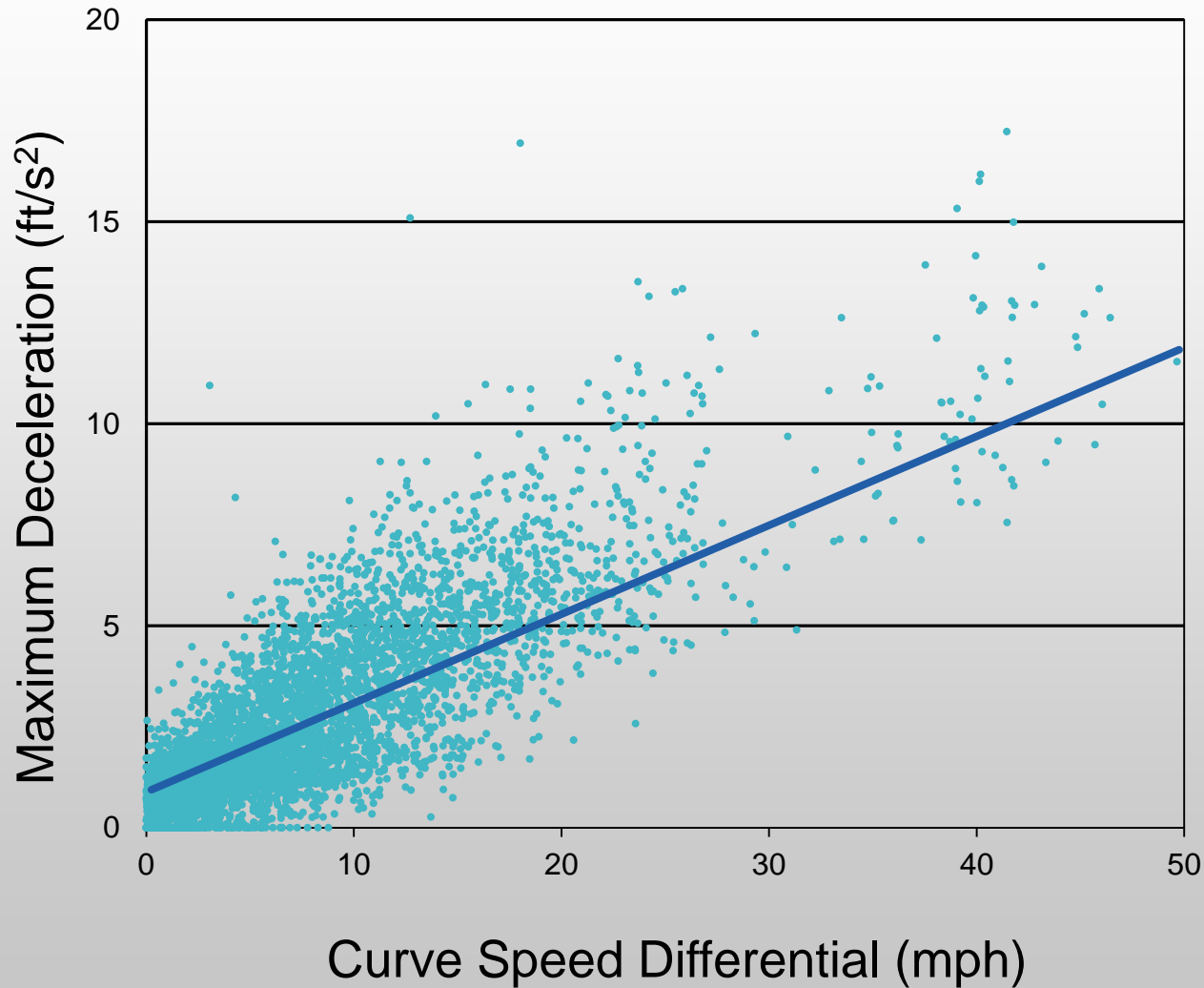
Note: Required means that the sign and/or plaque shall be used, recommended means that the sign and/or plaque should be used, and optional means that the sign and/or plaque may be used.

See Section 2C.06 for roadways with less than 1,000 ADT.

