



National Committee on Uniform Traffic Control Devices

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National Committee on Uniform Traffic Control Devices RWSTC RECOMMENDATION

TECHNICAL COMMITTEE:	Regulatory & Warning Signs			
TASK FORCE:	Pline, Heydel, Carlson, Paddick, Roadifer, Seyfried, Canfield , Ramisch			
STATUS/DATE OF ACTION:				
Task Force Drafts	11/29/05, 6/22/06	12/20/06		11/22/10
TC Approval:	1/19/06, 6/28/06	1/18/07	6/21/08	1/20/11
Transmitted to Sponsors:	3/10/06	9/11/06		
Council Approval: Denied	6/30/06	1/19/07	6/21/08	

TOPIC: Table 2C-5, Selection of Horizontal Alignment Traffic Control Signs

SUMMARY:

The RWSTC appointed a Task Force on 6/24/04 that reviewed all the current applicable research and developed new MUTCD provisions for horizontal alignment and advisory speed warning signs including the provisions of **Table 2C-5. Horizontal Alignment Sign Selection**. As noted above, the Table has been transmitted to Sponsors twice and previously approved by Council twice.

The FHWA proposed in the NPR that horizontal alignment signing should be recommended with a 5 mph speed differential and required with a 10 mph speed differential.. The Federal Register, Vol. 74, No. 240, page 66758, contained a summary of the rulemaking response with nine DOT's, six local DOT's, two NCUTCD members and one citizen (18 total) opposed the inclusion of the Table in the MUTCD. Also, six State DOT's, five local DOT's, a State Association of Counties and two traffic engineering consultants (14 total) suggested that the row for Chevrons be deleted in Table 2C-5. **Only the NCUTCD in response to the Notice of Proposed Rulemaking supported the inclusion of Table 2C-5 in the MUTCD. The Council approved the Table on 1/18/07 and reiterated that approval on 6/21/08 in response to the rulemaking.**

It was the initiative of a NCUTCD Technical Committee that reviewed the available research, considered engineering practice, and recommended Table 2C-5. It was the NCUTCD that took the lead in this matter and developed MUTCD provisions that were practical and acceptable on a national level only to have them adopted with more restrictive provisions

It was recognized by the NCUTCD that while most State Highway Systems presently have horizontal alignment and advisory speed signing there is a need to make that signing more compatible with current vehicle operating characteristics and driving practices. Concurrently, it appeared necessary to create realistic signing

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2. It is our understanding that the FHWA based their decision on calculation of the accident prediction model (AMF) from the new Highway Safety Manual. A 9 degree curve (1065 ft. radius) with 6% super-elevation on a 5,000 ADT roadway with two 12 foot lanes and 6 foot shoulders posted at 55 mph was assumed for the calculations. Then the curve radius was decreased to arrive at an AMF of 1.327 for an 835 foot radius (5 mph speed differential) and a AMF of 1.414 at a 660 foot radius (10 mph speed differential). From these calculations, they concluded that a 5 mph speed differential would have a 33% (1.327) more crashes and the 10 mph speed differential would have 41% (1.414) more crashes. Resulting in their decision to make the 5 mph speed differential a guidance (**Recommended**) provision for signing and the 10 mph speed differential mandatory (**Required**) . The same rationale' was used to recommend Chevron signs at the 10 mph speed differential (41% more crashes) and require Chevron signs at 15 mph speed differential which has 54% more crashes based on the accident prediction model for the assumed typical curve. In the accident prediction model, the 12 foot lanes and 6 foot shoulder provide a factor of 1.00 so the lane and shoulder widths would not influence the prediction factor. These FHWA calculations are questionable for a number of reasons as follows;
- a. The calculation of the recommended curve (advisory) speed based on the curve formula, ie. $V^2 = 15 R(e + f)$ yields different results than the FHWA used for the curves resulting in different differential speeds.

