Guardrail Training

July 2016
Presenter:
From the FDOT Roadway Design Office in Tallahassee...

Richard Stepp, P.E., Design Standards Engineer
richard.stepp@dot.state.fl.us
Phone: 850-414-4313
## Course Breakdown:

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td>New Index Sheets Nos. 1-10 (Part A)</td>
</tr>
<tr>
<td>Module 2</td>
<td>New Index Sheets Nos. 11-22 (Part B)</td>
</tr>
<tr>
<td>Module 3</td>
<td>Instructions for Design Standards (IDS)</td>
</tr>
<tr>
<td>Module 4</td>
<td>Design Tool – Length of Need (Excel)</td>
</tr>
</tbody>
</table>
Who’s interested in this class?

- Roadway Designers?
- Plans Reviewers?
- Project Managers?
- Construction Contractors?
- Maintenance Personnel?

The newly redeveloped Index 400 has many new features to assist contractors with structural aspects and construction, however we’ve geared this course towards information for Roadway Plans designers and reviewers.
• **Index 400 – Guardrail**
  • **Complete Restructuring Project**
    • New Index Sheets (Redrawn)
    • New Specifications (currently MSPs)
    • New Instructions for Design Standards (IDS)
    • New Length of Need “Design Tool” (Excel Program)
    • Modifications of Existing Indexes for Compatibility (e.g. Index 402, 410, 411)
    • Revised PPM Ch. 2 and 4 (Roadside Safety to Ch. 4)
For choosing when to use Guardrail and at what offset to place it, see the PPM Chapter 4 for Roadside Safety.

For more information, see Derwood Sheppard’s Portion of the PPM Design Update Training below...

http://www.dot.state.fl.us/rrddesign/Training/Webinar16/Pres16.shtm
We’re going to give you the Guardrail “crash course”

Here’s the Guardrail crash course....
MODULE 1: Index Overview – Sheets 1 thru 10

This Index 400 is a DSR, as of February 1, 2016
Why change?...

Clarity. Updates. Effectiveness.

OLD INDEX:
• 34 sheets long
• lengthy verbiage, ‘passive voice’
• old scanned-in drawings
• includes information for the designer
• includes Spec. style language
• has previous NCHRP350 Guardrail Transition to ‘Bridge Railings’
• has only TL-3 guardrail options
• ‘Length of Need’ uses a simplified method based on previous criteria

NEW INDEX:
• 22 sheets long (with Table of Contents)
• concise verbiage, ‘active voice’, note headings
• new drawings to scale, latest labeling practice
• designer information moved to PPM and IDS
• Spec. language moved to the Specifications
• has latest MASH tested Guardrail Transitions to ‘Rigid Barrier’ (Both Railings and Barriers)
• has both TL-3 & TL-2 guardrail options
• ‘Length of Need’ calculations cover more cases, based on AASHTO RDG criteria
Where is it?... *Easiest to Google “FDOT Standards”*

http://www.dot.state.fl.us/rddesign/DesignStandards/Standards.shtm

<table>
<thead>
<tr>
<th>Design Standards Revisions FY 2016-17</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DSR Reference Number</strong></td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>DSR400-01</td>
</tr>
<tr>
<td>DSR410-01</td>
</tr>
<tr>
<td>DSR411-01</td>
</tr>
</tbody>
</table>
Implementation Schedule...

Roadway Design Bulletin 16-01

The Index Sheets and Instructions for Design Standards discussed refer to the February 1\textsuperscript{st} DSR to the 2016-17 Design Standards eBook. The Specifications referred to will soon be available as Modified Special Provisions (MSPs).

The \textit{draft} Specifications (MSPs) and PPM language are currently in Bulletin 16-01.

These documents are available for use at the option of the Districts for all projects let prior to July 1\textsuperscript{st}, 2017.

If this option is used:
1. Place the \textit{DSR Reference Number on the Key Sheet} as described in the \textit{PPM}, Volume 2, Section 3.2.8
2. Request the applicable \textit{MSPs} from the District Specifications Office and include them in the project Specifications Package.

\textit{On July 1\textsuperscript{st}, 2017 this update will become mandatory, as it will be released with the 2017-18 Design Standards eBook.}
Table of Contents and General Notes:

GENERAL NOTES:

1. INSTALLATION: Construct guardrail in accordance with Specification Section 339. This Index, along with the plans and the manufacturers’ drawings as the Approved Products List (APL) is sufficiently detailed for installation of General Guardrail, Low-Speed Guardrail, End Treatment assemblies, and their connecting options shown herein. This procedure requires for shop drawing submittals unless otherwise specified in the plans.

2. COMPATIBILITY: The General Guardrail in this Index is based on the Midwest Guardrail System (MGS) design, with a 32” height at the top of the Panel (2” top flange height at the Edge of Panel) and a midplane passive as shown on Sheet 2. Guardrail components included on the APL which are compatible with this Index, may also be identified as “MGS” Guardrail.


4. BUTTON-HEAD WELDS: Install Button-Head Bolts where indicated using bolts, nuts, and washers as defined on Sheet 22. Place washers under nuts; washers are galvanized against steel flanges. 2½” diameter washers between bolt heads and panels, except where otherwise shown in this Index.

5. HEX-HEAD WELDS: Install Hex-head Bolts where indicated using bolts, nuts, and washers is in accordance with material properties of Specification Section 567. Place washers under nuts; washers are galvanized against steel flanges.

6. MISCELLANEOUS ASPHALT PAVERMIX: Install Miscellaneous Asphalt Pavement where indicated in accordance with Specification Section 339.

7. ADJACENT SIDEWALKS & SHARED USE PATHS: When guardrail posts are placed within 0’-0” of a sidewalk or shared use path, use timber posts, or use steel posts only if treated with Pipe Rail as shown on Sheet 20.

When timber posts are used, one of the following safety treatments is required for the bolts protruding from the back face of the posts:

a. After tightening the nut, trim the protruding bolt flush with the nut and galvanize per Specification Section 562. bolt. Use bolt washers 0’-0” in length and countersink the washer and nut down to ½” and 0’-0” deep into the back face of the post. Use O’-0” post bolts with sleeve nuts and washers. When End Treatment posts are within 0’-0” of a sidewalk or shared use path, steel posts are not permitted within the End Treatment segments. Terminate the Pipe Rail outside of End Treatment segments, as noted per Sheet 20.

b. CONNECTION TO EXISTING GUARDRAIL: When a transition to existing guardrail at 27” height is required, linearly transition the guardrail height over a distance ranging from 25’-0” to 37’-0”. Provide an immediate transition to the required midplane splice using the available panel options on Sheet 4.

8. PLAN CALLOUTS: Begin/End Station labels are shown throughout this Index as they correspond to the station and offset callouts specified in the plans.

In the plans, Begin/End Guardrail Station refers to General TL-3 Guardrail, and it may be abbreviated as Begin/End GS. Where Low-Speed TL-2 Guardrail is specifically required, the callout in the plans will then specify Low-Speed TL-2 GS. See.

9. QUANTITY MEASUREMENTS: Measure guardrail and corresponding components as defined in Specification Section S36. The guardrail length is measured along the centerline of installed Panels, between the points labeled Begin/End Guardrail Station shown on the following Index sheets and defined in the plans (typically measured from the top of the panel post bolt slots at the approach/trailing ends).
Table of Contents:

<table>
<thead>
<tr>
<th>SHEET NO.</th>
<th>CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General Notes; Index Contents</td>
</tr>
<tr>
<td>2</td>
<td>General, TL-3 Guardrail - Installed Plan and Elevation</td>
</tr>
<tr>
<td>3</td>
<td>Low-Speed, TL-2 Guardrail - Installed Plan and Elevation</td>
</tr>
<tr>
<td>4</td>
<td>W-Beam and Thrie-Beam Panel Details</td>
</tr>
<tr>
<td>5</td>
<td>Post and Offset Block Details</td>
</tr>
<tr>
<td>6</td>
<td>Guardrail Sections - Heights and Adjacent Slopes</td>
</tr>
<tr>
<td>7</td>
<td>End Treatment - Approach Terminal Geometry, Parallel and Flared</td>
</tr>
<tr>
<td>8</td>
<td>End Treatment - Approach Terminal Geometry, Curbed and Double Faced</td>
</tr>
<tr>
<td>9</td>
<td>End Treatment - Trailing Anchorage Type II</td>
</tr>
<tr>
<td>10</td>
<td>End Treatment - Component Details</td>
</tr>
<tr>
<td>11</td>
<td>End Treatment - Controlled Release Terminal (CRT) System</td>
</tr>
<tr>
<td>12</td>
<td>Layout for CRT System - Side Roads and Driveways</td>
</tr>
<tr>
<td>13</td>
<td>Approach Transition Connection to Rigid Barrier - General, TL-3</td>
</tr>
<tr>
<td>14</td>
<td>Approach Transition Connection to Rigid Barrier - Low-Speed, TL-2</td>
</tr>
<tr>
<td>15</td>
<td>Approach Transition Connection to Rigid Barrier - Details</td>
</tr>
<tr>
<td>16</td>
<td>Approach Transition Connection to Rigid Barrier - Double Faced Guardrail</td>
</tr>
<tr>
<td>17</td>
<td>Layout to Rigid Barrier - Approach Ends</td>
</tr>
<tr>
<td>18</td>
<td>Layout to Rigid Barrier - Approach Ends with Double Faced Guardrail, Layout to Rigid Barrier - Trailing Ends</td>
</tr>
<tr>
<td>19</td>
<td>Rub Rail Details</td>
</tr>
<tr>
<td>20</td>
<td>Pedestrian Safety Treatment - Pipe Rail</td>
</tr>
<tr>
<td>21</td>
<td>Modified Mount - Special Steel Post for Concrete Structure Mount; Modified Mount - Encased Post for Shallow Mount; Modified Mount - Frangible Leave-Out for Concrete Surface Mount</td>
</tr>
<tr>
<td>22</td>
<td>Barrier Delineators - Post Mounted; Clear Space - Reduced Post Spacing for Hazards; 5/8&quot; Button-Head Bolt System</td>
</tr>
</tbody>
</table>

Sheet Organization/Groupings:

2-3) Guardrail run types
4-5) Basic components
6) Guardrail Cross-Sections
7-12) End Treatments:
  • Approach “Terminal”
  • Trailing “Anchorage”
  • CRT (with layouts)
13-16) Transition Connections to Rigid Barriers
17-18) Example guardrail layouts showing how segments above will fit together
19-20) Guardrail supplements
  • Rub Rail
  • Pipe Rail
21) Modified Post Mounts
22) Miscellaneous Details
NOTES Highlights:

1. Use Spec 536. No project specific shop drawings needed.
2. This is considered 31” height Guardrail (based on MGS design)
3. Components based on AASHTO-AGC-ARTBA Design
4. Post Bolt type
5. Hex Bolt type
6. Asphalt type
7. Options for Contractor when posts fall within 4’ of sidewalk
8. How to connect to existing guardrail (transition)
9. Plans Callouts
10. Guardrail Length Measurement
General, TL-3 Guardrail Details:

- **Configuration for “General” run of W-beam guardrail**
- **Applicable for TL-3 Design Speed and below**

**NOTES:**

1. GENERAL: Install the General Guardrail configuration where applicable to the plan. This may include tapered segments if called for in the plan.

