Integrating Safety Countermeasures into the Design of Stop Controlled Intersections

Blair Perry, P.E. / Gresham, Smith and Partners
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Standard Design Resources

- AASHTO Green Book
  - Close to 90°
  - 60° min. intersection angle
  - Avoid sharp-radius horizontal curves on approaches
9.4.2 Alignment

Regardless of the type of intersection, to reduce costs and crash frequencies, intersecting roads should generally meet at or nearly at right angles. Roads intersecting at acute angles need extensive turning roadway areas and tend to limit visibility. Acute-angle intersections increase the exposure time for the vehicles crossing the main traffic flow. The practice of realigning roads intersecting at acute angles in the manner shown in Figure 9-14A and 9-14B has proved to be beneficial. The greatest benefit is obtained when the curves used to realign the roads allow operating speeds nearly equivalent to the major-highway approach speeds.

The practice of constructing short-radius horizontal curves on side-road approaches to achieve right-angle intersections should be avoided whenever practical. The intersection and traffic control devices at the intersection may be located outside the driver’s line of sight, resulting in the need to install advanced signing. Sharp curves may also result in increased lane encroachments.
Standard Drawings

TO-107 (Index No. 738)
- Details of Intersections and Turnouts
  - LTL-623 (Index No. 715)
    - Geometric Design and Striping Details for Speed Change Lanes With Median Crossovers With and Without Curbed Gore Areas
  - SL-710 (Index No. 1238)
    - Typical Stop & Yield Sign Location

PM-705-4 (Index No. 1031)
- Detail of Bituminous Rumble Strips
- PM-705-4 (Index No. 1032)
  - Detail of Thermoplastic Rumble Strips
- PS-701-8 (Index No. 1039)
  - Striping Details For Acceleration and Deceleration Lanes on Conventional Roads and Expressways
DETAIL OF INTERSECTION OF PROJECT WITH SIDE ROAD WHEN BRANCH ANGLE IS GREATER THAN 30° FROM NORMAL

NOTE: USE THE PRIVATE DRIVE LAYOUT FOR PUBLIC ENTRANCES WITH APPROX.
20 VEHICLES PER DAY. USE THE PUBLIC ROAD LAYOUT WITH GA-RADIUS FOR 20 TO
200 VEHICLES PER DAY. FOR PUBLIC ROADS EXCEEDING 200 VEHICLES PER DAY THE
DESIGN LAYERS LARGER THAN 50' IS PROPOSED. THE LAYOUT OF THE INTERSECTION WILL BE
SHOWN IN DETAIL ON THE PLANS.
Standard Drawing TO-107

- 70° Min. Intersection Angle
- 150’ Min. Approach Curve Radius
GENERAL NOTES:
1. USE MULTIPLE APPLICATIONS TO ACHIEVE DESIRED 6,300FT MINIMUM THICKNESS.
2. MATERIALS MAY BE CLASS 3, TYPE 1 PREMIUM SPEExX 05000-0475 (LATEX) OR THERMOPLASTIC MATERIAL IN A PREMIUM SPEExX 05000-0475 (LATEX).
3. FIVE ITEMS OF FLUORESCENT POWDER IN EACH APPLICATION.
4. SIZE DESIGNATION: LUMINOUS STRIP TO BE PAST 6000-050 15" HORIZONTAL DIRECTION; WIDTH DESIGNATION: AND LUMINOUS.

SPEED LIMIT (MPH)           DISTANCE FROM HORIZONTAL RUMBLE STRIP TO INTERSECTION
40 MPH                      000'  
40 MPH                      500'  
40 MPH                      1000' 
40 MPH                      2000' 

NOT TO SCALE
Stop Controlled Intersection Study

Common Issues
Common Issues

Inconsistent Signage

- Driver expectancy
- No “standards” for stop controlled intersection signage
- MUTCD
  - No concrete guidance on placement of warning, regulatory and guide signs approaching stop controlled intersection
  - Results in inconsistent signage
Stop Controlled Intersection Signage

Field Observations

- Not present for some approaches (County Roads)
- Typical 35 mph approach
  - 350’-400’ from stop line
- Typical 45 mph approach
  - 375’ to 715’ from stop line
- Typical 55 mph approach
  - 325’ to 1000’ from stop line