Advisory Speed		Speed Differential		Curve Radius	AMF
FHWA	Formula	FHWA	Modified ¹	with 6% e	W/O Spiral
55	65.67	0	+10	1065	1.257
50	58.15	5	+ 5	835	1.327
45	51.70	10	- 5	660	1.414
40	45.44	15	- 10	510	1.536
35	39.33	20	- 15	380	1.719

1. Based on the posted speed of 55 mph.

With the revised calculations, the Highway Safety Manual predicts an even greater collision potential than was used for the FHWA decision.

- b. Note, that the collision prediction factor for the 1065 ft. radius curve would be 1.257 or about 26% more collisions than would occur on the tangent section of the roadway. However, with an advisory speed of 65 mph the curve would not be signed either with the MUTCD provisions or engineering practice. **Is this 26% accident prediction factor the aggressive driver that would not be affected by warning signs?**
- c. The collision prediction calculations were based on a 5,000 ADT roadway with 12 foot lanes and 6 foot shoulders. This type of roadway would be typical of a State Highway not non-State arterials or collectors. In most cases, the State Highway alignment would

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presently be signed although the existing advisory speed signing may be 5 mph too conservative. **It is not expected that the Table 2C-5 provisions would have any impact on these existing signed highways let alone the accident reduction potential assumed by the FHWA. There are approximately 800,000 miles of State Highways that fall under the provisions of Table 2C-5 and in most cases presently have alignment signing although the advisory speeds need to be updated.**

- d. The typical non-State arterials and collector range from some expressways and multi-lane roadways to the bulk of the mileage being two lane roadways. The average ADT on these non-state arterials and collectors is about \pm 3,000 vehicles based on the FHWA Highway Statistics. There are approximately 400,000 miles of these non-state roadways that would be signed under the provisions of Table 2C-5. A portion of this local mileage is presently signed so it is estimated that maybe only half of these roadways currently do not have any horizontal alignment and advisory speed signing. **Therefore, it is not expected that these new MUTCD provisions will have only limited impact on the national collision data given the existing estimated mileage that is not signed.**
- e. **The decision to increase the MUTCD provision over the recommended values is not based on a sound predictable collision reduction rationale' and does not consider that a major portion of the roadways where Table 2C-5 is applicable are currently signed.**
- f. The decision to recommend Chevron signs at a 10 mph speed differential and require them at a 15 mph speed differential is not a sound rationale' as addressed above and would not have the collision reduction expected by FHWA. **No research data exists and the Highway Safety Manual does not provide an Accident Modification Factor for the installation of Chevron signs.**

- 180 3. It is the engineering practice to round up or down to the nearest five miles per
 181 hour when determining the Advisory Speed. Using the formula, $V^2 = 15R(e + f)$,
 182 the comparison of the **Old v. New** would be as follows;

183 **Computed Advisory Speeds**

184 Old Criteria = Normal Font **New Criteria = Bold Font** **Difference = Red**

185 Curve	186 Super-Elevation				
187 Radius	0.02	0.04	0.06	0.08	0.10
188 100 ft	20	20	20	20	20
189 200 ft	20	20	20	20	20
190 400 ft	25	25	30	30	30
191 600 ft	30	30	30	30	30
192 800 ft	35	35	35	40	40
193 1000 ft	35	40	40	40	45
194 1200 ft	40	45	45	45	50
195 1400 ft	45	45	50	50	55
196 1600 ft	50	50	55	55	55
197 1800 ft	55	55	55	60	60
198 2000 ft	55	55	60	60	65
199 2200 ft	60	60	65	65	70
200 2400 ft	60	60	65	65	70
201 2600 ft	65	65	70	70	75

202 The new criteria raised the Advisory Speed 5 mph in about 2/3 of the calculations
 203 and primarily for the larger radius curves. Upgrading the advisory speed signing
 204 to the new criteria will bring the signing closer to the speeds that drivers are
 205 driving the curves, approximates the AASHTO design criteria, and provides
 206 comfortable lateral acceleration based on the research studies.