2. MIDSPAN PANEL CAP SPlice: For proper structural function, place all Splice Screws at MIDSPAN unless otherwise indicated.

3. TRANSCITIONAL TRANSITIONS: Transitions, or other segment types are defined in the following Index Sheets, A PI Drawings, or the plans.


5. POST & OFFSET BLOCK DETAILS: See Sheet 5.

6. GUARDRAIL SECTIONS; For Sections showing typical mounting heights, grazing, and layout of parts in relation to adjacent roadway features, see Sheet 6.

7. MODIFIED PANELS: Where concrete structures, concrete barriers, or similar solid barriers, are encountered, SW maximum size Load Plate will be required.

8. DEFLATED SEGMENTS: The General Guardrail shown provides the basic configuration, including Post Spacing and splice locations. For Deflated segment modifications where indicated in the plans, refer to the Deflated Guardrail Details shown in this Index (e.g. Double Panel W-Beam, Solid Post, Steel Panel, etc).
General, TL-3 Guardrail Details:

- Configuration for “General” run of W-beam guardrail
- Applicable for TL-3 Design Speed and below
General, TL-3 Guardrail Details:

General, TL-3 Guardrail is the same as the Previous Standard:

- **31” Height**
- **6’-3” Post Spacing**
- **Midspan Panel Splice**
- **2” Miscellaneous Asphalt Pavt. (Mow Strip)**
- **1 Offset Block Per Post**
NOTES:

1. GENERAL: Install the General Guardrail configuration where indicated in the plans. This may include tapered segments if called for in the plans.

Use 12'-6" or longer W-Beam Panels. A single 6'-3" Panel may be used at the end of the run to meet the nominal Begin/End Guardrail Sta. requirements.

Where a differing guardrail configuration is required for constructability beyond the options shown in this Index or the plans, obtain approval from the Engineer prior to installation.

2. MIDSPAN PANEL LAP SPlice: For proper structural function, place all Lap Splices at midspan unless otherwise indicated.

Lap the Panels with the Splice Ridge oriented downstream of the final Direction of Traffic in the nearest traffic lane. Orienting Lap Splices for Temporary Traffic Control phasing is not required.

3. CONNECTION DETAILS: Connections to End Treatments, Approach Transitions, or other segment types are defined in the following Index Sheets, APL Drawings, or the plans.


5. POST & OFFSET BLOCK DETAILS: See Sheet 5.

6. GUARDRAIL SECTIONS: For Sections showing typical mounting heights, grading, and lateral offsets in relation to adjacent roadway features, see Sheet 6.

7. MODIFIED MOUNTS: Where concrete structures, concrete sidewalk, or shallow depth conditions are encountered, see Sheet 21 for additional post mounting options.

8. DEFINED SEGMENTS: The General Guardrail shown provides the base configuration, including Post Spacing and splice locations, for Defined Segment modifications where indicated in the plans and using the Guardrail Types, Sections, and/or hardware as shown in this Index (e.g. Double Faced W-Beam, Modified Thrie-Beam, Deep Posts at Slope Breaks, Pipe Rail, Rub Rail, or Reduced Post Spacing for Hazards).

NOTES Highlights:

1. Contractors must use 12’-6” or 25’-0” Panels, but they may use a 6’-3" Panel at the end of the run. *Designers should design the nearest 6’-3” Panel length, measured along CL of panels

2. Midspan Panel Lap Splices need to have exposed ridge facing downstream. This orientation is not required for TTC phasing.

8. General Guardrail is “base configuration” (e.g. post spacing, midspan splice, offset block) It is then “modified” where defined in the plans to add Pipe Rail, Double Faced Guardrail, Rub Rail, Deep Posts etc...
Low-Speed, TL-2 Guardrail Details:

- **All New!**
- **Double the post spacing**
- **Half the posts for cost savings (where applicable)**
- **Permitted for design speeds 45 MPH and Less (TL-2)**
- **Use only for flush shoulder conditions (no raised curbs)**
Low-Speed, TL-2 Guardrail Details:

- All New!
- Double the post spacing
- Half the posts for cost savings (where applicable)
- Permitted for design speeds 45 MPH and Less (TL-2)
- Use only for flush shoulder conditions (no raised curbs)
Low-Speed, TL-2 Guardrail Details:

Vehicle at rest

0.000 s 0.196 s 0.392 s 0.588 s
Low-Speed, TL-2 Guardrail Details:

Low-Speed, TL-2 Guardrail is the same as General Guardrail, except:

- 12’-6” Post Spacing
- Run ends with a 9’-4½” Panel to transition to other segment types (with 6’-3” span and midspan splice)
Low-Speed, TL-2 Guardrail Details:

NOTES:

1. **GENERAL:** Install the Low-Speed Guardrail configuration where indicated in the plans. Low-Speed Guardrail may include tapered segments if called for in the plans.

   Use 12’-6” or longer W-Beam Panels for normal spans, and use 9’-4½” Panels for end connections to adjoining segments as shown. A single 6’-3” Panel may be used at the end of the Low-Speed Guardrail run along with a single reduced 6’-3” post spacing to meet the nominal Begin/End Guardrail Sta. required. Where a differing guardrail configuration is required for constructability beyond the options shown in this Index or the Plans, obtain approval from the Engineer prior to installation.

2. **MIDSPAN PANEL LAP SPLICE:** For proper structural function, place all Lap Splices at midspan unless otherwise indicated.

   Lap the Panels with the Splice Ridge oriented downstream of the final direction of traffic in the nearest traffic lane. Orienting Lap Splices for temporary traffic control phasing is not required.

3. **CONNECTION DETAILS:** Connections to End Treatments, Approach Transitions, or other segment types are defined in the following Index Sheets, APL Drawings, or the plans.

4. **W-BEAM PANEL DETAILS:** See Sheet 4.

5. **POST & OFFSET BLOCK DETAILS:** See Sheet 5.

6. **GUARDRAIL SECTIONS:** For sections showing typical mounting heights, grading, and lateral offsets in relation to adjacent roadway features, see Sheet 6.

7. **MODIFIED MOUNTS:** Where concrete structures, concrete sidewalk, or shallow depth conditions are encountered, see Sheet 21 for additional post mounting options.

8. **DEFINED SEGMENTS:** The Low-Speed Guardrail shown provides the base configuration, including post spacing and splice locations, for defined segment modifications where indicated in the plans and using the Guardrail Types, Sections, and/or hardware as shown in this Index (e.g. Double Faced W-Beam, Modified Thrie-Beam, Deep Posts at Slope Breaks, Pipe Rail, Rub Rail, or Reduced Post Spacing for Hazards).

**NOTES Highlights:**

1. Contractors must use 12’-6” or longer Panels with a 12’-6” Post spacing, but they may use a 6’-3” Panel and Post spacing only at the end of the run to meet the Plans station callouts...

   *Designers can place this segment to the nearest 6’-3” Panel length, measured along CL of guardrail panels (Similar to General Guardrail).

Remaining Notes are similar to previously discussed General Guardrail.
W-Beam and Thrie-Beam Panel Details:

- Panel Options Shown on single Sheet
- Panels are used in General and Low-Speed Guardrail, Approach Transitions, End Treatments Etc...
Design Standards Index 400, Sheet 4

W-Beam and Thrie-Beam Panel Details:

Traditional Panel Jargon:
- Double Panel = 25’-0”
- Full Panel = 12’-6”
- Half Panel = 6’-3”
- Quarter Panel = 3’-1½”
W-Beam and Thrie-Beam Panel Details:

More Flexibility Provided for Contractors:

- **6'-3” Panel** may be used at end of run to meet new guardrail length tolerance of ± 3'-1½” (Spec. 536)

- **9’-4½” or 15’-7½” Panels** may be used to transition to midspan panel lap splices (for connecting to existing older guardrail with splices at post location)

- **25’-0” Panels** may now be used to reduce the number of splice bolt installations required by half
Post and Offset Block Details:

- Covers all Options for Post and Offset Block Configurations
- New “Consolidated” Steel Post type
- New variations of Post length and offset block height are given
Post and Offset Block Details:

Offset Block Dimension is
6” x 8” Nominal
(5.5” x 7.5” Actual)

7.5” is the offset dimension
Post Details:

- **2 Post Lengths** (Depths)
  - *Standard ‘L’*
  - *Deep Post ‘L’*

- **Standard Post ‘L’** is default for General and Low-Speed Guardrail, End Treatments, Approach Transitions Etc..

- **Deep Post ‘L’** may be used only for “Slope Break Condition” where Designer calls for it in Plans (we’ll cover requirements later)

↑ **NEW! Consolidated Steel Post Type:** Its universal bolt hole placement now handles, W-Beam, Thrie-Beam, and Pipe Rail (contractors can stockpile)
Offset Block Details:

- Timber Blocks are the Standard
- Steel Blocks are Not Permitted (Except for Modified Thrie-Beam)
- APL Composite Offset Blocks may be substituted for timber
- Thrie-Beam Offset Block now has 2 height versions
  - Standard Thrie-Beam height (default)
  - General Approach Transition Connection height (only where shown later in Standard)
    - Per MASH crash testing
1. What is the Post Spacing of TL-2, Low-Speed Guardrail?