Source: MUTCD, Chapter 2C
Other Signs Used

Field Observations

T Intersection Signs (W2-4)

- Infrequently found
- MUTCD (Section 2C.46)
  - Option: May be used
Destination Signs (D1 Series)

- Inconsistent use
- MUTCD (Section 2D.37)
  - Guidance: Should be used at US/State route intersections

Source: MUTCD, Chapter 2D
Other Signs Used

Field Observations

Junction Assembly

- Inconsistent use
- MUTCD (Section 2D.30)
  - Standard: Shall be installed in advance of every intersection where a numbered route is intersected by another numbered route

Source: MUTCD, Chapter 2D
Other Signs Used
Field Observations

Advanced Route Turn Assembly

- Inconsistent use
- MUTCD (Section 2D.31)
  - Standard: Shall be installed in advance of an intersection where a turn must be made to remain on the indicated route

Source: MUTCD, Figure 2D-6
Directional Assemblies

- Always used
- MUTCD (Section 2D.32)
  - Standard: Required at route/route intersections
  - Guidance:
    - Near right corner preferred
    - Far right or left corner (to supplement near side)
    - Far right corner (if near right corner not practical)
Stop Controlled Intersection Signage

Source: MUTCD, Figure 2A-4

Source: MUTCD, Figure 2D-6
Stop Controlled Intersection Signage Research
MUTCD

- Challenge – Minimum sign spacing for lower speed approaches

Source: MUTCD, Chapter 2C

Source: MUTCD, Figure 2A-4

Stop Controlled Intersection Signage: Research
MUTCD

- Challenge – Figure 2D-6 does not include advance warning signs

Source: MUTCD, Figure 2D-6
Texas DOT (TXDOT)

- **TXDOT Sign Crew Field Book**
- Figures and Tables for all signs for Stop controlled intersection approaches

### Table 5-1: Approach Placement Distances

<table>
<thead>
<tr>
<th>Placement Distance for Speed Condition(^1) (Distance from near edge of intersecting roadway)</th>
<th>Type of Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Speed (≤40 mph), ft(^2)</td>
<td>High-Speed (≤45 mph), ft(^2)</td>
</tr>
<tr>
<td>6-50</td>
<td>6-50</td>
</tr>
<tr>
<td>200-400</td>
<td>325-500</td>
</tr>
<tr>
<td>320-600</td>
<td>650-825</td>
</tr>
<tr>
<td>700-920</td>
<td>975-1130</td>
</tr>
<tr>
<td>1000-1180</td>
<td>1300-1475</td>
</tr>
<tr>
<td>1300-1440</td>
<td>1675-1800</td>
</tr>
<tr>
<td>1500-1700</td>
<td>1950-2125</td>
</tr>
</tbody>
</table>

**Notes:**

1. A sign installation should not be moved closer to the intersection if another sign is not used. In other words, the junction assembly should always be 1825-1800 ft from the intersection, even if the advance route turn assembly is not installed.
2. Generally rounded to the nearest 10 ft.  
3. Generally rounded to the nearest 25 ft.

Figure 5-3. Convention for Sign Placement Distances on Low Speed Approach

Sources: TXDOT Sign Crew Field Manual
### Table 2-1: Minimum Advance Placement Distances for Warning Signs

| Post Speed (mph) | Condition A | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 |
|-----------------|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 20              | 225         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 25              | 325         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 30              | 400         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 35              | 550         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 40              | 650         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 45              | 750         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 50              | 850         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 55              | 950         | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 60              | 1000        | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 65              | 1100        | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 70              | 1200        | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 75              | 1300        | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 80              | 1475        | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

Notes:
- These are minimum placement distances. Signs may be placed further away if appropriate.
- See Table 2-2 for a list of the signs associated with each condition. The preceding page describes each of the conditions.
- Calculated placement distance is less than 30 ft. Accordingly, no suggested placement distance provided.
- See Table 2-3 for Condition B.
- Undivided distances are not provided in MUTCD Table 3C-4.
- Advisory speed is greater than the posted speed, placement distance not appropriate.