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- 208 4. The sensitivity of the values in the criteria are substantially modified by the
 209 rounding of the advisory speed determinations to the nearest five miles per hour.
 210 The side friction can vary up to 0.04 or 0.06 without changing the advisory speed
 211 or 2 degrees on the Ball Bank measurements. The sensitivity of the curve radius
 212 would be approximately ± 50 feet. Therefore, there is some latitude in the
 213 accuracy of the field measurements but with the rounding to the nearest five
 214 miles per hour these variations could produce a 5 mile per hour difference in the
 215 advisory speed determination. However, the 5 mph difference is not critical to
 216 the safety of the curve since the side friction demand with smooth tires on wet
 217 concrete pavement is 0.40 or more. It is reasonable that a five mile per hour
 218 variation in the curve advisory speed determinations could be found in two
 219 different engineering studies giving the rounding of the calculations and the
 220 accuracy of field measurements. The 2009 MUTCD provisions recommend that
 221 the alignment sign with advisory speed be installed with a five mile per hour
 222 differential speed. That increment of differential speed is not within the accuracy
 223 of the engineering methods and would be difficult to support technically as a
 224 basis for either installing or not installing the signs on a specific curve. A number
 225 of States presently do not sign for a 5 mph speed differential recognizing the

226 validity of the speed studies. Because of this sensitivity of values and the
227 rounding of the determinations, the 5 mph speed differential in Table 2C-5 should
228 be **Optional** for signing rather than **Recommended** as contained in the 2009
229 MUTCD. In the graduated signing approach, this would make the 10 mph speed
230 differential recommended and the 15 mph speed differential required (Table 2C-
231 5, Line 273).

232 5. The use of Chevron Alignment signs were approved for the MUTCD in 1977 with
233 the application based on engineering judgment until the current requirements
234 added to the 2009 MUTCD. Chevrons Alignment signs have been used the past
235 30 years to emphasize changes in alignment where there were major speed
236 reductions or problem sites. These signs have gained in popularity and are more
237 widely used now than the One Direction Large Arrow. The intent would be to
238 initially mark the curve alignment with either roadway edge lines or delineators
239 with only the One Direction Large Arrow or Chevrons used for those alignments
240 where there may be a problem (Optional use for 5mph and 10 mph speed
241 differential) , should be used (recommended for a 15 mph differential, and
242 required on all curves where there is a 20 mph or greater speed differential. The
243 2009 MUTCD provisions means that the States and local jurisdictions have to
244 install a number of either large arrows or chevrons because of the required
245 signing at 15 mph and recommended signing at 10 mph speed differential
246 curves. On some curvilinear alignments, Chevrons or Large Arrows will have to
247 be used for each change in the alignment because of the recommended 10 mph
248 speed differential. **The value of curve delineation is recognized but the
249 added application of chevrons or large arrows to a greater number of
250 curves will detract from their effectiveness for the sharper, more critical,
251 curves.**

252 6. These new provisions in the MUTCD are a new approach generated by the
253 concern for roadway safety. They are recognized as a beneficial safety
254 countermeasure as cited in the Federal Register. However, the degree of impact
255 based on the combination of more devices has not been tested. Considering the
256 dramatic change from engineering judgment to mandated provisions and the
257 economic impact of the new requirements, **the MUTCD should move
258 incrementally into the new requirements until a full understanding of the
259 costs versus benefits are known.**

260 7. The new MUTCD provisions for advisory speed determinations will require that
261 all roadway jurisdictions; Federal, State and local, restudy and upgrade their
262 signing for horizontal alignments. **In these times of economic constraints and
263 limited budgets, it is not desirable to overly burden the jurisdictions with
264 added signing requirements on top of the engineering study .when the
265 benefits are not thoroughly documented by research.**

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272 **RECOMMENDED MUTCD PROVISIONS/ REVISIONS**

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274 It is recommended that the revisions as shown in **RED** in Table 2C-5 below be
 275 approved;

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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 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 Optional	Required Recommended	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended Optional	Required Recommended	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended Optional	Required Recommended	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required

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VOTE: RWSTC (January 2011)

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For: 21

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Opposed: 1

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Abstentions: 1

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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.