12'-6"

2. At what Design Speed is TL-2 Guardrail Permitted?

45 mph and less

3. What Length Panel must contractors use at the end of a TL-2 Low-Speed Guardrail run? Why?

9'-4½" panel for transitioning to adjacent segment’s midspan splice

4. At what length increment must designers plan a General or Low-Speed Guardrail run? (excluding Approach Transitions and End Treatments)

6'-3" increment

5. When else would a contractor use 9’-4½” or 15’-7½” Panels?

6. What is the “offset” length dimension of a Standard Offset Block?”
Guardrail Sections:

Summary:
- Guardrail Heights & Depths
- Adjacent Grading (a.k.a. Slopes)
- 2” Misc. Asphalt Mow Strip
- Concrete Sidewalk
- Curb Conditions
- Shoulder Gutter
- Rub Rail
Guardrail Sections:

Types of Guardrail:

- The **Heights**, ‘H’, and **Depths**, ‘D’, are used later in Standard drawings where any of the below guardrail types may be used.

*NOTE: Grading at base of post established at 1:10 Max. slope (1:10 or flatter)*
Guardrail Sections:

Slope Break Condition, “Deep Posts” **NEW!**

- Contractor may only use Deep Posts where called for in the Plans.

PPM 4.4.6.2 “With approval of the District Design Engineer and where right-of-way is restricted (i.e. constrained condition), the Deep Post guardrail option, as detailed in Design Standards, Index 400 Slope Break Condition, may be used in lieu of providing a 2 ft. setback to the slope break point. Coordinate the use of the Deep Post guardrail option with the District Drainage Engineer and District Maintenance Engineer.”
Guardrail Sections:

Typical Grading and Pavement Placement Detail

This Provides basic dimensions that may then be superseded by specific differences of other Standard Guardrail Sections. (e.g. curbed or shoulder gutter sections)
Guardrail Sections:

Curb and Gutter Sections

- Notice where Height, ‘H’, is measured up from in each scenario.

- **NEW!** Guardrail placed ‘Adjacent to Curb’ may now be placed at either 0” or 5” from Face of curb, defined per the Plans.
  (5” preferred to avoid nuisance hits, such as rearview mirrors)

- Lateral Offsets are defined per the Plans.
  *See PPM Section 2.3 “Shoulders” & Figure 4.4.12 “Offset to Guardrail”
Guardrail Sections:

With Shoulder

- 2’-0” misc. asphalt to paved Shoulder Connection (supersedes typical)
- Configuration for Drainage, Matches PPM Table 2.3
- “Varies” for ‘Crossover’ Taper, Bridge Approach Layout
- Rub Rail is now only permitted for median side, slopes between 1:6 & 1:10
Guardrail Sections:

Concrete Sidewalk **NEW!**

**Concrete is not permitted around base of post.**
A low strength “frangible” material must be used (either misc. asphalt of flowable fill)

- 7” Clearance is required from the back of post to the rigid concrete to facilitate proper rotation of posts upon vehicle impact
- If 2” Misc. Concrete Can’t be placed at post location due to surrounding concrete, use the “Frangible Leave-Out” (defined later in the Index)
- When the back of steel posts will be within 4’ of a Sidewalk or Shared Use Path, Pipe Rail must be used for pedestrian safety.

**NOTE:** requires defining Begin/End Stations and length in the Plans
Approach Terminal Geometry, Parallel and Flared:

- Shows basic geometry and grading requirements for APL Approach Terminals
- Provides predefined Lengths ‘LE’ that will accommodate all APL Terminals (for simpler Plans design)
Approach Terminal Geometry, Parallel and Flared:

- Shows basic geometry and grading requirements for APL Approach Terminals

- Provides pre-defined Lengths ‘LE’ that will accommodate all APL Terminals (for simpler Plans design)
Approach Terminal Geometry, Flared:

- **Begin/End Guardrail Station** called out – Corresponds to Roadway Plans callout (Plans station & offset given at Face of Guardrail) – *Length of guardrail measured from here*

- Slope Break’s Taper Rate back to Typical (Parallel) Slope Break has changed to **1:10** (previous Standard showed 1:15)

- Offset to Slope Break has changed to 6’-0” from face of guardrail (previous Standard showed 3’-0” from back of assembly)

- Maximum flare is still 4’-0”, measured at post(1). This might be important for later!
Approach Terminal Geometry, Curbed and Double Faced:

- Same idea as Sheet 7, but shows “Curbed” and “Double Faced” segments
Approach Terminal Geometry, Curbed:

- **Type ‘E’ Curb** Required where shown:
  - 63’-1½” for TL-3
  - 50’-7½” for TL-2
  
  Show and Label in Plans. Include in Summary of Curb & Gutter.

- **Guardrail Height, ‘H’,** is measured from the top of curb (not the lip of gutter) for Approach Terminals. This raises the height a bit.
  - Just FYI! *No Action needed from Roadway Designer.*
Approach Terminal Geometry, Double Faced:

- ‘Double Faced’ option has always been available on the APL, but now it’s shown in the Standard for better awareness.
  - Crash tested
  - Initial installation cost savings versus crash cushion

- 1:10 Max. cross slope extends to Approach Terminal on both sides.
  - Drainage structures may be required to convey median water
  - Outside of ‘LE’, transition longitudinally to typical median cross slope at 1:10 Max (in direction parallel to roadway).
Trailing Anchorage - Type II:

- Apply to “Trailing” guardrail ends to “Anchor” the guardrail. (Not “head-on” crashworthy like Approach Terminals are)

- Nearly same as previous Standard, just drafted more clearly
Trailing Anchorage - Type II:

- Begin/End Guardrail Station called out – Corresponds to Roadway Plans callout (Stationing and Offset given at Face of Guardrail) – Length of guardrail measured from here

From Previous Standard...

Anchor Block Option Removed
End Treatment Component Details:

- Component Details are used in Type II and CRT End Treatments (on the previous and following pages, respectively).
- Construction Stuff!
End of 2nd Quarter Review Questions!

1. What is the minimum distance required from the back of post to the front slope break?

2. For Guardrail adjacent to curb, what’s the distance between the face of Guardrail and the face of curb?

3. What is the maximum slope permitted for all approach grading to Guardrail or End Treatments?

4. For what “condition” are Deep Posts intended to be used?

5. To what distance, behind post(1) of an approach terminal, must the 1:10 slope be maintained?

6. What type of curb must be used in front of an Approach Terminal?

7. Where is the “Type II” End Treatment used?
This Index 400 is a DSR, as of February 1, 2016
End Treatment - Controlled Release Terminal (CRT) System:

- For use with short radius guardrail systems as shown on the next sheet.

- This is the same as the previous Standard, only detailed more clearly.
Layout for Controlled Release Terminal (CRT) System:

- Used for 90 degree intersection of principle roadway and side road or driveway

- This is nearly the same as the previous standard, only detailed more clearly

- Draw corresponding dimensions and radius in the Plans

- When terminating with a CRT End Treatment, the guardrail extends 15’-7½” from Match Line
Layout for Controlled Release Terminal (CRT) System:

- Begin/End CRT Station called out – Corresponds to Roadway Plans callout (e.g. “Begin CRT 24 Ft. R. Sta. 100+00”)
- Begin/End Guardrail Station called out – Corresponds to Roadway Plans callout. It’s also shown on Elevation view. – Length of guardrail measured from here
- Min. Clear Area - Maintain 1:10 Slope to 2’ behind the posts. Beyond that, maintain an area clear of hazards with a 1:2 or flatter slope.
Approach Transition Connection to Rigid Barrier, General TL-3:

- **ALL NEW!**
- **MASH Tested**
- **Applicable to all Design Speeds**
- **About 12’-6” shorter than old “Detail J” from Rigid Barrier (about 25’ shorter including previous barrier overlap)**
- **New raised ‘Alignment Curb’ required**
- **Section Views on Sheet 15**
Approach Transition Connection to Rigid Barrier, General TL-3:
**Approach Transition Connection to Rigid Barrier, General TL-3:**

- **Begin/End Guardrail Station** called out – Corresponds to Roadway Plans callout – *Length of guardrail measured from here*

- **Begin/End Rigid Barrier** Station called out - **Different from Begin/End Guardrail Station** (governed by Thrie-Beam Terminal Connector with its Edge flush with Rigid Barrier) Guardrail’s 7¾” overlap with the Rigid Barrier should be drawn this way in Plans

- **End Transition of Curb** – This is *where typical curb type begins*, if here on project (e.g. Type F, Shoulder Gutter) **Starts 28’-1½”** from Begin/End Guardrail Station
Approach Transition Connection to Rigid Barrier, General TL-3:

- **Rigid Barrier Shoulder Line**: Aligns with “Standard Shoulder Line” of Shoulder Gutter as shown in Index 300. This Shoulder Gutter aligns at Section E-E.

- **Taper to Guardrail Offset per the Plans**: If roadway guardrail has a different lateral offset than the bridge railing guardrail, then your “Begin/End Taper” callout is given at Section E-E. (Starts 28’-1½” from Begin/End Guardrail Station)
  
  *This leads to typical section, generally meeting PPM Fig 4.4.12*

- **End Transition of Curb** – This is *where typical curb type begins*, if here on project (e.g. Type F, Shoulder Gutter; Starts 28’-1½” from Begin/End Guardrail Station)
Approach Transition Connection to Rigid Barrier, General TL-3:

• **Taper to Guardrail Offset per the Plans**: This guardrail taper generally leads to these typical sections. Per PPM 4.4.12...
Approach Transition Connection to Rigid Barrier, General TL-3:

Sneak Peak of Sheet 17... the bigger picture of tapering to typical section!

- **Taper to Guardrail Offset per the Plans**: This guardrail taper generally leads to these typical sections. Per PPM 4.4.12...
Approach Transition Connection to Rigid Barrier, Low-Speed TL-2:

- **ALL NEW!**
- MASH Tested
- Applicable to Design Speeds \( \leq 45 \text{ mph} \)
- Shorter and less robust design for cost savings
- New raised ‘Alignment Curb’ required
- Section Views on Sheet 15
Approach Transition Connection to Rigid Barrier, *Low-Speed TL-2*:

- **ALL NEW!**
- MASH Tested
- Applicable to Design Speeds \( \leq 45 \text{ mph} \)
- Shorter and less robust design for cost savings
- New raised ‘Alignment Curb’ required
- Section Views on Sheet 15
Approach Transition Connection to Rigid Barrier, **Low-Speed TL-2**:

- **Similar Connection and Curb Design as the General TL-3 Version!**
- **Begin/End Guardrail Station** called out – Corresponds to Roadway Plans callout – **Length of guardrail measured from here**
- **Begin/End Rigid Barrier** Station called out - **Different from Begin/End Guardrail Station**
- **End Transition of Curb** – This is **where typical curb type begins**, if here on project (e.g. Type F, Shoulder Gutter) **Starts 18’-9”** from Begin/End Guardrail Station
**Approach Transition Connection to Rigid Barrier, Low-Speed TL-2:**

- **Rigid Barrier Shoulder Line:** Aligns with “Standard Shoulder Line” of Shoulder Gutter as shown in Index 300. This Shoulder Gutter aligns at Section E-E.