### Figure 5-2: Conventional for Sign Placement Distances on High Speed Approach

Source: TXDOT Sign Crew Field Manual
Sign distances from stop line are very large compared to MUTCD
  • PRT for inter-sign spacing almost double MUTCD
A given type of sign should remain approximately the same distance from the intersection in all applications
Stop Controlled Intersection Signage

Proposed Detail

- Blends MUTCD guidance and TXDOT Sign Crew Field Manual
- 2.5 second PRT (per MUTCD) for spacing between signs
- 100’ buffer for sign legibility if legend is <6” or contains four (4) or more words
### Placement Distance for Speed Condition (R)

<table>
<thead>
<tr>
<th>Type of Sign</th>
<th>Placement Distance for Speed Condition (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Speed (&lt;40 mph)</td>
<td>20</td>
</tr>
<tr>
<td>Direction Assembly or Stop Sign</td>
<td>6</td>
</tr>
<tr>
<td>Reserved for Future Use</td>
<td>150</td>
</tr>
<tr>
<td>Destination Sign1</td>
<td>220</td>
</tr>
<tr>
<td>Advance Warning Sign</td>
<td>350</td>
</tr>
<tr>
<td>Advance Route Turn Assembly</td>
<td>450</td>
</tr>
<tr>
<td>Junction Assembly</td>
<td>500</td>
</tr>
<tr>
<td>Intersection Sign</td>
<td>600</td>
</tr>
<tr>
<td>Minimum Recommended Sign Spacing Distance</td>
<td>2.5</td>
</tr>
</tbody>
</table>

### PRT (sec)

<table>
<thead>
<tr>
<th>Type of Sign</th>
<th>PRT (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Speed (&lt;40 mph)</td>
<td>20</td>
</tr>
<tr>
<td>Direction Assembly or Stop Sign</td>
<td>6</td>
</tr>
<tr>
<td>Reserved for Future Use</td>
<td>150</td>
</tr>
<tr>
<td>Destination Sign1</td>
<td>220</td>
</tr>
<tr>
<td>Advance Warning Sign</td>
<td>350</td>
</tr>
<tr>
<td>Advance Route Turn Assembly</td>
<td>450</td>
</tr>
<tr>
<td>Junction Assembly</td>
<td>500</td>
</tr>
<tr>
<td>Intersection Sign</td>
<td>600</td>
</tr>
<tr>
<td>Minimum Recommended Sign Spacing Distance</td>
<td>2.5</td>
</tr>
</tbody>
</table>

1. Placement distance is measured from the near edge of pavement of the intersecting roadway.
2. The Destination Sign should be used at the intersection of US or State numbered routes with interstates, US State or State numbered routes, or other destinations reached by a radial or radial route. If the condition on the right, then use the “Type of Sign” Column on the left.
3. PRT 2.5 seconds. The minimum PRT determined for a certain distance is 100 feet. Therefore, for a PRT of 2.5 seconds, for 20 mph and 25 mph, the minimum PRT distance associated with those speeds will be 100 feet, instead of the 75 feet and 95 feet calculated. Also, a buffer of 100 feet was added for an upper range to allow for sign legibility when sign contained legends last 6" or four (4) or more words.
### Type of Sign with Destination Sign

