INTERCHANGE SIGNING PLAN (ISP)

Plans for Addressing Ramp Safety

December 6, 2018
OBJECTIVES

- Reduce curve departure and truck rollover crashes
- Implement **consistency** in the application and placement of:
  - Signage
  - Delineation
  - Pavement Markings, and
  - Intelligent Transportation Systems (ITS)
- Reduce occurrences of wrong-way system entry incidents
To develop consistent Standards utilizing signs, delineation, pavement markings, and ITS devices...

1. Perform research to ensure effectiveness
   • State-of-the-industry in ramp safety
   • Review of PA Turnpike’s System
   • Outreach to users

2. Apply safety experience & knowledge
   • Determine minimum requirements
   • Develop “Levels” of escalation
   • Develop an effective & efficient method to apply escalation
   • Develop a clear format that can be applied to the PA Turnpike System
78 Interchanges on Turnpike System

- 67% are Trumpets
- 29% are Diamonds
- 4% are Cloverleafs

- 17 Service Plazas
- 11 Mainline Tolling
✓ “Levels” were developed for:
  • Similar groups of ramps for interchange & service plaza
  • Appropriate groups of guidance information for each of the Levels of ramps

✓ Used 15 Interchanges/Service Plazas for review
  • What makes them different?
  • What makes ENTRANCE & EXIT ramps different?
ANALYSIS OF SYSTEM

✓ Reviewed crash history

✓ Completed Advisory Speeds Assessments
  • Data collected using Rieker Inc.’s CARS™
    (Curve Advisory Reporting Service)
  • Correlated Advisory Speeds vs. Curve Radius

✓ Find factors that define the various Levels for the guidance information
BRINGING A HIGHER LEVEL OF POSITIVE GUIDANCE AND HUMAN FACTORS CONSIDERATIONS TO MOTORISTS OF THE PA TURNPIKE

- Provide comprehensive guidance information...
- Emphasizing Geometry & Advisory Speed...
- In a Consistent & Escalating fashion
“Level” is designated for each ramp within an interchange

Levels are unique for Entrance Ramps and Exit Ramps

Each Level has different placement requirements

Each Level enhances devices from previous Level
# RAMP "LEVEL" DEVELOPMENT

## Traffic Control Devices Summary

<table>
<thead>
<tr>
<th>Traffic Device</th>
<th>Size</th>
<th>Side</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merge Right Sign (W4-1R) or Added Lane Right Sign (W4-3R) on Mainline</td>
<td>48” x 48”</td>
<td>RIGHT</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
<td>N/A</td>
</tr>
<tr>
<td>Advisory Ramp Speed Sign (W13-3)</td>
<td>48” x 60”</td>
<td>RIGHT</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
<td>N/A</td>
</tr>
<tr>
<td>Combination Horizontal Alignment / Advisory Ramp Speed Sign (W13-7R)</td>
<td>48” x 84”</td>
<td>RIGHT</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
<td>N/A</td>
</tr>
<tr>
<td>Advisory Exit Speed Sign (W13-2)</td>
<td>48” x 60”</td>
<td>RIGHT</td>
<td>N/A</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Combination Horizontal Alignment / Advisory Exit Speed Sign (W13-6R)</td>
<td>48” x 84”</td>
<td>RIGHT</td>
<td>N/A</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Exit Gore Sign with Yellow Object Markers (OM1-3) on Posts</td>
<td>Variable; 18” x 18”</td>
<td>GORE</td>
<td>N/A</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Service Plaza Sign with Yellow Object Markers (OM1-3) on Posts</td>
<td>84” x 72”; 18” x 18”</td>
<td>GORE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Horizontal Alignment Warning Sign (Various) with Advisory Speed Plaque (W13-1P)</td>
<td>48” x 48”; 30” x 30”</td>
<td>RIGHT</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Horizontal Alignment Warning Sign (Various) with Advisory Speed Plaque (W13-1P)</td>
<td>48” x 48”; 30” x 30”</td>
<td>LEFT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Alignment Warning Sign (Various) with Advisory Speed Plaque (W13-1P)</td>
<td>60” x 60”</td>
<td>OVERHEAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck Rollover Sign (W1-13R/L) with Advisory Speed Plaque (W13-1P)</td>
<td>48” x 48”; 30” x 30”</td>
<td>RIGHT</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Truck Rollover Sign (W1-13R/L) with Advisory Speed Plaque (W13-1P)</td>
<td>48” x 48”; 30” x 30”</td>
<td>LEFT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Truck Rollover Sign (W1-13R/L) with Advisory Speed Plaque (W13-1P)</td>
<td>60” x 60”</td>
<td>OVERHEAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24/7 Flashing Beacon System on Truck Rollover Sign</td>
<td>VARIABLE</td>
<td>RIGHT</td>
<td></td>
<td></td>
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<td>OVERHEAD</td>
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<td></td>
<td></td>
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<tr>
<td>Exit Speed Sign (E13-1P) under Exit Gore Sign</td>
<td>72” x 24”</td>
<td>RIGHT</td>
<td>N/A</td>
<td>X</td>
<td>N/A</td>
<td>X</td>
</tr>
<tr>
<td>Chevron Alignment Signs (W1-8)</td>
<td>36” x 48”</td>
<td>LEFT OR RIGHT</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sequential LED Chevron Alignment Signs</td>
<td>VARIABLE</td>
<td>RIGHT OR LEFT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination Horizontal Alignment / Advisory Speed Sign (W1-1aR/L)</td>
<td>48” x 48”</td>
<td>RIGHT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LEVEL 1 DESIGNATION

