



National Committee on Uniform Traffic Control Devices

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National Committee on Uniform Traffic Control Devices (NCUTCD) Recommended Changes to Proposed Text for 11th Edition of the MUTCD Docket Number: FHWA-2020-0001

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Federal Register Item Number: 389-393 (see listing below)

NPA MUTCD Section Number: Chapter 4C

Legend: Base text shown in proposal is the NPA “clean” proposed text.

- [NCUTCD recommendation for text to be added in final rule.](#)
- ~~NCUTCD recommendation for text to be deleted in final rule.~~
- [NCUTCD recommendation for text to be moved/relocated in final rule.](#)
- NPA text that was not previously approved by NCUTCD but is now approved.
- Explanatory note: [\[Note that explains purpose of recommended change.\]](#)

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The following pages present NCUTCD recommendations for changes to the MUTCD NPA proposed text, tables, and figures for Chapter 4C. Below is a short summary of the NCUTCD position for each section of this chapter. A more detailed summary is provided at the beginning of each section.

- NPA #389, Section 4C.01: NCUTCD agrees with NPA content.
- NPA #390-391, Section 4C.02: NCUTCD agrees with NPA content.
- NPA #391, Section 4C.03: NCUTCD agrees with NPA content.
- NPA #N/A, Section 4C.04: NCUTCD agrees with NPA content.
- NPA #391-392, Section 4C.05: NCUTCD agrees with NPA content.
- NPA #N/A, Section 4C.06: NCUTCD agrees with NPA content.
- NPA #N/A, Section 4C.07: NCUTCD agrees with NPA content.
- NPA #391-393, Section 4C.08: NCUTCD agrees with NPA content
- NPA #N/A, Section 4C.09: NCUTCD agrees with NPA content.
- NPA #N/A, Section 4C.10: NCUTCD agrees with NPA content.

Section 4C.01 Comments: NCUTCD agrees with 4C.01 as presented in the NPA.

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

Except for temporary traffic control signals (see Section 4D.10), before a traffic control signal is installed at a particular location, an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at that location.

The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:

Warrant 1, Eight-Hour Vehicular Volume

- 42 **Warrant 2, Four-Hour Vehicular Volume**
- 43 **Warrant 3, Peak Hour**
- 44 **Warrant 4, Pedestrian Volume**
- 45 **Warrant 5, School Crossing**
- 46 **Warrant 6, Coordinated Signal System**
- 47 **Warrant 7, Crash Experience**
- 48 **Warrant 8, Roadway Network**
- 49 **Warrant 9, Intersection Near a Grade Crossing**

50 **The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation**
51 **of a traffic control signal.**

52 Support:

53 Sections 8D.08 and 8D.14 contain information regarding the use of traffic control signals instead of
54 gates and/or flashing-light signals at highway rail grade crossings, respectively.

55 *Guidance:*

56 *When considering the installation of a traffic control signal, alternatives to traffic control signals,*
57 *including those listed in Section 4B.05, should also be considered.*

58 *A traffic control signal should not be installed unless one or more of the factors described in this*
59 *Chapter are met.*

60 *A traffic control signal should not be installed unless an engineering study indicates that installing a*
61 *traffic control signal will improve the overall safety and/or operation of the intersection.*

62 *A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.*

63 *The study should consider the effects of the right-turn vehicles from the minor-street approaches.*
64 *Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is*
65 *subtracted from the minor-street traffic count when evaluating the count against the signal warrants*
66 *listed in Paragraph 2.*

67 *Engineering judgment should also be used in applying various traffic signal warrants to cases where*
68 *major-street approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic*
69 *characteristics should dictate whether a major-street approach is considered as one lane or two lanes.*
70 *For example, for a major-street approach with one lane for through and right-turning traffic plus a left-*
71 *turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the*
72 *traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be*
73 *applied against the signal warrants as a one-lane approach. The major-street approach should be*
74 *considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane*
75 *is of sufficient length to accommodate all left-turn vehicles.*