<table>
<thead>
<tr>
<th>Type of Sign with Destination Sign</th>
<th>Placement Distance for Speed Condition (ft)</th>
<th>Type of Sign without Destination Sign</th>
<th>Placement Distance for Speed Condition (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Speed (≤ 40 mph)</td>
<td></td>
<td>Low-Speed (≤ 40 mph)</td>
<td></td>
</tr>
<tr>
<td>Direction Assembly or Stop Sign</td>
<td>6'-0&quot;</td>
<td>8'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>Reserved for Future Use</td>
<td>150'-0&quot;</td>
<td>150'-0&quot;</td>
<td>150'-0&quot;</td>
</tr>
<tr>
<td>Destination Sign</td>
<td>250'-0&quot;</td>
<td>250'-0&quot;</td>
<td>250'-0&quot;</td>
</tr>
<tr>
<td>Advance Warning Sign</td>
<td>350'-0&quot;</td>
<td>350'-0&quot;</td>
<td>350'-0&quot;</td>
</tr>
<tr>
<td>Advance Route Turn Assembly</td>
<td>450'-0&quot;</td>
<td>450'-0&quot;</td>
<td>450'-0&quot;</td>
</tr>
<tr>
<td>Intersection Sign</td>
<td>550'-0&quot;</td>
<td>550'-0&quot;</td>
<td>550'-0&quot;</td>
</tr>
<tr>
<td>Minimum Recommended Sign Spacing Distance</td>
<td>90'-0&quot;</td>
<td>90'-0&quot;</td>
<td>90'-0&quot;</td>
</tr>
<tr>
<td>High-Speed (&gt; 45 mph)</td>
<td></td>
<td>High-Speed (&gt; 45 mph)</td>
<td></td>
</tr>
<tr>
<td>Direction Assembly or Stop Sign</td>
<td>6'-0&quot;</td>
<td>8'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
<tr>
<td>Reserved for Future Use</td>
<td>100'-0&quot;</td>
<td>100'-0&quot;</td>
<td>100'-0&quot;</td>
</tr>
<tr>
<td>Destination Sign</td>
<td>200'-0&quot;</td>
<td>200'-0&quot;</td>
<td>200'-0&quot;</td>
</tr>
<tr>
<td>Advance Warning Sign</td>
<td>300'-0&quot;</td>
<td>300'-0&quot;</td>
<td>300'-0&quot;</td>
</tr>
<tr>
<td>Advance Route Turn Assembly</td>
<td>400'-0&quot;</td>
<td>400'-0&quot;</td>
<td>400'-0&quot;</td>
</tr>
<tr>
<td>Intersection Sign</td>
<td>500'-0&quot;</td>
<td>500'-0&quot;</td>
<td>500'-0&quot;</td>
</tr>
<tr>
<td>Minimum Recommended Sign Spacing Distance</td>
<td>120'-0&quot;</td>
<td>120'-0&quot;</td>
<td>120'-0&quot;</td>
</tr>
</tbody>
</table>

1. Placement distance is measured from the near edge of pavement of the intersecting roadway.
2. The Destination Sign should be used at the intersection of US. Or State numbered routes with interstates, US or State numbered routes, and at points where they serve to direct traffic from US or State numbered routes to the Business Section of towns, or to other destinations reached by a networked system. If a Destination Sign is used with a Pacific Route, it may be used in place of the Posts. The Placement Distance is measured from the post edge of pavement of the intersecting roadway.
### Table: Placement distance for speed condition (ft)

<table>
<thead>
<tr>
<th>Direction Assembly or Stop Sign</th>
<th>Low-Speed (≤ 40 mph)</th>
<th>High-Speed (&gt; 40 mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable Future Use</td>
<td>150 - 250</td>
<td>255 - 355</td>
</tr>
<tr>
<td>Destination Sign</td>
<td>220 - 320</td>
<td>335 - 435</td>
</tr>
<tr>
<td>Advance Warning Sign</td>
<td>350 - 450</td>
<td>470 - 570</td>
</tr>
<tr>
<td>Advance Route Turn Assembly</td>
<td>450 - 550</td>
<td>570 - 670</td>
</tr>
<tr>
<td>Junction Assembly</td>
<td>800 - 900</td>
<td>Minimum recommended sign spacing distance</td>
</tr>
<tr>
<td>Intersection Sign</td>
<td>1000 - 1190</td>
<td>1200 - 1390</td>
</tr>
</tbody>
</table>

Minimum recommended sign spacing distance:

- **Minimum** 100 ft
- **Medium** 100
- **High** 110
- **Very High** 130
- **Very Very High** 150

**Type of Sign**

- **Without Destination Sign**

**PRT (sec)**: 2.5

**Type of Sign**

- **With Destination Sign**

**PRT (sec)**: 100

- **High-Speed (> 40 mph)**

**PRT (sec)**: 100

- **With Destination Sign**

**PRT (sec)**: 45

**Type of Sign**

- **Without Destination Sign**

**PRT (sec)**: 50

- **High-Speed (> 40 mph)**

**PRT (sec)**: 60

- **With Destination Sign**

**PRT (sec)**: 275

**Type of Sign**

- **Without Destination Sign**

**PRT (sec)**: 325

- **High-Speed (> 40 mph)**

**PRT (sec)**: 60

- **With Destination Sign**

**PRT (sec)**: 275

**Type of Sign**

- **Without Destination Sign**

**PRT (sec)**: 90

- **High-Speed (> 40 mph)**

**PRT (sec)**: 60

1. Placement distance is measured from the near edge of pavement of the intersecting roadway.

2. The Destination signs should be used at the intersection of US or State numbered routes with interstates, US or State numbered Routes, and at points where they serve to direct traffic from US or State Numbered Routes to the Business Section of towns, or to other destinations reached by numbered routes. If using the Destination Sign, then use the "Type of Sign" Column on the left. If not using the Destination Sign, then use the "Type of Sign" Column on the right.