# Two-pronged approach

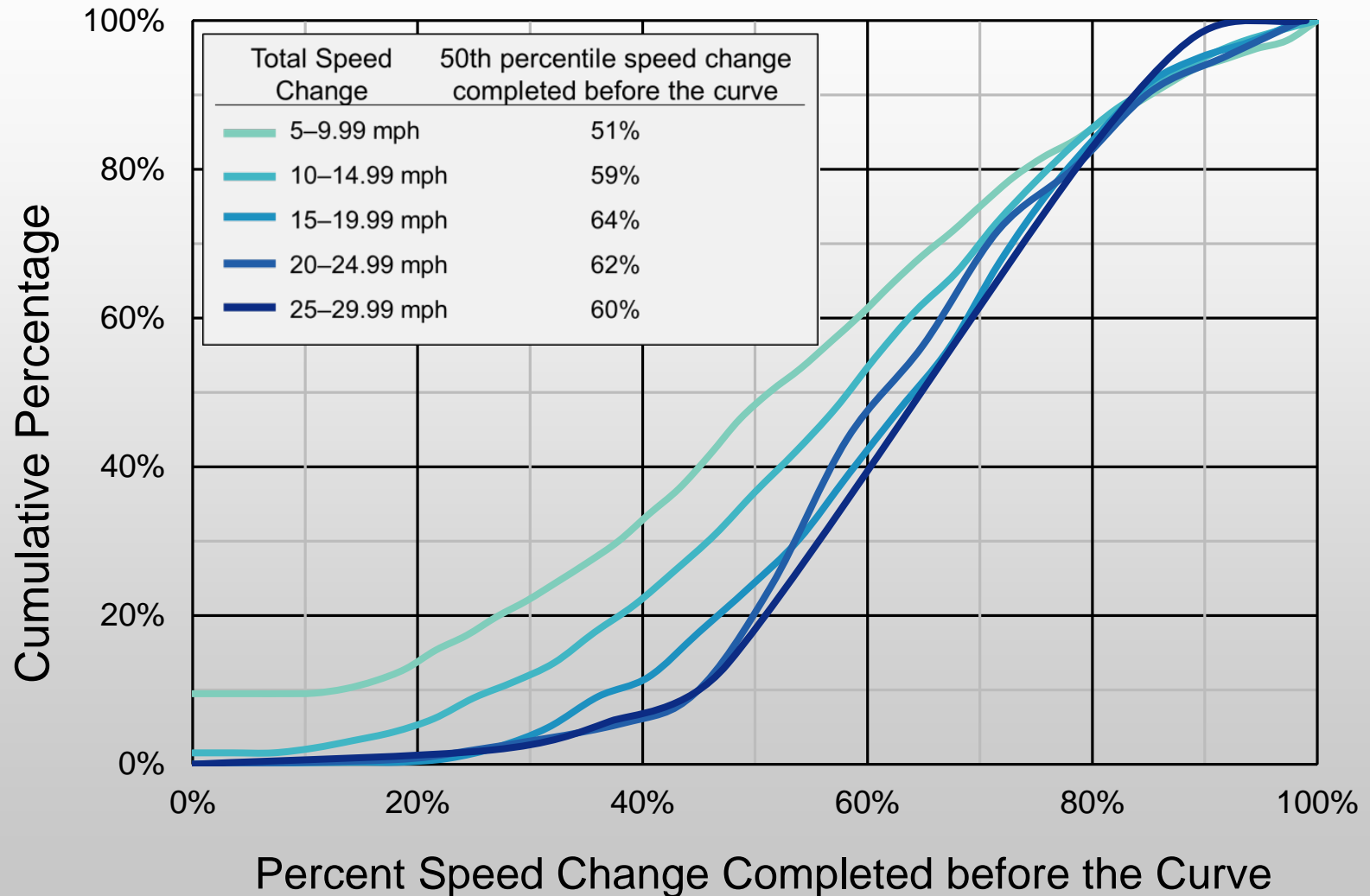
- Driver behavior: 
    - Does behavior change when different TCDs are used?
    - Unfamiliar drivers in instrumented vehicle
    - 3 states
    - 4,800 observations
  - Safety: 
    - What are the safety effects of TCDs at curves?
    - Crash frequencies at curves
    - 4 states
    - 541 total sites  $\times$  3 years = 1,623 site years
    - Developed CMFunctions for TCDs on different crash types
-