76 *Similar engineering judgment and rationale should be applied to a minor-street approach with one*
77 *through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn*
78 *traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be*
79 *included in the minor-street volume if the movement enters the major street with minimal conflict. The*
80 *minor-street approach should be evaluated as a one-lane approach with only the traffic volume in the*
81 *through/left-turn lane considered. If a minor-street approach has an exclusive left-turn lane, the*
82 *approach should either be analyzed as a two-lane approach based on the sum of the traffic volumes using*
83 *both lanes or as a one-lane approach based on only the traffic volume in the approach lane with the*
84 *highest volume.*

85 *At a location that is under development or construction or at a location where it is not possible to*
86 *obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated*
87 *as part of an engineering study for comparison with traffic signal warrants. Except for locations where*
88 *the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal*
89 *installed under projected conditions should have an engineering study done within 1 year of putting the*

90 *signal into steady (stop-and-go) operation to determine if the signal is justified. If not justified, the signal*
91 *should be taken out of steady (stop-and-go) operation or removed.*

92 Option:

93 For signal warrant analysis, a location with a wide median, may be analyzed as one intersection or as
94 two intersections based on engineering judgment.

95 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant
96 analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as
97 the “minor-street” volume and the corresponding single direction of opposing traffic on the major street
98 as the “major-street” volume.

99 For signal warrants requiring conditions to be present for a certain number of hours in order to be
100 satisfied, any four consecutive 15-minute periods may be considered as 1 hour if the separate 1-hour
101 periods used in the warrant analysis do not overlap each other and both the major-street volume and the
102 minor-street volume are for the same specific one-hour periods.

103 For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

104 Support:

105 When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic
106 are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually
107 counted as pedestrians.

108 Option:

109 Engineering study data may include the following:

- 110 A. The number of vehicles entering the intersection in each hour from each approach during 12
111 hours of an average day. It is desirable that the hours selected contain the greatest percentage of
112 the 24-hour traffic volume.
- 113 B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type
114 (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations,
115 bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the
116 afternoon during which total traffic entering the intersection is greatest.
- 117 C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in
118 Item B and during hours of highest pedestrian volume. Where young, elderly, and/or persons
119 with physical or visual disabilities need special consideration, the pedestrians and their crossing
120 times may be classified by general observation.
- 121 D. Information about nearby facilities and activity centers that serve the young, elderly, and/or
122 persons with disabilities, including requests from persons with disabilities for accessible crossing
123 improvements at the location under study. These persons might not be adequately reflected in the
124 pedestrian volume count if the absence of a signal restrains their mobility.
- 125 E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to
126 the location.
- 127 F. A condition diagram showing details of the physical layout, including such features as
128 intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and
129 routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad
130 crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land
131 use.
- 132 G. A collision diagram showing crash experience by type, location, direction of movement, severity,
133 weather, time of day, date, and day of week for at least 1 year.

134 The following data, which are desirable for a more precise understanding of the operation of the
135 intersection, may be obtained during the periods described in Item B of Paragraph 17:

- 136 A. Vehicle-hours of stopped time delay determined separately for each approach.

- B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
 - C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
 - D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
 - E. Queue length on stop-controlled approaches.
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Section 4C.02 Comments: NCUTCD agrees with 4C.02 as presented in the NPA.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analyses of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

Guidance:

The need for a traffic control signal should be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:

- A. *The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the more critical minor-street approaches, respectively, to the intersection; or*
 - B. *The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the more critical minor-street approaches, respectively, to the intersection.*
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Table 4C-1 Comments: NCUTCD agrees with Table 4C-1 as presented in the NPA.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Standard:

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours that are selected for the Condition A analysis shall not be required to be the same 8 hours that are selected for the Condition B analysis.

Support:

On the minor street, the more critical volume is not required to be on the same approach during each of these 8 hours. The more critical minor-street volume is the one that meets the warranting criteria for

182 that approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane
183 minor-street approach might not have the higher volume.