3. The minimum PRT determined for a certain distance is 100 feet. Therefore, for a PRT of 2.5 seconds, for 20 mph and 25 mph, the minimum PRT distance associated with those speeds will be 200 feet, instead of the 175 feet and 195 feet calculated. Also, a buffer of 100 feet was added for an upper range to allow for sign legibility when sign contains legends less than 6" or four (4) or more words.

4. Placement distance is measured from the near edge of pavement of the intersecting roadway.

5. The Destination sign should be used at the intersection of all State Route Numbered Routes with interstates, US State Route Numbered Routes, and at points where they serve to direct traffic from US or State Numbered Routes to the Business Section of towns, or to other destinations reached by numbered routes. If using the Destination Sign, then use the "Type of Sign" Column on the right.

6. The minimum PRT determined for a certain distance is 100 feet. Therefore, for a PRT of 2.5 seconds, for 20 mph and 25 mph, the minimum PRT distance associated with those speeds will be 200 feet, instead of the 175 feet and 195 feet calculated. Also, a buffer of 100 feet was added for an upper range to allow for sign legibility when sign contains legends less than 6" or four (4) or more words.
<table>
<thead>
<tr>
<th>Type of Sign with Destination Sign</th>
<th>Placement distance for speed condition (ft)</th>
<th>Type of Sign Without Destination Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Speed (≤ 40 mph)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction Assembly or Stop Sign</td>
<td>150 - 250</td>
<td>150 - 250</td>
</tr>
<tr>
<td>Destination Sign</td>
<td>150 - 250</td>
<td>150 - 250</td>
</tr>
<tr>
<td>Advance Warning Sign</td>
<td>150 - 250</td>
<td>150 - 250</td>
</tr>
<tr>
<td>Advance Route Turn Assembly</td>
<td>150 - 250</td>
<td>150 - 250</td>
</tr>
<tr>
<td>Junction Assembly</td>
<td>150 - 250</td>
<td>150 - 250</td>
</tr>
<tr>
<td>Intersection Sign</td>
<td>150 - 250</td>
<td>150 - 250</td>
</tr>
<tr>
<td>High-Speed (&gt; 45 mph)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction Assembly or Stop Sign</td>
<td>250 - 325</td>
<td>250 - 325</td>
</tr>
<tr>
<td>Destination Sign</td>
<td>250 - 325</td>
<td>250 - 325</td>
</tr>
<tr>
<td>Advance Warning Sign</td>
<td>250 - 325</td>
<td>250 - 325</td>
</tr>
<tr>
<td>Advance Route Turn Assembly</td>
<td>250 - 325</td>
<td>250 - 325</td>
</tr>
<tr>
<td>Junction Assembly</td>
<td>250 - 325</td>
<td>250 - 325</td>
</tr>
<tr>
<td>Intersection Sign</td>
<td>250 - 325</td>
<td>250 - 325</td>
</tr>
</tbody>
</table>

Minimum Recommended Sign Spacing Distance (PMT sec):

- Low-Speed (≤ 40 mph):
  - 100
  - 110
  - 120
  - 130
  - 140

- High-Speed (> 45 mph):
  - 150

Placement distance is measured from the near edge of pavement of the intersecting roadway.

- The Destination sign should be used at the intersection of US or State numbered routes with interstates, U.S. State or State Numbered Routes, and at points where traffic from US State or Route Numbers enter the Business Section of towns, or to other destinations reached by unnumbered routes. If using the Destination Sign, then use the "Type of Sign" Column on the left. If not using the Destination Sign, then use the "Type of Sign" Column on the right.