- **Taper to Guardrail Offset per the Plans:** If roadway guardrail has a different lateral offset than the bridge railing guardrail, then your “Begin/End Taper” callout is given at Section E-E. (Starts 18’-9” from Begin/End Guardrail Station)  
  *This leads to typical section, generally meeting PPM Fig 4.4.12*

- **End Transition of Curb** – This is *where typical curb type begins*, if here on project (e.g. Type F, Shoulder Gutter; Starts 18’-9” from Begin/End Guardrail Station)
**Approach Transition Connection Details:**

- Shows Cross Section details for Approach Transitions on previous Sheets.

- Provides curb transitions for three types of curb Options
  1. Shoulder Gutter
  2. Raised Curb
  3. No Curb
Approach Transition Connection Details:

Curb Sections – Alignment Curb Segment

- “Alignment Curb”
  - aligns with face of rigid barrier
  - reduces potential for vehicle snagging at start of Rigid Barrier (per TTI recommendation)
  - follows same lateral offset (both curb and face of guardrail) from Section B-B to D-D
**Approach Transition Connection Details:**

Curb Sections – Transition to **Shoulder Gutter** Option (1 of 3)

**Standard Shoulder Line** per Index 300 – This offset aligns with Rigid Barrier and face of Alignment curb (i.e. the Rigid Barrier’s Shoulder Line)

**Section E-E**, Shoulder Gutter shape is established: Begin guardrail offset taper to typical section as the project’s shoulder width requires (Index Sheet 6).

Typical section generally has face of guardrail at Shoulder Line plus 2’ (or back edge of shoulder gutter plus 6’’). Guardrail Taper Rate guidance is provided in the IDS.
Approach Transition Connection Details:

Curb Sections – Transition to Raised Curb Option (2 of 3)

Section E-E, Raised Curb Established (e.g. Type F or Type E). This will generally keep its face aligned with the Rigid Barrier’s shoulder line (same as Alignment Curb).

At Section E-E, begin the guardrail offset taper to typical section (Sheet 6).

Taper Rate guidance is provided in the IDS.
**Approach Transition Connection Details:**

**Curb Sections – Transition to No Curb Option (3 of 3)**

**Section E-E, Curb is Terminated:**

At Section E-E, begin guardrail offset taper to typical section as the project’s shoulder width requires (Sheet 6).

Typical section generally has face of guardrail at Shoulder Line plus 2’ (or back edge of shoulder gutter plus 6”). Guardrail Taper Rate guidance is provided in the IDS.
Approach Transition Connection to Rigid Barrier, Double Faced:

- **ALL NEW!**
- Applicable to all Design Speeds
- “Hybrid” of previous Double Faced Transition and MASH-Tested TL-3 Approach Transition
- Adds 12’-6” barrier overlap needed to transition guardrail to Rigid Barrier Width
**Approach Transition Connection to Rigid Barrier, Double Faced:**

- **Begin/End Double Faced Guardrail Station** called out – Corresponds to Roadway Plans callout – Length of guardrail measured from here

- **Begin/End Rigid Barrier** Station called out - *Different from Begin/End Guardrail Station* (Required for Double Faced Guardrail width to transition into the narrower Rigid Barrier) Guardrail’s 13’-1¼” overlap with the Rigid Barrier should be drawn this way in Plans.

- **Length of Approach Transition, ‘LA’** – Has the same post spacing as the ‘General’ Approach Transition. The curb is omitted, because the guardrail panels are held away from the Rigid Barrier by the added offset blocks (reducing vehicle snagging).
Approach Transition Connection to Rigid Barrier, **Double Faced**:

- **Rigid Barrier** – “Full” Double Faced Barrier per Index 410. It is narrower than Double Faced Guardrail System.

- **Trimmed Std. Offset Blocks to Rigid Barrier** – Wider guardrail system transitioning to Rigid Barrier width. The reason for the guardrail overlapping with the Rigid Barrier!

- **Taper to Guardrail Offset per the Plans** – Similar to Section E-E in that this is where the Plans will begin transition to a different guardrail offset if needed (40’-7½” from Begin/End Guardrail Sta.)
1. When is a CRT configuration used?

2. For Approach Transition Connections, when is the guardrail panel overlap with Rigid Barrier of *about* 12’-6” required?

3. For *single faced* Approach Transition Connections, what is the location difference between the Begin Guardrail Station and the face of the Rigid Barrier? (in inches)

4. All *single faced* Approach Transition Connections require an Alignment Curb underneath... *True or False*?

5. All *double faced* Approach Transition Connections require an Alignment Curb underneath... *True of False*?

6. For single faced Approach Transition Connections, at what ‘Section’ on the Index Sheet do you begin the guardrail Taper (usually headed towards 2’ from shoulder line)?
Design Standards Index 400, Sheet 17

Layouts to Rigid Barrier, Single Barrier Approach or Median Crossover:

- Provides Example Layout “Types” that will correspond to callouts in the Plans
- Shows how segments in previous sheets connect together

**Notes:**
1. **Installation:** The Plan views shown are schematic only, showing example geometry for connecting guardrail segments includes taper locations and Double Faced Guardrail requirements as applicable. Work this figure with the plans, where shown, and offsets for Double Faced Guardrail, Beveled Edge Taper, and Beveled End Taper are specified.
2. **Segments:** On lane intersecting segments, if double, construct this segment as shown in the plans. For the case where this segment's offset differs from the Approach Gradient, an overlap taper the guardrail between the Beveled Taper Station and offsets as specified in the plans.
3. **Length of Guardrail:** The length of the Double Faced Guardrail panel shown shall be based on the length of the panel segments, longer than the offset or side of the road. Based on the panel segment longer than the dimensions specified for the Panel and Bevel Taper to align with a panel Bevel tool.
4. **End Treatment Options:** For Single Panel application, use either a Double Faced Approach Terminal shown per Sheet 7, or a Double Faced Guardrail shown per Sheet 17. For other systems, meet the TTD adjustment grading requirements for Approach Terminal shown on Sheet 9.
5. **Slope Guard:** Where indicated in the plans, install a guardrail segment between bridge approach, and should be in the bridge approach. Each guardrail segment shown shall include guardrail panels at the ends and both sides of the approach segment. The system may also be strengthened by installing two mounted end units as defined on Sheet 9.

**Layout to Rigid Barrier - Approach Ends**

**Notes:**
1. **INSTALLATION:** The Plan views shown are schematic only, showing example geometry for connecting guardrail segments includes taper locations and Double Faced Guardrail requirements as applicable. Work this figure with the plans, where shown, and offsets for Double Faced Guardrail, Beveled Edge Taper, and Beveled End Taper are specified.
2. **Segments:** On lane intersecting segments, if double, construct this segment as shown in the plans. For the case where this segment's offset differs from the Approach Gradient, an overlap taper the guardrail between the Beveled Taper Station and offsets as specified in the plans.
3. **Length of Guardrail:** The length of the Double Faced Guardrail panel shown shall be based on the length of the panel segments, longer than the offset or side of the road. Based on the panel segment longer than the dimensions specified for the Panel and Bevel Taper to align with a panel Bevel tool.
4. **End Treatment Options:** For Single Panel application, use either a Double Faced Approach Terminal shown per Sheet 7, or a Double Faced Guardrail shown per Sheet 17. For other systems, meet the TTD adjustment grading requirements for Approach Terminal shown on Sheet 9.
5. **Slope Guard:** Where indicated in the plans, install a guardrail segment between bridge approach, and should be in the bridge approach. Each guardrail segment shown shall include guardrail panels at the ends and both sides of the approach segment. The system may also be strengthened by installing two mounted end units as defined on Sheet 9.

**Layout to Rigid Barrier - Plan View**

**Notes:**
1. **INSTALLATION:** The Plan views shown are schematic only, showing example geometry for connecting guardrail segments includes taper locations and Double Faced Guardrail requirements as applicable. Work this figure with the plans, where shown, and offsets for Double Faced Guardrail, Beveled Edge Taper, and Beveled End Taper are specified.
2. **Segments:** On lane intersecting segments, if double, construct this segment as shown in the plans. For the case where this segment's offset differs from the Approach Gradient, an overlap taper the guardrail between the Beveled Taper Station and offsets as specified in the plans.
3. **Length of Guardrail:** The length of the Double Faced Guardrail panel shown shall be based on the length of the panel segments, longer than the offset or side of the road. Based on the panel segment longer than the dimensions specified for the Panel and Bevel Taper to align with a panel Bevel tool.
4. **End Treatment Options:** For Single Panel application, use either a Double Faced Approach Terminal shown per Sheet 7, or a Double Faced Guardrail shown per Sheet 17. For other systems, meet the TTD adjustment grading requirements for Approach Terminal shown on Sheet 9.
5. **Slope Guard:** Where indicated in the plans, install a guardrail segment between bridge approach, and should be in the bridge approach. Each guardrail segment shown shall include guardrail panels at the ends and both sides of the approach segment. The system may also be strengthened by installing two mounted end units as defined on Sheet 9.
Layouts to Rigid Barrier, Single Barrier Approach:

- Shows Approach Transition, General Guardrail, and Approach Terminal End Treatment as one system. 
  NOTE: For shortest case of Rigid Barrier end protection, General Guardrail segment may be omitted (simply ‘LA’ + ‘LE’)

- **Begin/End Guardrail Stations** called out – Corresponds to Roadway Plans callout – Corresponds to callouts on preceding sheets – *Defines length of Guardrail*

- **Begin/End Taper Stations** called out - Corresponds to Roadway Plans callout – 
  This is typically where the Guardrail begins tapering to its typical section on Sheet 6 
  (guardrail face usually goes to paved shoulder line plus 2 feet, or it’s measured from face of curb). 
  *This starts at Section E-E on Sheets 13-15!*
  Taper rate guidance is provided in the IDS.
• **Begin/End Taper Stations** called out – The circled Taper Sta. will generally look like one of these! From PPM Figure 4.4.12
Layouts to Rigid Barrier, “Median Crossover Guardrail”:

- Shows layout for shielding Rigid Barriers of dual bridges, where the concrete railing across the median is within the clear zone (this places the back of the shielding guardrail in the opposing lane’s clear zone as well)

- The “Median Guardrail Crossover” is most efficient design for the shortest Length of Need

- The new ‘Guardrail Length of Need Program’ assists with this design, providing station and offset information. We’ll cover specifics of ‘Double Faced Approach Terminals’ and ‘Crash Cushions’ when we discuss this later.
Layouts to Rigid Barrier, “Median Crossover Guardrail”:

- **Begin/End Double Faced Guardrail Stations** called out – Corresponds to Roadway Plans
  
  **NOTE:** The Double Faced Guardrail Pay Item applies from the Rigid Barrier Connection to the End Treatment (even over the single faced Approach Transition Connection).