184 Option:

185 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph,
186 or if the intersection lies within the built-up area of an isolated community having a population of less
187 than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100
188 percent columns.

189 *Guidance:*

190 *The combination of Conditions A and B is intended for application at locations where Condition A is*
191 *not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other*
192 *alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic*
193 *problems.*

194 *The need for a traffic control signal should be considered if an engineering study finds that both of*
195 *the following conditions exist for each of any 8 hours of an average day:*

- 196 A. *The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist*
197 *on the major-street and the more critical minor-street approaches, respectively, to the*
198 *intersection; and*
199 B. *The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist*
200 *on the major-street and the more critical minor-street approaches, respectively, to the*
201 *intersection.*

202 **Standard:**

203 **These major-street and minor-street volumes shall be for the same 8 hours for each condition;**
204 **however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied**
205 **in Condition B.**

206 Support:

207 On the minor street, the more critical volume is not required to be on the same approach during each
208 of the 8 hours. The more critical minor-street volume is the one that meets the warranting criteria for that
209 approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane minor-
210 street approach might not have the higher volume.

211 Option:

212 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph,
213 or if the intersection lies within the built-up area of an isolated community having a population of less
214 than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80
215 percent columns.

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218 **Section 4C.03 Comments: NCUTCD agrees with 4C.03 as presented in the NPA.**

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220 **Section 4C.03 Warrant 2, Four-Hour Vehicular Volume**

221 Support:

222 The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the
223 volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

224 *Guidance:*

225 *The need for a traffic control signal should be considered if an engineering study finds that, for each*
226 *of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street*
227 *(total of both approaches) and the corresponding vehicles per hour on the more critical minor-street*

228 approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing
229 combination of approach lanes.

230 Support:

231 On the minor street, the more critical volume is not required to be on the same approach during each
232 of these 4 hours. The more critical minor-street volume is the one that meets the warranting criteria for
233 that approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane
234 minor-street approach might not have the higher volume.

235 Option:

236 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph,
237 or if the intersection lies within the built-up area of an isolated community having a population of less
238 than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

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241 **Figure 4C-1 Comments:** NCUTCD agrees with Figure 4C-1 as presented in the NPA.

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243 **Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume**

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246 **Figure 4C-2 Comments:** NCUTCD agrees with Figure 4C-2 as presented in the NPA.

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248 **Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)**

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251 **Section 4C.04 Comments:** NCUTCD agrees with 4C.04 as presented in the NPA.

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253 **Section 4C.04 Warrant 3, Peak Hour**

254 Support:

255 The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that
256 for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or
257 crossing the major street.

258 *Guidance:*

259 *This signal warrant should be applied only in unusual cases, such as office complexes, manufacturing*
260 *plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers*
261 *of vehicles over a short time.*

262 *The need for a traffic control signal should be considered if an engineering study finds that the*
263 *criteria in either of the following two categories are met:*

264 *A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute*
265 *periods) of an average day:*

266 *1. The total stopped time delay experienced by the traffic on one minor-street approach (one*
267 *direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane*
268 *approach or 5 vehicle-hours for a two-lane approach; and*

269 *2. The volume on the same minor-street approach (one direction only) equals or exceeds 100*
270 *vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving*
271 *lanes; and*

- 272 3. *The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour*
273 *for intersections with three approaches or 800 vehicles per hour for intersections with four or*
274 *more approaches.*
- 275 B. *The plotted point representing the vehicles per hour on the major street (total of both*
276 *approaches) and the corresponding vehicles per hour on the more critical minor-street approach*
277 *(one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls*
278 *above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.*

281 **Figure 4C-3 Comments: NCUTCD agrees with Figure 4C-3 as presented in the NPA.**

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283 **Figure 4C-3. Warrant 3, Peak Hour**

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286 Option:

287 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph,
288 or if the intersection lies within the built-up area of an isolated community having a population of less
289 than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to evaluate the criteria in the second
290 category of the Standard.