- The Minimum PMT time (PMT) of 2.5 seconds. The minimum PMT determined for a certain distance is 100 feet. Therefore, for a PMT of 2.5 seconds, for 20 mph and 25 mph, the minimum PMT distance associated with those speeds will be 200 feet, instead of the 75 feet and 95 feet calculated. Also, a buffer of 100 feet was added for an upper range to allow for sign legibility when sign contains legends less than 6" or four (4) or more words.

- Placement Distance is measured from the near edge of pavement of the intersecting roadway.

- The Distance sign should be used at the intersection of US or State numbered routes with interstates, U.S. State or State Numbered Routes, and at points where traffic from US State or Route Numbers enter the Business Section of towns, or to other destinations reached by unnumbered routes. If using the Distance Sign, then use the "Type of Sign" Column on the left. If not using the Distance Sign, then use the "Type of Sign" Column on the right.

- The Minimum PMT determined for a certain distance is 100 feet. Therefore, for a PMT of 2.5 seconds, for 20 mph and 25 mph, the minimum PMT distance associated with those speeds will be 200 feet, instead of the 75 feet and 95 feet calculated. Also, a buffer of 100 feet was added for an upper range to allow for sign legibility when sign contains legends less than 6" or four (4) or more words.
### Placement Distance for Speed Condition (R)

<table>
<thead>
<tr>
<th>Direction Assembly or Stop Sign</th>
<th>Low-Speed (≤ 40 mph)</th>
<th>High-Speed (&gt; 45 mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>15</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>10</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

### Minimum Recommended Sign Spacing Distance

- **For Type of Sign:**
  - With Destination Sign: 2.5
  - Without Destination Sign: 2.5

- **For Speed Condition:**
  - Low-Speed (≤ 40 mph): 2.5
  - High-Speed (> 45 mph): 2.5

---

1. Placement distance is measured from the near edge of pavement at the intersecting roadway.
2. The destination signs should be used at the intersection of US or State numbered routes with interstates, US or State numbered routes to the Business Section of towns, or to other destinations reached by an arterial route. If the distance is not more than 100 feet, a buffer of 100 feet should be added for an upper range to allow for sign legibility when sign maintains required legible at 8' or four (4) or more words.
Two Way Stop Intersection
Four Way Stop Intersection
Common Issues:
Inadequate ISD or SSD
Intersection Sight Triangles

AASHTO Green Book (Ch. 9.5.2)

U.S. Customary

\[ ISD = 1.47 \times V_{\text{major}} \times t_g \]  

(9-1)

where:

- \( ISD \) = intersection sight distance (length of the leg of sight triangle along the major road) (ft)
- \( V_{\text{major}} \) = design speed of major road (mph)
- \( t_g \) = time gap for minor road vehicle to enter the major road (s)

Figure 9-15 Intersection Sight Triangles
Inadequate ISD

- Obstructions in ISD Sight Triangle
  - Tall grass on shoulder
  - Overhanging trees
  - Terrain (cut banks)
  - Large directional sign assemblies
  - Private signs
  - Private structures
  - Parked vehicles
  - Vehicles in adjacent driveways
Inadequate ISD

- Obstructions in ISD Sight Triangle
  - Tall grass on shoulder
  - Trees in ROW
  - Overhanging trees
Inadequate ISD

- Obstructions in ISD Sight Triangle
  - Tall grass on shoulder
  - Trees in ROW
  - Overhanging trees
Inadequate ISD or SSD

- Passenger Car
- 55 mph
Inadequate ISD or SSD

- Check ISD triangles
  - Tractor Trailer
  - 55 mph
Inadequate ISD

- Obstructions in ISD Sight Triangle
  - Terrain (cut banks)
  - Large directional sign assemblies
  - Crest VC on cross street
Inadequate ISD

- Obstructions in ISD Sight Triangle
  - Crest VC on cross street
  - Tall grass on shoulder
Inadequate ISD

- Obstructions in ISD Sight Triangle
  - Parked vehicles
    - In ROW?
    - Do we have enough ROW?
Common Issues

Inadequate ISD

- Obstructions in ISD Sight Triangle
  - Parked vehicles
Intersection Sight Triangles

- Need to control intersection sight triangles
  - ISD triangles within ROW
  - Access Management
    - Driveways
    - Parking
  - Directional sign placement
Driveway locations at intersections
ALDOT Access Management Manual