- Gradual curves
- Short distance from tollbooth (slower speeds)
- Long deceleration lane (slower speeds)

ENTRANCE RAMP

EXIT RAMP
Summary of Traffic Control Device Requirements

- MUTCD Minimum Guidelines
- Advisory speed plaque on all Horizontal Alignment Warning signs
- 270° Curve Warning Sign for loop ramps
- High level of delineation:
  - Continual delineators on both sides
  - Durable pavement markings
LEVEL 2 DESIGNATION

- Sharper curves
- Short distance from tollbooth
- Long deceleration lane

ENTRANCE RAMP

EXIT RAMP
Summary of Traffic Control Device Requirements

- Chevron Alignment signs
  - ✔ Enhanced delineation (reflective post panels)

- Truck Rollover with advisory speed signs

- *Optional* combination Horizontal Warning with Advisory Speed signs
LEVEL 3 DESIGNATION

- Sharp curves
- Longer distance from tollbooth (higher speeds)
- Short deceleration lane (higher speeds)

ENTRANCE RAMP

EXIT RAMP
Summary of Traffic Control Device Requirements

- Conspicuity plaques on warning signs
- Flashing beacons on critical signs
- Advisory speed plaques on Exit Gore and Destination signs (Type A or Overhead)
- Increased enhanced delineation
- Dynamic Speed Display
LEVEL 4 DESIGNATION

- Sharp curves
- Long distance from tollbooth
- Short deceleration lane
- Existing or emerging crash history

ENTRANCE RAMP

EXIT RAMP
LEVEL 4 DESIGNATION

Summary of Traffic Control Device Requirements

- TRUCK ALERT sign
- SLOW CURVE Pavement Markings
- Curve Warning/Truck Rollover System
- **OVERHEAD** Dynamic Speed Display
Selection based on 2 geometric items:

- “Approach Speed” versus “Recommended Speed” at the “Critical Curve”
- Tangent length between reverse curves, if present

Selection Charts model speeds and determine appropriate Level
EXAMPLE

CONCEPTUAL INTERCHANGE PLAN FOR
I-76, EXIT 13 – BEAVER VALLEY INTERCHANGE
BEAVER VALLEY INTERCHANGE
Westbound Entrance Ramp

1. Acquire Geometry
   a) Length Available for Acceleration: 850 LF
   b) Shortest radius of curves (only one): 117 LF
   c) Single Lane ramp
   d) Advisory Speed: 20 mph

2. Level Selection – Chart A
   Level 2
Westbound Exit Ramp

1. Acquire Geometry
   a) Length Available for Deceleration: 450 LF
   b) Radius of *Initial* Curve: 413 LF
   c) Single Lane ramp
   d) No adjustment for grade
   e) Advisory Speed: 25 mph

2. Level Selection – Chart B

* Decrease LENGTH AVAILABLE FOR DECELERATION...
  ...by 5% if ramp is on a negative grade of 0 - 3%
  ...by 10% if ramp is on a negative grade of > 3%
  ...by 25% if ramp has dual lanes
LEVEL 2 ENTRANCE RAMP DIAGRAM

LEVEL 2 ENTRANCE RAMP DIAGRAMS

NOTES:
1. Place in accordance with Table 2C-5 of MUTCD (Manual on Uniform Traffic Control Devices), 2009 Edition, at near as possible to the start of the deceleration lane at full-width.