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293 **Figure 4C-4 Comments: NCUTCD agrees with Figure 4C-4 as presented in the NPA.**

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295 **Figure 4C-4. Warrant 3, Peak Hour (70% Factor)**

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298 If this warrant is the only warrant met and a traffic control signal is justified by an engineering study,
299 the traffic control signal may be operated in the flashing mode during the hours that the volume criteria of
300 this warrant are not met.

301 *Guidance:*

302 *If this warrant is the only warrant met and a traffic control signal is justified by an engineering study,*
303 *the traffic control signal should be traffic-actuated.*

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306 **Section 4C.05 Comments: NCUTCD agrees with 4C.05 as presented in the NPA.**

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308 **Section 4C.05 Warrant 4, Pedestrian Volume**

309 Support:

310 The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major
311 street is so heavy that pedestrians experience excessive delay in crossing the major street.

312 *Guidance:*

313 *The need for a traffic control signal at an intersection or midblock crossing should be considered if*
314 *an engineering study finds that one of the following criteria is met:*

- 315 A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour
- 316 on the major street (total of both approaches) and the corresponding pedestrians per hour
- 317 crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5; or
- 318 B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point
- 319 representing the vehicles per hour on the major street (total of both approaches) and the
- 320 corresponding pedestrians per hour crossing the major street (total of all crossings) falls above
- 321 the curve in Figure 4C-7.

322 **Figure 4C-5 Comments: NCUTCD agrees with Figure 4C-5 as presented in the NPA.**

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324 **Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume**

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326 Option:

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328 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph,

329 or if the intersection lies within the built-up area of an isolated community having a population of less

330 than 10,000, Figure 4C-6 may be used in place of Figure 4C-5 to evaluate Criterion A in Paragraph 2,

331 and Figure 4C-8 may be used in place of Figure 4C-7 to evaluate Criterion B in Paragraph 2.

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333 **Figure 4C-6 Comments: NCUTCD agrees with Figure 4C-6 as presented in the NPA.**

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335 **Figure 4C-6. Warrant 4, Pedestrian Four-Hour Volume (70% Factor)**

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338 **Figure 4C-7 Comments: NCUTCD agrees with Figure 4C-7 as presented in the NPA.**

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340 **Figure 4C-7. Warrant 4, Pedestrian Peak Hour**

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343 **Figure 4C-8 Comments: NCUTCD agrees with Figure 4C-8 as presented in the NPA.**

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345 **Figure 4C-8. Warrant 4, Pedestrian Peak Hour (70% Factor)**

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349 Where there is a divided street having a median of sufficient width for pedestrians to wait, the criteria

350 in Items A and B of Paragraph 2 may be applied separately to each direction of vehicular traffic.

351 *Guidance:*

352 *The Pedestrian Volume signal warrant should not be applied at locations where the distance to the*

353 *nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less*

354 *than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of*

355 *traffic.*

356 **Standard:**

357 **If this warrant is met and a traffic control signal is justified by an engineering study, the traffic**

358 **control signal shall be equipped with pedestrian signal heads complying with the provisions set**

359 **forth in Chapter 4I.**

360 *Guidance:*

361 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

362 *A. If it is installed at an intersection or major driveway location, the traffic control signal should*
363 *also control the minor-street or driveway traffic, should be traffic-actuated, and should include*
364 *pedestrian detection.*

365 *B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at*
366 *least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and*
367 *should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection*
368 *crossing, at least one of the signal faces should be over the traveled way for each approach,*
369 *parking and other sight obstructions should be prohibited for at least 100 feet in advance of and*
370 *at least 20 feet beyond the crosswalk or site accommodations should be made through curb*
371 *extensions or other techniques to provide adequate sight distance, and the installation should*
372 *include suitable standard signs and pavement markings.*

373 *C. Furthermore, if it is installed within a signal system, the traffic control signal should be*
374 *coordinated.*

375 *Option:*

376 The criterion for the pedestrian volume crossing the major street may be reduced as much as 50
377 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

378 A traffic control signal may not be needed at the study location if adjacent coordinated traffic control
379 signals consistently provide gaps of adequate length for pedestrians to cross the street.