- **Begin/End Taper Stations** called out - Corresponds to Roadway Plans callout. The station and offset callouts define the linear taper rate for the contractor.
  
  **NOTE:** The ‘Guardrail Length of Need Program’ assists with providing these stations and offsets.
Design Standards Index 400, Sheet 17

Layouts to Rigid Barrier, “Median Crossover Guardrail”:

• **End Double Faced Panels Required** – Show how far the double faced panels continue graphically in the Plans (Regarding Payment, the entire layout here is considered Double Faced Guardrail).

• **Slope Guard** - Place in Plans between bridges at 6’-6” from the slope break. Tabulate an estimated length as the adjacent guardrail type and include in the Plans (separate quantity entry). More info in IDS.
Layouts to Rigid Barrier, Double Faced Approach and Trailing End:

- More Example Layout “Types” that will correspond to callouts in the Plans
- Shows how segments in previous sheets connect together
Layouts to Rigid Barrier, Double Faced Approach:

- Shows Approach Transition, General Guardrail, and Approach Terminal End Treatment as one system. NOTE: For shortest case of Rigid Barrier end protection, General Guardrail segment may be omitted (simply ‘LA’ + ‘LE’)

- **Begin/End Double Faced Guardrail Stations** called out – Corresponds to Roadway Plans callout – Corresponds to callouts on preceding sheets – *Defines length of Guardrail*

- **Begin/End Taper Stations** called out - Corresponds to Roadway Plans callout – This is typically where the Guardrail begins tapering to its typical section on Sheet 6 (guardrail face usually goes to paved shoulder line plus 2 feet, or it’s measured from face of curb). The start of taper location is shown on Sheet 16. Taper rate guidance is provided in the IDS.
Layouts to Rigid Barrier, Trailing End:

- Shows Trailing Connection, General Guardrail, and Trailing Anchorage (Type II).

- **Begin/End Guardrail Stations** called out – Corresponds to Roadway Plans callouts

- **Begin/End Taper Stations** called out - Corresponds to Roadway Plans callouts

- **ALL NEW – Trailing Connection** detailed on same Sheet. Now uses Thrie-Beam Transition Panel to create similar connection as approach end.
Rub Rail Details:

- **NEW!** Rub Rail Details are now provided for the same old Rub Rail!

- Previous Standard had referenced AASHTO-ARTBA-TF13 “Guide to... Barrier Hardware”, but this did not show installed Rub Rail in finished condition.

- Now added more specific detail about where to begin and end Rub Rail.
Rub Rail Details:

- Label Begin/End Rub Rail Stations as explained in the IDS.
- Terminate Rub Rail outside of End Treatment Segments (Approach Terminal ‘LE’, Trailing Anchorage ‘LT’) and Crash Cushion Transition segments.
- Remember, from Sheet 6, use Rub Rail only for median slopes greater than 1:10 (with a 1:6 Max. slope in general).
Pedestrian Safety Treatment – Pipe Rail:

- This is the same as the previous Standard, only detailed more clearly and with more construction issues addressed.
Pedestrian Safety Treatment – Pipe Rail:

- Pipe Rail segments are required where Steel Posts will be located within 4’ of sidewalks or shared use paths.

- Designers should generally assume steel posts are used and include pipe rail callouts and quantities in the Plans (to give contractor the post option).

- Pipe Rail must terminate outside of End Treatment segments (At least 3'-1½" outside of 'LE', 'LA', 'LT', and/or Crash Cushion segments). Notice that the first post outside of these segments is timber where Pipe Rail is used.

- Begin/End Pipe Rail Station corresponds to the Plans callouts.
**Special Steel Post, Encased Post, Frangible Leave Out:**

- **NEW AND IMPROVED!** (mostly)
- "Modified Mounts" allow different post mounting options for the scenarios of:
  - Posts atop a concrete structure
  - Posts over shallow underground utilities
  - Post atop concrete surface (sidewalk)

---

**SPECIAL STEEL POST FOR CONCRETE STRUCTURE MOUNT**

**ENCASED POST FOR SHALLOW MOUNT**

**FRANGIBLE LEAVE-OUT FOR CONCRETE SURFACE MOUNT**
**Special Steel Post for Concrete Structure Mount:**

- Contractor may use Special Steel Posts when it is called for in the Plans or as-needed (billed beyond the Plans quantity).

- If a post falls entirely upon a concrete structure (base plate beyond 3” from the edge), a Special Steel Post is used (with base plate mounted into the structure via adhesive-bonded anchor bolts).
Special Steel Post for Concrete Structure Mount:

If a post falls on the concrete edge, then this is called an “Edge Conflict”, and the contractor has two options:

- **Option 1, Standard Post:** Move the post up to a quarter span in the direction away from the structure, and plant the post in the soil
  
  *NOTE:* The contractor is allowed to use up to 2 additional Offset Blocks to miss the structure

- **Option 2, Special Steel Post:** Move the post up to a quarter span in the direction of the structure, and use a Special Steel Post with its base plate entirely atop the structure
Encased Post for Shallow Mount (Over Underground Obstacles):

- This option saves 20” of depth versus Standard Posts.
- The contractor has the option to use as-needed (billed beyond the Plans quantity).
- This may only be used for non-consecutive posts.
- If the designer happens to know of a definite post-utility conflict, then this may be called out and quantified in the Plans as well (perhaps on a short guardrail run with predictable post locations).
Frangible Leave-out for Concrete Surface Mount:

- **ALL NEW!** If a post falls atop a concrete surface or sidewalk (undesirable), then the contractor must use a “Frangible Leave-Out” around the base of the post.

- The Frangible Leave-out involves blocking out the concrete around the base of the post and backfilling it with low-strength “Flowable Fill” (max 150 psi).

  *This allows the post to rotate correctly upon vehicle impact.*

- These Leave-outs can either be called out in the Plans for predictable post locations, or the contractor can use them as-needed (billed beyond the Plans quantity).
Barrier Delineators, Reduced Post Spacing, Bolt System:

- **LAST INDEX SHEET!**
- Includes Miscellaneous Details for the Contractor like Barrier Delineation and Standard Bolt Information
- The “Reduced Post Spacing for Hazards” detail simplifies post spacing transitions for designers
Reduced Post Spacing for Hazards (Reduced Setback Clearance):

- When an aboveground hazard is within 5'-0" behind the face of guardrail, *reduced post spacing* may be used to reduce the “Setback” requirement to the hazard (see PPM Table below)

- The designer must call out the reduced post spacing as required per the table, and the Design Standard will handle the transition of post spacing before and after

- The Standard extends the reduced post spacing to the nearest post outside of the station range called for.

- The Standard also handles Low-speed Guardrail 12'-6" spacing, explaining that the spacing sequence remains the same, but with the 12'-6" adjacent to the 6'-3" spacing.

From PPM: Table 4.4.2 Minimum Barrier Setback:

<table>
<thead>
<tr>
<th>Semi-Rigid Barrier</th>
<th>Setback (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-Beam with Post Spacing @ 6'-3&quot; (TL-3)</td>
<td>5'-0&quot;</td>
</tr>
<tr>
<td>W-Beam with Post Spacing @ 3'-1½&quot; (½ Spacing)</td>
<td>3'-10&quot;</td>
</tr>
<tr>
<td>W-Beam with Post Spacing @ 1'-6¼&quot; (¼ Spacing)</td>
<td>3'-2&quot;</td>
</tr>
<tr>
<td>Nested W-Beams with Post Spacing @ 3'-1½&quot; (½ Spacing)</td>
<td>3'-0&quot;</td>
</tr>
<tr>
<td>Nested W-Beams with Post Spacing @ 1'-6¼&quot; (¼ Spacing)</td>
<td>2'-8&quot;</td>
</tr>
<tr>
<td>Modified Thrie-Beam with Post Spacing @ 6'-3&quot;</td>
<td>3'-0&quot;</td>
</tr>
</tbody>
</table>
End of Game Review Questions!
(Everyone wins!... of course)

1. What station and offset callouts are required to define a Guardrail Crossover for Median configuration?

2. When is Rub Rail required?

3. When is Pipe Rail required?

4. Concerning Pipe Rail, the Roadway Plans should assume steel posts are used (True or False)

5. How many options does a contractor have when a post has an “Edge Conflict” with a structure?

6. When is a Frangible Leave-Out used?

7. When is a Reduced Post Spacing segment used?
MODULE 3: 
Instructions for Design Standards (IDS) 

 Index 400 is a DSR, as of February 1, 2016
### Index 400 Guardrail – IDS

**Where is it?...**

**Office of Design**

**Office of Design / Design Standards / Design Standards Revisions FY 2016-17**

**Design Standards Revisions FY 2016-17**

<table>
<thead>
<tr>
<th>Index Number</th>
<th>Revised Sheets</th>
<th>Index Title</th>
<th>Design Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>1-22 of 22</td>
<td>Guardrail</td>
<td>IDS-00400</td>
</tr>
<tr>
<td>410</td>
<td>2,10, 16-18 of 25</td>
<td>Concrete Barrier Wall</td>
<td>XLS</td>
</tr>
<tr>
<td>411</td>
<td>6 of 10</td>
<td>Pier Protection Barrier</td>
<td>N/A</td>
</tr>
</tbody>
</table>

n/a = Non Applicable  
n/c = No Change
Length of Need Concept:

Length of Need (LON) is the length of guardrail required to provide a degree of shielding to prevent errant vehicles from impacting roadside hazards – measured from the hazard’s approach face to the approach end of the redirective guardrail segment.