# Findings – Driver Behavior



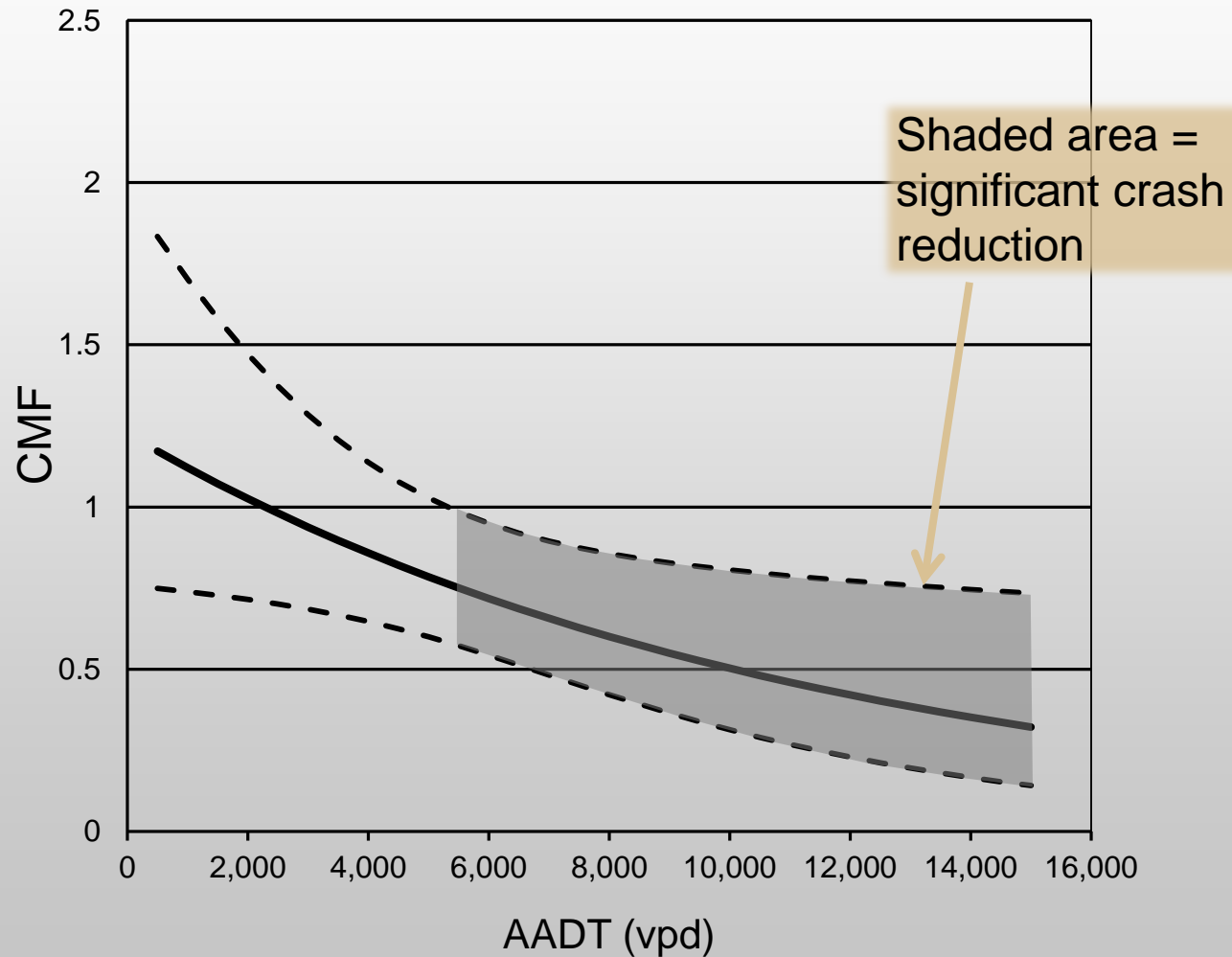


# Findings – Driver Behavior



# Findings – Safety

- Some CMFs were a function of AADT



# Recommended guidelines

		Curve Speed (mph)										
		20	25	30	35	40	45	50	55	60	65	70
Approach Speed (mph)	25											
	30											
	35											
	40											
	45											
	50											
	55											
	60											
	65											
	70											
	75											

Pavement Markings

Warning Sign + Markings

Delineators + Warning Sign + Markings

Chevrons + Warning Sign + Markings

Pavement Markings
Warning Sign + Markings
Delineators + Warning Sign + Markings
Chevrons + Warning Sign + Markings

## Notes:

1. Advisory Speed plaques are to be included on advance warning signs when the difference between the approach and curve speeds is 15 mph or greater.
2. A Large Arrow sign may be used as an alternative to delineators or chevrons when geometric conditions limit the number of delineators or chevrons that can be installed below the number required in the MUTCD.
3. TCDs are *required* for AADT > 4,000 vpd; *recommended* for AADT > 2,000 vpd.