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382 **Section 4C.06 Comments:** NCUTCD agrees with 4C.06 as presented in the NPA.

383

384 **Section 4C.06 Warrant 5, School Crossing**

385 *Support:*

386 The School Crossing signal warrant is intended for application where the fact that schoolchildren
387 cross the major street is the principal reason to consider installing a traffic control signal. For the
388 purposes of this warrant, the word “schoolchildren” includes elementary through high school students.

389 *Guidance:*

390 *The need for a traffic control signal should be considered when an engineering study of the frequency*
391 *and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of*
392 *schoolchildren at an established school crossing across the major street shows that the number of*
393 *adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is*
394 *less than the number of minutes in the same period and there are a minimum of 20 schoolchildren during*
395 *the highest crossing hour.*

396 *Before a decision is made to install a traffic control signal, consideration should be given to the*
397 *implementation of other remedial measures, such as warning signs and flashers, school speed zones,*
398 *school crossing guards, or a grade-separated crossing.*

399 *The School Crossing signal warrant should not be applied at locations where the distance to the*
400 *nearest traffic control signal along the major street is less than 300 feet, unless the proposed traffic*
401 *control signal will not restrict the progressive movement of traffic.*

402 **Standard:**

403 **If this warrant is met and a traffic control signal is justified by an engineering study, the traffic**
404 **control signal shall be equipped with pedestrian signal heads complying with the provisions set**
405 **forth in Chapter 4I.**

406 *Guidance:*

407 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

- 408 A. *If it is installed at an intersection or major driveway location, the traffic control signal should*
409 *also control the minor-street or driveway traffic, should be traffic-actuated, and should include*
410 *pedestrian detection.*
- 411 B. *If it is installed at a non-intersection crossing, the traffic control signal should be installed at*
412 *least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and*
413 *should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection*
414 *crossing, at least one of the signal faces should be over the traveled way for each approach,*
415 *parking and other sight obstructions should be prohibited for at least 100 feet in advance of and*
416 *at least 20 feet beyond the crosswalk or site accommodations should be made through curb*
417 *extensions or other techniques to provide adequate sight distance, and the installation should*
418 *include suitable standard signs and pavement markings.*
- 419 C. *Furthermore, if it is installed within a signal system, the traffic control signal should be*
420 *coordinated.*

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422

423 **Section 4C.07 Comments: NCUTCD agrees with 4C.07 as presented in the NPA.**

424

425 **Section 4C.07 Warrant 6, Coordinated Signal System**

426 Support:

427 Progressive movement in a coordinated signal system sometimes necessitates installing traffic control
428 signals at intersections where they would not otherwise be needed in order to maintain proper platooning
429 of vehicles.

430 *Guidance:*

431 *The need for a traffic control signal should be considered if an engineering study finds that one of the*
432 *following criteria is met:*

- 433 A. *On a one-way street or a street that has traffic predominantly in one direction, the adjacent*
434 *traffic control signals are so far apart that they do not provide the necessary degree of vehicular*
435 *platooning.*
- 436 B. *On a two-way street, adjacent traffic control signals do not provide the necessary degree of*
437 *platooning and the proposed and adjacent traffic control signals will collectively provide a*
438 *progressive operation.*

439 *The Coordinated Signal System signal warrant should not be applied where the resultant spacing of*
440 *traffic control signals would be less than 1,000 feet.*

441

442

443 **Section 4C.08 Comments: NCUTCD agrees with 4C.08 as presented in the NPA.**

444

445 **Section 4C.08 Warrant 7, Crash Experience**

446 Support:

447 The Crash Experience signal warrant conditions are intended for application where the severity and
448 frequency of crashes are the principal reasons to consider installing a traffic control signal.