Place horizontal alignment signs at location using established engineering practices outlined in Section 2C.06 of MUTCD, 2009 Edition.

3. Advisory speed depicted determined by established engineering practices appropriate for the determination of the recommended advisory speed for a horizontal curve as outlined in Section 2C.08 of MUTCD, 2009 Edition.

5. Place in accordance with Section 2C.40 of MUTCD, 2009 Edition, and position so view of entering traffic is not obstructed.

6. Replace with W-3-1R (48” x 48”) when merging movements are not required.

7. Replace with W-1-11L (48” x 48”) when curve has a change of direction ≥ 130°.

8. Replace with W-1-3L (48” x 48”) when the tangent distance separating reverse curves < 600.

Follow Note 7 to determine if W1-13R (Truck Rollover) may be needed with W13-1P (Advisory Speed)
LEVEL 2 EXIT RAMP DIAGRAM

NOTES:
1. Place per Table 2C-5 of MUTCD (Manual on Uniform Traffic Control Devices), 2009 Edition, as near as possible to start of deceleration lane at full width.

Replace with W13-6R (48\* x 84\*) when exit ramp curve has a change of direction of approximately 270°. Advisory speed depicted should represent the lowest advisory speed for all curves on the ramp, including any truck advisory speeds, as determined by established engineering practices appropriate for the determination of the recommended advisory speed for a horizontal curve outlined in Section 2C.08 of MUTCD, 2009 Edition.

2. Replace with W1-2R (48\* x 48\*) when advisory speed of initial curve is determined to be > 30 mph.

Replace with W1-3R (45\* x 45\*) when two changes in roadway alignment in opposite directions are separated by a tangent distance < 600'.

Replace with W1-11R (48\* x 48\*) when curve has a change of direction of approximately 135° or more.

3. Location/placement of horizontal alignment sign is determined by established engineering practices outlined in Section 2C.08 of MUTCD, 2009 Edition.

4. Advisory speed depicted is to be determined by established engineering practices appropriate for the determination of the recommended advisory speed for a horizontal curve as outlined in Section 2C.08 of MUTCD, 2009 Edition.

5. Eliminate when two changes in roadway alignment in opposite directions are separated by a tangent distance ≥ 600'.

6. Placed at approximately 50' spacing on outside of every curve from Point of Curvature (POC) to Point of Tangent (POT).

7. Place 3’ wide yellow PennDOT approved Type X1 retroreflective sheeting along the length of the sign post facing oncoming traffic.

8. Install when either of the following considerations is met:
   A. The following curve radius and length available for deceleration relationship is met:
      - Radius is < 175' and Length Available for Deceleration is < 1000'
      - Radius is < 350' and Length Available for Deceleration is < 800'
      - Radius is < 600' and Length Available for Deceleration is < 600'
   B. Radius of curve is < 350' and immediately in advance of the second curve of a reverse curve with a tangent length ≤ 600'.

Place W1-13R in advance of a curve to the right, or W1-13L in advance of a curve to the left, at location determined by established engineering practices.

Advisory speed should depict the recommended speed for vehicles with a higher center of gravity using established engineering practices outlined in Section 2C.13 of MUTCD, 2009 Edition. If this speed is lower than the recommended speed for the corresponding horizontal alignment warning sign(s), this recommended speed should also be used for the horizontal alignment warning sign(s).

9. Eliminate sign when curve has a change of direction of approximately 270°.

10. Sign can be eliminated when advisory speed is > 30 MPH or when tangent length in advance of reverse curve is > 600'. Place at or near Point of Curvature (POC).

Follow Note 8 to determine if W1-13R (Truck Rollover) may be needed with W13-1P (Advisory Speed)
NEXT STEPS
NEXT STEPS

• Revisions to Interchange Signing Plan currently underway.
  - Integration of Wrong-Way Signage into document
  - Minor changes to recommendations
• Publish Interchange Signage Plan in 2019/2020 for application on PA Turnpike System
• Present the PA Motor Truck Association (PMTA) the final results and implementation plans for ISP.
NEXT STEPS

• Prepare for possible expansion/integration of current and future ITS Devices

• Continually scrutinize ISP for improvement opportunities as technology, traffic control, and traffic operations change
  ➔ Update Level Selection Charts
  ➔ Incorporate emerging technologies
QUESTIONS?