From the Guardrail-LON program:

A picture is worth a thousand words, so....
Length of Need Concept:

Length of Need, X (Ft.)

\[ X = \frac{L_A - Y}{L_A/L_R} \]

AASHTO RDG (5-3)

<table>
<thead>
<tr>
<th>Lateral Area Concern, L_A (Ft.)</th>
<th>the lesser distance from the 'Edge of Traffic Lane' to the 'Clear Zone Limit' or 'Back of Hazard'</th>
</tr>
</thead>
<tbody>
<tr>
<td>End Treatment Offset, Y (Ft.)</td>
<td>the distance from the Edge of Traffic Lane at the start of the guardrail's gating portion “Start LON” (shown at Post 3)</td>
</tr>
<tr>
<td>Runout Length, L_R (Ft.)</td>
<td>taken from the AASHTO RDG, Table 5-10(b), based on Design Speed (mph) and Traffic Volume (AADT)</td>
</tr>
</tbody>
</table>
**Length of Need**

**Quick Example:**

Design Speed = 45 mph  
AADT = 5000 veh/day  

Y = 8.5 Ft. (by design, guardrail offset plus flare effect)  
Back of Hazard = 22 Ft. (from ‘Edge of Traffic Lane’)  
Clear Zone = 24 Ft. (from PPM Table 4.2.1)  
Lateral Area Concern, $L_A = 22$ Ft.  
Runout Length, $L_R = 160$ Ft. (from RDG Table 5-10b)

$$X = \frac{L_A - Y}{L_A/L_R} = (22-8.5) / (22/160)$$

$$X = 98.2 \text{ Ft.}$$
Length of Need, Quick Example:

Notice that \( L_g \), the “Length of Gating”, was ignored in the previous Calculation. This is the “break away” stuff, so we only count the “non-gating” re-directive segment for Length of Need. We’ll talk more about this in Part C.

Also, we’ll see more Length of Need Design Examples when we discuss the “Length of Need Design” Tool... Stay tuned!
"An End Treatment segment is required for all guardrail ends where the guardrail does not transition into another barrier type (e.g. Approach or Trailing End Transition Connections to Rigid Barrier). End Treatments are divided into three types."

**End Treatment Types:**

1. Trailing Anchorages
2. Approach Terminals
   i. Flared
   ii. Parallel
   iii. Double Faced
3. Crash Cushions
End Treatments – 1. Trailing Anchorage:

“Place a Trailing Anchorage (Type II) on the downstream ends of all guardrail runs with respect to the nearest traffic lane, except where the location is within the Clear Zone of an opposing traffic lane.”

Index 400, Sheet 9 ➡ Good Ole’ Type II!!
“Place an Approach Terminal on the approach ends of all guardrail runs, for all locations within the Clear Zone of an adjacent traffic lane.”
1. **Flared**: Use where raised curbs are not present and lateral clearance is available. This is the preferred option, because it provides shortest Length of Need requirement for shielding hazards and reduces driver propensity to shy away from the End Treatment under normal conditions.
End Treatments – 2. Approach Terminal:

2. Parallel: Use for curbed conditions or where lateral clearance behind the End Treatment is limited.
End Treatments – 2. Approach Terminal:

3. Double Faced: Use with Double Faced Guardrail segments. As an alternative, a Crash Cushion may be substituted for a Double Faced Approach Terminal.
End Treatments – 2. Approach Terminal:

Predefined Length Concept:
Standard Length of End Treatment, ‘LE’

‘LE’ = 53’-1½” for TL-3, and ‘LE’ = 40’-1½” for TL-2
Use when possible. These lengths allow all APL Approach Terminals to fit on the Project (contractor’s choice).

Allow for at least this much length in the Plans, measured from Post (1)
This length should not overlap with other design segments, like Approach Transitions ‘LA’ or trailing anchorages ‘LT’.
End Treatments – 2. Approach Terminal:

Design Length Concept:
Only when Standard ‘LE’ won’t fit, look to APL drawings for shortest ‘Design Length’:

TL-3 Example:

In the Plans, allow for ‘Design Length’ plus midspan panel lap splice.
In this example, provide 37’-6” plus 3’-1½” = 40’-7½” outside of other segments.

Add ‘Design Length’ notes to the Roadway Plan callout and Summary of Guardrail per the IDS (e.g. "Design Length ≤ 37.5 Ft., See Summary of Guardrail Note").
End Treatments – 2. Approach Terminal:

Gating Terminal Concept for ‘LON’ Design:

Most Approach Terminals have break-away “gating” between posts 1 and 3:

⇒ Gating Terminals typically require 12’-6” between Post (1) and the start of the Length of Need, X, measurement (See “Departure Line”)
End Treatments – 2. Approach Terminal:

Non-Gating Terminal Concept for ‘LON’ Design:

Non-Gating Terminals save space by
Starting the Length of Need Measurement at Post (1):

Only specify a Non-Gating Terminal in the Plans where this space savings is required to fit. In the Roadway Plan view, specify "Non-Gating" preceding the Approach Terminal callout. Additionally, add a Summary of Guardrail note per the IDS.
End Treatments – 3. Crash Cushions:

Crash Cushions May be Used for Doubled Faced Guardrail End Treatments

From the IDS:
“Where applicable, use a Crash Cushion on the approach ends of double faced guardrail as a substitute for Double Faced Approach Terminals. Crash Cushion use should be considered for locations with an expected high frequency of severe impacts, such as within the gore area of a high speed facility. Additionally, some Crash Cushions may offer reduced length and maintenance cost advantages.”

So, use engineering judgement...
or ask Derwood!
Approach Transition Connections to Rigid Barrier:

- Use to connect guardrail to Rigid Barriers (Concrete Barriers and Traffic Railings)
- In the Plans, provide for at least the lengths, ‘LA’, shown per Test Level (value shown from Rigid Barrier, for value from Begin Guardrail, add 7¼”)
Pipe Rail:

Pipe Rail segments are required where Steel Posts will be located within 4’ of sidewalks or shared use paths. Designers should generally assume steel posts are used and include pipe rail callouts and quantities in the Plans (to give contractor steel or timber post option).

Pipe Rail must terminate outside of End Treatment segments (At least 3'-1½" outside of 'LE', 'LT', and/or Crash Cushion segments).

Begin/End Pipe Rail Station corresponds to the Plans callouts.

Measure length along the centerline, including curvature effects. Include in the Summary of Guardrail Box (See the BOE Manual, CH 8).
Rub Rail:

Remember:

• Use Rub rail only for median slopes greater than 1:10

• Place Rub Rail outside of End Treatment Segments (Approach Terminal ‘LE’, Trailing Anchorage ‘LT’) and Crash Cushion Transition segments.

Rub Rail Callouts and Length Example:

Measure length along the centerline, including curvature effects. Include in the Summary of Guardrail Box (See the BOE Manual, CH 8)
Deep Posts:

Remember:

• “With approval of the District Design Engineer and where right-of-way is restricted (i.e. constrained condition), Deep Posts may be used with the slope break located at the post centerline as defined per the Slope Break Condition in the Index.”

• Deep Posts are only permitted for segments with a post spacing of 6'-3" or less.

Deep Post Callouts Example:

To determine the quantity (EA.) of Deep Posts, divide the length needed by the post spacing (6.25 Ft.) and add one. Place quantity in the Summary of Guardrail Box under Special Guardrail Posts (Deep Posts) See the BOE Manual, CH 8 for details.
Modified Mounts – Special Posts:

1. Special Steel Post (with Base Plate) for Concrete Structure Mount

2. Encased Post for Shallow Mount (over underground utilities)

3. Frangible Leave-Out for Concrete Surface (sidewalks)

The designer can estimate where these posts will be in the Plans to include in the Summary of Guardrail Box and Summary of Pay Items And/Or...

The contractor will use unforeseen items as-needed (billed beyond Plans quantity)
## Special Posts:

### Special Post Callouts and Length Example:

- **Begin Frangible Leave-Outs**
  - STA: 101+00.0
  - Length: 22.0 LT.

- **End Frangible Leave-Outs**
  - STA: 101+37.5
  - Length: 22.0 LT.

- **Encased Post**
  - STA: 101+56.3
  - Length: 22.0 LT.

- **Special Steel Post**
  - STA: 102+01.0
  - Length: 22.0 LT.

- **End GR., TL-3 Flared Terminal**
  - STA: 103+87.5
  - Length: 26.00' LT.

### Summary Box Example:

#### SUMMARY OF GUARDRAIL

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SIDE</th>
<th>SPECIAL GUARDRAIL POST (DEEP POST)</th>
<th>SPECIAL GUARDRAIL POST (SPECIAL STEEL POST)</th>
<th>SPECIAL GUARDRAIL POST (ENCASED POST)</th>
<th>SPECIAL GUARDRAIL POST (FRANGIBLE LEAVE-OUT)</th>
<th>END TREATMENT (FLARED)</th>
<th>DESIGN NOTES</th>
<th>CONSTRUCTION REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STA. TO STA.</td>
<td></td>
<td>0536 7 1</td>
<td>0536 7 2</td>
<td>0536 7 3</td>
<td>0536 7 4</td>
<td>0536 85 22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100+00.0</td>
<td>LT</td>
<td>10</td>
<td><strong>E</strong></td>
<td><strong>E</strong></td>
<td><strong>E</strong></td>
<td><strong>E</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>101+07.0</td>
<td></td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100+37.5</td>
<td>LT</td>
<td>10</td>
<td><strong>E</strong></td>
<td><strong>E</strong></td>
<td><strong>E</strong></td>
<td><strong>E</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>101+37.5</td>
<td></td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101+56.3</td>
<td>LT</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>102+01.0</td>
<td></td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>103+87.5</td>
<td>LT</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Guardrail Taper Rate:

Call out a guardrail taper whenever a change in lateral offset from the CL is warranted.

Taper Rates are:

- Design Speed ≤ 45 MPH = Max. 1:10
- Design Speed > 45 MPH = Max. 1:15

Taper Rates may be refined further per AASHTO RDG

The Station and Offset at the Begin and End of Taper define the linear taper rate for the contractor.