- Driveway locations at intersections
  - Number of driveways (Ch. 4.3.1 & 4.3.2)
  - Commercial/Industrial → 1 driveway for <660’ of frontage

**TABLE 4.2 Required Parcel Frontage for Driveways**

<table>
<thead>
<tr>
<th>Desired Number of Driveways*</th>
<th>Required Parcel Frontage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>660 ft - 1,980 ft</td>
</tr>
<tr>
<td>3 or more</td>
<td>&gt;1,980 ft</td>
</tr>
</tbody>
</table>

*Subject to minimum trip criteria and other roadway conditions such as proximity to driveways from adjacent properties, ALDOT may require fewer driveways.
ALDOT Access Management Manual

- Driveway locations at intersections
  - Corner driveway clearance

**TABLE 4.3 Corner Clearance Connection Spacing Requirements WITHOUT MEDIAN**

<table>
<thead>
<tr>
<th>Connection Type</th>
<th>Minimum Required Corner Clearance WITHOUT MEDIAN</th>
<th>2-lane rural *</th>
<th>All other</th>
<th>&gt; 45 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-In (upstream only)</td>
<td>125 ft</td>
<td>250 ft</td>
<td>440 ft</td>
<td></td>
</tr>
<tr>
<td>Right-Out (downstream only)</td>
<td>125 ft</td>
<td>250 ft</td>
<td>680 ft</td>
<td></td>
</tr>
<tr>
<td>Right-In/Right-Out</td>
<td>250 ft</td>
<td>275 ft</td>
<td>680 ft</td>
<td></td>
</tr>
<tr>
<td>Full Access (unsigned)</td>
<td>250 ft</td>
<td>360 ft</td>
<td>1,320 ft</td>
<td></td>
</tr>
<tr>
<td>Full Access (signalized)</td>
<td>1,320 ft</td>
<td>1,320 ft</td>
<td>2,049 ft</td>
<td></td>
</tr>
</tbody>
</table>

* Minimum spacing criteria only applies to 2-LANE RURAL roads exhibiting ALL of the following characteristics:
  1. Outside of Metropolitan Planning Organization (MPO) boundaries.
  2. Current ADT levels < 2,000.
  3. Peak hour trip generation potential of the proposed development < 50 total peak hour trips.

Note: It is desirable to maximize the distance between the corner parcel connection and the adjacent intersection. Minimum connection spacing criteria for corner clearance should only be considered when greater spacing cannot be achieved.
ALDOT Access Management Manual

- Driveway locations at intersections
  - Corner driveway clearance

**TABLE 4.4 Corner Clearance Connection Spacing Requirements WITH MEDIAN**

<table>
<thead>
<tr>
<th>Connection Type</th>
<th>Minimum Required Corner Clearance WITH MEDIAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 45 mph</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td>Right-in (upstream only)</td>
<td>125 ft</td>
</tr>
<tr>
<td>Right-Out (downstream only)</td>
<td>125 ft</td>
</tr>
<tr>
<td>Right-In/Right-Out</td>
<td>250 ft</td>
</tr>
<tr>
<td>Full Access (unsignalized)</td>
<td>660 ft</td>
</tr>
<tr>
<td>Full Access (signalized)</td>
<td>1,320 ft</td>
</tr>
</tbody>
</table>

|                            | > 45 mph                                      |
|                            | Urban                                         |
| Right-in (upstream only)   | 250 ft                                        |
| Right-Out (downstream only)| 250 ft                                        |
| Right-In/Right-Out         | 500 ft                                        |
| Full Access (unsignalized) | 1,320 ft                                      |
| Full Access (signalized)   | 2,040 ft                                      |

1. Minimum connection spacing criteria for corner clearance should only be considered when greater spacing cannot be achieved.
2. Minimum spacing criteria only applies to roads in MPO areas (see Appendix) with high density traffic conditions.
3. It is desirable to maximize the distance between the corner parcel connection and adjacent intersections.