449 *Guidance:*

450 *The need for a traffic control signal should be considered if an engineering study finds that all of the*
451 *following criteria are met:*

452 *A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce*
453 *the crash frequency; and*

454 *B. At least one of the following conditions applies to the reported crash history (where each*
455 *reported crash considered is related to the intersection and apparently exceeds the applicable*
456 *requirements for a reportable crash):*

457 *1. The number of reported angle crashes and pedestrian crashes within a one-year period*
458 *equals or exceeds the threshold number in Table 4C-2 for total angle crashes and pedestrian*
459 *crashes (all severities); or*

460 *2. The number of reported fatal-and-injury angle crashes and pedestrian crashes within a one-*
461 *year period equals or exceeds the threshold number in Table 4C-2 for total fatal-and-injury*
462 *angle crashes and pedestrian crashes ; or*

463 *3. The number of reported angle crashes and pedestrian crashes within a three-year period*
464 *equals or exceeds the threshold number in Table 4C-3 for total angle crashes and pedestrian*
465 *crashes (all severities); or*

466 *4. The number of reported fatal-and-injury angle crashes and pedestrian crashes within a three-*
467 *year period equals or exceeds the threshold number in Table 4C-3 for total fatal-and-injury*
468 *angle crashes and pedestrian crashes; and*

469 *C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80*
470 *percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80*
471 *percent columns of Condition B in Table 4C-1 exists on the major-street and the more critical*
472 *minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not*
473 *less than 80 percent of the requirements specified in the Pedestrian Volume warrant.*

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476 **Table 4C-2 Comments: NCUTCD agrees with Table 4C-2 as presented in the NPA.**

477

478 **Table 4C-2. Minimum Number of Reported Crashes in a One-Year Period - Urban Area**

479

480

481 **Table 4C-3 Comments: NCUTCD agrees with Table 4C-3 as presented in the NPA.**

482

483 **Table 4C-3. Minimum Number of Reported Crashes in a Three-Year Period - Urban Area**

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485

486 **Standard:**

487 **These major-street and minor-street volumes shall be for the same 8 hours.**

488 Support:

489 On the minor street, the more critical volume is not required to be on the same approach during each
490 of these 8 hours. The more critical minor-street volume is the one that meets the warranting criteria for
491 that approach, and in the case of a one-lane minor-street approach that is opposite from a multi-lane
492 minor-street approach might not have the higher volume.

493 Option:

494 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph,
495 or if the intersection lies within the built-up area of an isolated community having a population of less
496 than 10,000:

497 A. The traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80
498 percent columns.

499 B. Tables 4C-4 and 4C-5 may be used in place of Tables 4C-2 and 4C-3.

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501

502 **Table 4C-4 Comments: NCUTCD agrees with Table 4C-4 as presented in the NPA.**

503

504 **Table 4C-4. Minimum Number of Reported Crashes in a One-Year Period - Rural Area**

505

506

507 **Table 4C-5 Comments: NCUTCD agrees with Table 4C-5 as presented in the NPA.**

508

509 **Table 4C-5. Minimum Number of Reported Crashes in a Three-Year Period - Rural Area**

510

511

512 **Section 4C-09 Comments: NCUTCD agrees with 4C-09 as presented in the NPA.**

513

514 **Section 4C.09 Warrant 8, Roadway Network**

515 Support:

516 Installing a traffic control signal at some intersections might be justified to encourage concentration
517 and organization of traffic flow on a roadway network.