Guardrail Taper Callout Example:

TAPER TO DIFFERING GUARDRAIL OFFSET EXAMPLE:
(Where General or Low-Speed guardrail run has a different offset from the Approach Transition Connection)
** Median Crossover Guardrail (Double Faced): 

Use when all of the following conditions are met:

1. The end of an opposing lane's concrete Rigid Barrier is within the Clear Zone, aligned laterally across the median (typical with a bridge configuration).

2. The guardrail system is within the Clear Zone of the opposing lane's traffic.

3. The guardrail system, including the End Treatment, will be designed for the minimum length.
Median Crossover Guardrail (Double Faced):

- “This Crossover Guardrail layout includes a taper segment, which reduces the Length of Need required for shielding the opposing lane's concrete railing while also using Double Faced Guardrail to shield the opposing lane's traffic.”

- In the Plans, call out the Begin/End Double Faced Guardrail Stations and Offsets as well as the Begin/End Taper Station and Offsets where shown above.

- For quantities, the entire length of guardrail shown above is considered “Double-Faced”

- In the Plans, graphically show the double faced guardrail panels as well extending to the point shown above.
Median Crossover Guardrail (Double Faced):

- The FDOT ‘Guardrail Length of Need’ Excel Program will assist with providing these Station and Offsets above. We will use in the next session...
**Reduced Post Spacing Segments**

**Remember:**
- When a rigid hazard is within 5’-0” of the face of guardrail, reduced post spacing may be used to reduce the “Setback” requirement to the hazard (see PPM Table 4.4.2)
- In the Plans, the designer should call out the reduced post spacing as required
- This is included in the price of Guardrail, so there is no need to place in Summary Boxes

**Reduced Post Spacing Callout Example:**

<table>
<thead>
<tr>
<th>Begin Quarter Spacing</th>
<th>End Quarter Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>100+00</td>
<td>100+57</td>
</tr>
<tr>
<td>22.0 LT.</td>
<td>End GR., TL-3 Flared Terminal 103+87.5 26.00' LT.</td>
</tr>
</tbody>
</table>

**DETAIL ‘S’ - QUARTER SPACING ELEVATION (AS REQ’D. PER THE PLANS)**
Additional Offset Blocks

• The designer may call out up to two additional offset blocks where needed to avoid a ground level obstructions (non-consecutive preferred)

• The contractor may also use additional offset blocks as-needed (billed beyond the Plans quantity)

• The Standard handles adjusting the miscellaneous asphalt concrete to keep it at 10” behind the post (slope break point is measured form back of post as well)
Additional Offset Blocks

**IMPORTANT:** When adding additional offset blocks, the required “Setback” to a Hazard per PPM Table 4.4.2 must be increased by 7.5” per added Offset Block.

- For Example, if **two Offset Blocks are added** to W-Beam Guardrail @ 1'-6¾” Post Spacing, then the required “Setback” (measured from the Face of Guardrail) is...

  - Adjusted Setback = (3’-2”) + (7.5” + 7.5”) = 4’-5”

From PPM: Table 4.4.2 Minimum Barrier Setback:

<table>
<thead>
<tr>
<th>Semi-Rigid Barrier</th>
<th>Minimum Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-Beam with Post Spacing @ 6'-3” (TL-3)</td>
<td>5’-0”</td>
</tr>
<tr>
<td>W-Beam with Post Spacing @ 3’-1½” (½ Spacing)</td>
<td>3’-10”</td>
</tr>
<tr>
<td>W-Beam with Post Spacing @ 1’-6¾” (¼ Spacing)</td>
<td>3’-2”</td>
</tr>
<tr>
<td>Nested W-Beams with Post Spacing @ 3’-1½” (½ Spacing)</td>
<td>3’-0”</td>
</tr>
<tr>
<td>Nested W-Beams with Post Spacing @ 1’-6¾” (¼ Spacing)</td>
<td>2’-8”</td>
</tr>
<tr>
<td>Modified Thrie-Beam with Post Spacing @ 6'-3”</td>
<td>3’-0”</td>
</tr>
</tbody>
</table>
CRT Segments:
Remember...

- In the Plan view, call out the CRT segment station and offset (corresponding to Index callout). No need to place in summary box.
- In the Plan view, call out the Guardrail Begin/End Station at Post (1) of the CRT End Treatment (unless there’s a transition to existing guardrail). The callout for CRT End Treatment would be included here too.
- Min. Clear Area - Maintain 1:10 Slope to 2’ behind the posts. Beyond that, maintain an area clear of hazards with a 1:2 or flatter slope.
**Slope Guards:**

- Call out in Plan view
- Add to Summary of Guardrail Box as an entry to Guardrail W-Beam, General, TL-3 (Or Low-Speed, TL-2 if you happen to be using that instead nearby).
General: “same ‘ole same ‘ole”: Show the guardrail system to scale, including the depiction of the post, offset block, and panel type in its design location.

Typical Sections: Design and label the 'Lateral Offset' from the Face of Curb or Edge of Traffic Lane as it corresponds to the Guardrail Sections sheet in the Index. (PPM CH2.3 “Shoulders” & 4.4.6.1 “Barrier Offset”)

Cross Sections & Typical Sections: Meet the offset requirements of the PPM and the adjacent grading requirements as shown in the Index.
Roadway Plan: Label the Station and Offset (From the Station Reference, Centerline or Baseline) for the Face of Guardrail at the locations with corresponding Begin/End Stations shown in the Index, including the following:

1. **Begin/End GR. Stations** label the limits of the guardrail length measurement, generally located at centerline of Post (1) in End Treatments and/or at the Terminal Connector splice of an Approach Transition Connection segment. See the Index layouts for details.

   If Low-Speed (TL-2) guardrail is required, change this label to "Begin/End TL-2 GR." Instructions for Design Standards Topic No. 625-010-003 Index 400 Guardrail February 2016

2. **Begin/End Taper Stations** label the offset Face of Guardrail locations for the start and end of linear tapers (e.g. for a change in typical section or for a Crossover Taper segment). The Guardrail Taper Rate requirements above will govern these transitions.

3. **Begin/End CRT(8, 16, 24, or 32) Ft. R. Station** labels the starting point for the Controlled Release Terminal (CRT) System and the radius, 'R'.

4. **Begin/End Pipe Rail Stations** label the limits of Pipe Rail length measurement, generally located at centerline of the Terminal Posts.

5. **Begin/End Rub Rail Stations** label the limits of Rub Rail length measurement, generally located at centerline of the Terminal Posts. NOTE: This is not depicted in the Index.

   For Double Face Guardrail, place labels pointing to Face of Guardrail on the side requiring the Rub Rail. If Rub Rail is required on both sides, use a different label on each side or add "(Both Sides)" to the callout.

6. **Begin/End Half Sp. Stations** label the limits of Reduced Post Spacing at 3'-1½". The overall length of this segment must be a multiple of 6'-3".

7. **Begin/End Quarter Sp. Stations** label the limits of Reduced Post Spacing at 1'-6¾". The overall length of this segment must be a multiple of 6'-3".
Roadway Plan:

Label the Station and Offset at the Face of Guardrail for the following guardrail end features:

1. TL-2 Flared Terminal
2. TL-2 Parallel Terminal
3. TL-2 Dbl. Faced Terminal
4. TL-3 Flared Terminal
5. TL-3 Parallel Terminal
6. TL-3 Dbl. Faced Terminal
7. TL-3 C.C.
8. TL-4 C.C.
9. Type II Anchorage
10. CRT End Treatment
12. TL-3 Apprh. Trans.

NOTE: The above labels may be included with the Begin/End Guardrail Station callouts.

...Label conventions straight from IDS
...We’ve seen these
...More examples to come...
Roadway Plan:

Label the Station and Offset at the Face of Guardrail for the following miscellaneous guardrail features:

1. Encased Post
2. Special Steel Post
3. Frangible Leave-Out
4. Deep Post
5. Two Offset Blocks
6. Three Offset Blocks
7. GR. Slope Guard.

...Label conventions straight from IDS
...We’ve seen these
...More examples to come...
Summary of Guardrail Table:

Include Pay Items from the FDOT Design Quantities and Estimates System (DQE), the Basis of Estimates Manual (BOE), and Specifications Section 536.

- See the BOE, Chapter 8, for more information on Summary Boxes

- The Department's CADD tools, including the Design and Computation Manager and Data Link Manager, may be used to assist in populating the table...

See the Engineering / CADD Systems Office website for training in the use of Summary Boxes (at left) [http://www.dot.state.fl.us/ecso/downloads/webinars/Posted.shtm#loadSection](http://www.dot.state.fl.us/ecso/downloads/webinars/Posted.shtm#loadSection)
Guardrail Length Measurement Example:

- Include End Treatment lengths added as the basic connecting guardrail type, such as General or Low-Speed Guardrail.
- End Treatment Pay Items consider costs as over-and-above basic guardrail.

---

**SUMMARY OF GUARDRAIL**

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SIDE</th>
<th>GUARDRAIL (W-BEAM, GENERAL, TL-3)</th>
<th>END TREATMENT (FLARED)</th>
<th>DESIGN NOTES</th>
<th>CONSTRUCTION REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>STA. TO STA.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99+00.0</td>
<td>LT.</td>
<td>0536 1 1</td>
<td>0536 85 22</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>100+87.5</td>
<td>LT.</td>
<td>187.5</td>
<td></td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>99+00.0</td>
<td>LT.</td>
<td>1</td>
<td>4' Flare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100+87.5</td>
<td>LT.</td>
<td>1</td>
<td>4' Flare</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Guardrail Length Measurement Examples:

• Include End Treatment and Approach Transition lengths added as the basic connecting guardrail type, such as General or Low-Speed Guardrail.

• End Treatment and Approach Transition Pay Items consider costs as over-and-above basic guardrail.

• What’s the length of Guardrail? (approx., assuming linear)

  1000 Ft.

• What’s the Station for the Approach Transition?

  100+00

• What’s the Station and Flare of the End Treatment?