*Figure 4.5 – Corner Spacing Criteria for Departing Intersections (Not to Scale)*

Refer to Tables 4.5 and 4.4 for additional corner spacing criteria.
Stop Controlled Intersection Safety:
Other Countermeasures
Unsignalized Intersection Safety

Resources

- Objectives and Strategies for Improving Safety at Unsignalized and Signalized Intersections, FHWA
- Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections, FHWA
- Unsignalized Intersection Improvement Guide, ITE
Side Road Splitter Islands

- Increased visibility
- High minor road speeds
- Second stop sign
- CRFs
  - 40-45% (Urban, all crashes)
  - 35% (Rural)
- Check truck turning movements
  - Traversable splitter island
- Cost $5,000 to $20,000

Source: FHWA Unsignalized Intersection Safety Strategies
Transverse Rumble Strips

- Use sparingly (NCHRP Report 500)
- Try less intrusive measures first
  - Stop Ahead pavement markings
- NCHRP Synthesis of Highway Practice 191
- Issues
  - Noise (nearby residents)
  - Loss of control for bicycles & motorcycles
- CRF: -35% to 33%
- Low cost: $2,100 - $2,500 per approach
Enhanced Conspicuity of Stop Sign

- Oversize Stop Sign
  - ALDOT Standard Size 36”x36”
  - 48”x48” Oversize Signs
- Up to 19% crash reduction for all crashes (one study)
- Low cost
  - Standard sign (single post) ~ $275
  - Oversize sign (dual post) ~ $500
- Quick Implementation
- 4 Way supplemental plaque not MUTCD compliant
- MUTCD Section 2B.05

Supplemental plaques with legends such as 2-WAY, 3-WAY, 4-WAY, or other numbers of ways shall not be used with STOP signs.
Enhanced Conspicuity of Stop Sign

- Double stop signs
- CRF:
  - 11% All crashes
  - 55% Right angle crashes

Source: FHWA Unsignalized Intersection Safety Strategies
Enhanced Conspicuity of Stop Sign

- Red reflective strip on stop sign post
- MUTCD Section 2A.15 & 2A.21
- 2” wide strip vs. wrap
- Cost $30-$60 each
Enhanced Conspicuity of Stop Sign

- LED Stop Signs
- CRF:
  - 41% Right angle crashes
- Cost: $1,500 to $2,500
Flashing Beacons

- Mitigate right angle and rear end crashes due to stop sign violations
- Mixed results
  - Some studies little or no crash reduction
  - Some studies showed increase in crashes
  - Florida (red/yellow beacon)
    - CRF 26% for all crashes
    - CRF 50% for injury crashes
  - CMF Clearinghouse
    - CRF 15% for angle crashes
    - CRF 5%-10% for all crashes
Convert Stop Controlled Intersection to Roundabout

- Two way stop with high number of right angle or turning crashes
- Four way stop with operational problems
- Alternative to traffic signal
- CRFs:
  - All crashes → 29% to 87%
  - Serious/minor injury crashes → 68% to 88%

Source: New Hampshire DOT
  - St. Clair County
  - Two way stop controlled intersection
  - 31 crashes in 5 ½ years
  - 25 angle crashes
  - 30 injuries
  - 1 fatality

Convert Stop Controlled Intersection to Roundabout
- Two way stop controlled intersection
- 29 crashes in 5 years
- 24 angle crashes
- 54 injuries
- 2 fatalities
Convert Stop Controlled Intersection to Mini Roundabout

- Capshaw Rd. at E Limestone Rd., Limestone County
- Four way stop controlled intersection
- Operational problems
- Mini roundabout with 90’ ICD
- SR-11/SR-124/Galilee Church Road, Jackson County, GA
- Four way stop controlled intersection
- Problem: About 50 car recurring queue on SR-11 SB

Convert Stop Controlled Intersection to Mini Roundabout
- SR-11/SR-124/Galilee Church Road, Jackson County, GA
- Mini roundabout with 90’ ICD
- Construction time: 9 days
- In-house maintenance project
- Completed 7.5 weeks after problem identified
- Cost: $63,353

Source: Mini-Roundabouts for the U.S. and Traffic Models, VDOT Statewide Roundabout Workshop, Wei Zhang, Ph.D., P.E., Program Manager, FHWA Intersection Safety R&D
Thank You!

Blair Perry, P.E.
State Leader – Transportation Services
Gresham, Smith and Partners
205.298.9232
205.937.5413
blair_perry@gspnet.com