518 *Guidance:*

519 *The need for a traffic control signal should be considered if an engineering study finds that the*
520 *common intersection of two or more major routes meets one or both of the following criteria:*

521 A. *The intersection has a total existing, or immediately projected, entering volume of at least 1,000*
522 *vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic*
523 *volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an*
524 *average weekday; or*

525 B. *The intersection has a total existing or immediately projected entering volume of at least 1,000*
526 *vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).*

527 *A major route as used in this signal warrant should have at least one of the following characteristics:*

528 A. *It is part of the street or highway system that serves as the principal roadway network for through*
529 *traffic flow.*

530 B. *It includes rural or suburban highways outside, entering, or traversing a city.*

531 C. *It appears as a major route on an official plan, such as a major street plan in an urban area*
532 *traffic and transportation study.*

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Section 4C-10 Comments: NCUTCD agrees with 4C-10 as presented in the NPA.

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Section 4C.10 Warrant 9, Intersection Near a Grade Crossing

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Support:

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The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity of a grade crossing on an approach controlled by a STOP or YIELD sign at a highway-highway intersection is the principal reason to consider installing a traffic control signal.

544

Guidance:

545

This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:

548

A. Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or

549

550

B. Reassigning the stop controls at the highway-highway intersection to make the approach across the track a non-stopping approach.

551

552

The need for a traffic control signal should be considered if an engineering study finds that both of the following criteria are met:

553

554

A. A grade crossing exists on an approach controlled by a STOP or YIELD sign at a highway-highway intersection and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and

555

556

557

B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) of the highway-highway intersection and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1C.02.

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Figure 4C-9 Comments: NCUTCD agrees with Figure 4C-9 as presented in the NPA.

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Figure 4C-9. Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)

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Figure 4C-10 Comments: NCUTCD agrees with Figure 4C-10 as presented in the NPA.

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Figure 4C-10. Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)

574

575

The following considerations apply when plotting the traffic volume data on Figure 4C-9 or 4C-10:

576

A. Figure 4C-9 should be used if there is only one lane approaching the highway-highway intersection at the track crossing location and Figure 4C-10 should be used if there are two or more lanes approaching the highway-highway intersection at the track crossing location.

577

578

- 579 B. *After determining the actual distance D, the curve for the distance D that is nearest to the actual*
580 *distance D should be used. For example, if the actual distance D is 95 feet, the plotted point*
581 *should be compared to the curve for D = 90 feet.*
582 C. *If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be*
583 *used.*

584 Option:

585 The traffic volume on the minor-street approach to the highway-highway intersection may be
586 multiplied by up to three adjustment factors as provided in Paragraphs 6 through 8.

587 Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per
588 hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-6 for
589 the appropriate number of occurrences of rail traffic per day.

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592 **Table 4C-6 Comments:** NCUTCD agrees with Table 4C-6 as presented in the NPA.

593

594 **Table 4C-6. Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic**

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597 Because the curves are based on typical vehicle occupancy, if at least 2% of the vehicles crossing the
598 track are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be
599 multiplied by the adjustment factor shown in Table 4C-7 for the appropriate percentage of high-
600 occupancy buses.

601

602

603 **Table 4C-7 Comments:** NCUTCD agrees with Table 4C-7 as presented in the NPA.

604

605 **Table 4C-7. Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses**

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608 Because the curves are based on tractor-trailer trucks comprising 10% of the vehicles crossing the
609 track, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor
610 shown in Table 4C-8 for the appropriate distance and percentage of tractor-trailer trucks.

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612

613 **Table 4C-8 Comments: NCUTCD agrees with Table 4C-8 as presented in the NPA.**

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615 **Table 4C-8. Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks**

616 **Standard:**

617 **If this warrant is met and a traffic control signal at the highway-highway intersection is**
618 **justified by an engineering study, then:**

- 619 **A. The traffic control signal shall have actuation on the minor street;**
- 620 **B. Preemption control shall be provided in accordance with Sections 4F.19 and 8D.09; and**
- 621 **C. The grade crossing shall have flashing-light signals (see Section 8D.02).**

622 *Guidance:*

623 *If this warrant is met and a traffic control signal at the highway-highway intersection is justified by*
624 *an engineering study, the grade crossing should have automatic gates (see Section 8D.03).*