  110+00, 4 foot flare
Guardrail Length Measurement Examples:

- What’s the linear feet of Guardrail?
  (Pythagorean theorem, anyone?)
  \[ 21.9 + \sqrt{6^2 + 87.3^2} + 28.1 = 137.5 \]

- What type of guardrail is this measured length?
  **Double Faced**

- What Station is the Approach Transition called out at?
  **99+00**

- Include C.C. “Guardrail Transition” length per Index 430 (to Post 1) and Approach Transition length added as the basic connecting guardrail type, such as General or Low-Speed Guardrail

- Approach Transitions consider costs as over-and-above basic guardrail

- The reduced post spacing for the C.C. “Guardrail Transition” segment is included in the cost of Guardrail.
Guardrail Length Measurement Examples:

- This is an Approach Transition plus an Approach Terminal Only...
- What type of guardrail is this measured length?
  - **Single Faced – W-Beam**
- How did we come up with this guardrail length?...
  (Next Page)

This is the shortest possible guardrail length per the Design Standard (without using APL Design Lengths)
Guardrail Length Measurement Examples:

- What’s the shortest length of TL-3 Guardrail needed to shield a Rigid Barrier End?

\[ LA + 7\frac{1}{2}'' + LE = 84.3' \]
Taper to Different Guardrail Offset Example:

- What is the likely offset difference between the shoulder line and the Face of Guardrail?
  
  **2 feet per PPM**

- What is the approximate Taper Rate shown here?
  
  **1:15**

- Using the Design Standard drawing for approach transitions, where did this Taper shown begin? (See Next Page)...
**Taper to Different Guardrail Offset Example:**

PPM Figure 4.4.12:
Guardrail Face in relation to Shoulder Line....

Where does Taper to Guardrail Offset above begin?

(about 28.1 feet from Begin/End Guardrail Sta. using Elevation View... or just add standard panel lengths)
Miscellaneous Guardrail Layout Examples (from IDS):

TYPICAL HAZARD SHIELDING EXAMPLE:
ROADSIDE AND MEDIAN
('LON' Program Part 'A')
Miscellaneous Guardrail Layout Examples (from IDS):

TYPICAL HAZARD SHIELDING EXAMPLE:
2-LANE, 2-WAY ROAD; HAZARD WITHIN OPPOSING LANE CLEAR ZONE
('LON' Program Parts 'A' & 'B')
Bridge Railing Shielding Example:
Opposing Lane's Concrete Railing Outside of Clear Zone
**Miscellaneous Guardrail Layout Examples (from IDS):**

**BRIDGE RAILING SHIELDING EXAMPLE:**
'CROSSOVER GUARDRAIL'; OPPOSING LANE'S CONCRETE RAILING WITHIN CLEAR ZONE
('LON' Program Part 'C' or 'D')
BRIDGE RAILING SHIELDING EXAMPLE:
2-WAY, 2-LANE ROAD; CONCRETE RAILING
WITHIN OPPOSING LANES' CLEAR ZONE
(Min. Length Guardrail Shown)
BEGIN MODULE 4: ‘LON’ Program

GUARDRAIL LENGTH OF NEED v1.0 - ROADSIDE HAZARD SHIELDING:

PART A: LENGTH OF NEED FOR NEAR LANE

[Diagram showing various components of guardrail length calculations, including Lh, Lr, X, and other relevant measurements and annotations.]
### Design Standards Revisions FY 2016-17

**Office of Design**

- **Where is it?...**

**n/a = Non Applicable**  
**n/c = No Change**

<table>
<thead>
<tr>
<th>Index</th>
<th>Revised Sheets</th>
<th>Index Title</th>
<th>Design Information</th>
<th>Data Table Library</th>
<th>Borderless DGNs</th>
<th>Associated Design Bulletin</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>1-22 of 22</td>
<td>Guardrail</td>
<td>IDS-00400</td>
<td>(PDF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>410</td>
<td>2,10, 16-18 of 25</td>
<td>Concrete Barrier Wall</td>
<td>N/A</td>
<td>(PDF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>411</td>
<td>6 of 10</td>
<td>Pier Protection Barrier</td>
<td>N/C</td>
<td>(ZIP) Terms of Use</td>
<td></td>
<td>RDB16-01</td>
</tr>
</tbody>
</table>
### “Part A” Drawing:

![Diagram of guardrail length calculation](image)

<table>
<thead>
<tr>
<th>Input:</th>
<th>Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction of Near Lane Traffic</td>
<td>for relative stationing calculations</td>
</tr>
<tr>
<td>AADT (Vehicles Per Day)</td>
<td></td>
</tr>
<tr>
<td>Design Speed (MPH)</td>
<td></td>
</tr>
<tr>
<td>Approach Face of Hazard Station</td>
<td>enter as total feet (do not input a plus sign)</td>
</tr>
<tr>
<td>Length of Hazard, L&lt;sub&gt;H&lt;/sub&gt; (Ft.)</td>
<td></td>
</tr>
<tr>
<td>Lateral Area Concern, L&lt;sub&gt;A&lt;/sub&gt; (Ft.)</td>
<td>the lesser distance from the 'Edge of Traffic Lane' to the 'Clear Zone Limit' or 'Back of Hazard'</td>
</tr>
<tr>
<td>Lateral Offset of Guardrail, L&lt;sub&gt;O&lt;/sub&gt; (Ft.)</td>
<td>the typical guardrail offset from the 'Edge of Traffic Lane,' near the 'Hazard' location (outside of flare)</td>
</tr>
</tbody>
</table>
| Length of Gating, L<sub>G</sub> (Ft.) | "Gating" Terminals typically have a 'Start LON' at Post 3 or Post 4, per the APL Drawings. For "Non-Gating" Terminals, the 'Start LON' is at 'Post 1' (L<sub>G</sub> = 0).  
NOTE: The flare rate effect on L<sub>G</sub>, assumed parallel to the roadway, is negligible and may be omitted. |
| Terminal Flare @ Post(1) (Ft.)  | 4 Ft. Max. per Index 400 detail, measured offset at Post(1); enter zero for "Parallel" Terminals |
| Flare Taper Length (Ft.)       | default value is acceptable at 35'-0", but this may be refined per specific APL drawing (Input used to calculate 'Y') |
Part A – Example:

**Given:**
Design Speed = 55 mph
AADT = 5000 veh/day
Clear Zone = 30 feet
(PPM Table 4.2.1)
Flare = 4 feet
Terminal Type = Gating

**TYPICAL HAZARD SHIELDING EXAMPLE:**
2-LANE, 2-WAY ROAD;
('LON' Program Part 'A')

**Program Inputs:**
- Direction Traffic = **WB**
- Length of Hazard, \( L_H = 35 \) feet
- Lateral Area of Concern, \( L_A = 26 \) feet
- Approach Face of Hazard Sta. = **100+00**
- Original Guardrail Offset, \( L_0 = 10 \) feet
- Length of Gating, \( L_G = 12.5 \) feet
- Flare@Post 1 = **4**

**Program Outputs:**
- \( Y = 12.6 \)
- Runout Length, \( L_R = 220 \)
- Length of Need, \( X = 113.6 \)
- Unadjusted Begin/End GR. Sta. = **101+26.1**

*Type II Trailing Anchorage Applicable? Why?*
PART B Required? (User Input Needed)

Y/N (Toggle)

Is this a 2-lane, 2-way road with the Hazard in the Far Lane's Clear Zone limit? If "No" Part B will be excluded from the placement calculation output below.

Lateral Area Concern, $L_A$ (Ft.)

the lesser distance from the 'Edge of Traffic Lane' (Far Lane) to the 'Clear Zone Limit' or 'Back of Hazard'

Lateral Offset of Guardrail, $L_O$ (Ft.)

the typical guardrail offset from the 'Edge of Traffic Lane' (Far Lane), near the 'Hazard' location (outside of flare)

Length of Gating, $L_G$ (Ft.)

per the APL Drawings, "Gating" Terminals typically have a 'Start LON' at Post 3 or Post 4. For "Non-Gating" Terminals, the Start LON is at 'Post 1' ($L_G = 0$). NOTE: The flare rate effect on $L_G$, assumed parallel to the roadway, is negligible and may be omitted.

Terminal Flare @ Post(1) (Ft.)

4 Ft. Max. per Index 400 detail; measured to Post(1); enter zero for 'Parallel' Terminals

Flare Taper Length (Ft.)

default value is acceptable at 35'-0", but this may be refined per specific APL drawing (Input used to calculate 'Y')
Part B – Example (Far Lane):

Given:
Design Speed = 55 mph
AADT = 5000 veh/day
Clear Zone = 30 feet
(TPM Table 4.2.1)
Flare = 0 feet (for example)
Terminal Type = Gating

TYPICAL HAZARD SHIELDING EXAMPLE:
2-LANE, 2-WAY ROAD; HAZARD WITHIN
OPPOSING LANE CLEAR ZONE
('LON' Program Parts 'A' & 'B')

Program Inputs:
Part B Required? = (Y / N) Toggle
Lateral Area of Concern, \( L_A \) = 30
Original Guardrail Offset, \( L_0 \) = 22
Length of Gating, \( L_G \) = 12.5
Flare@Post 1 = 0

Program Outputs:
\( Y = 22 \)
Face of Hazard (Far Lane) Sta. = 99+65
Runout Length, \( L_R \) = 220
Length of Need, \( X \) = 58.7
Unadjusted Begin/End GR. Stat. = 98+93.8
**Part A & B – Result Summary**

TYPICAL HAZARD SHIELDING EXAMPLE:
2-LANE, 2-WAY ROAD; HAZARD WITHIN
OPPOSING LANE CLEAR ZONE
(‘LON’ Program Parts ‘A’ & ‘B’)

### DESIGN OUTPUT SUMMARY: GUARDRAIL ROADSIDE HAZARD SHIELDING

<table>
<thead>
<tr>
<th>Limit:</th>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Begin/End Guardrail Sta. @ PRIMARY Approach Terminal (From Part A)</td>
<td>≥</td>
</tr>
<tr>
<td>Guardrail Offset from Nearest Edge of Traffic Lane (Ft.)</td>
<td>14.0</td>
</tr>
<tr>
<td>Adjusted Begin/End Guardrail Sta. @ Trailing Anchorage (Type II) (From Part A, If Applicable)</td>
<td>-</td>
</tr>
<tr>
<td>Guardrail Offset from Nearest Edge of Traffic Lane (Ft.)</td>
<td>N.A.</td>
</tr>
<tr>
<td>Adjusted Begin/End Guardrail Sta. @ SECONDARY Approach Terminal (From Part B, If Applicable)</td>
<td>≤</td>
</tr>
<tr>
<td>Guardrail Offset from Nearest Edge of Traffic Lane (Ft.)</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Outputs assume linear stationing:
To adjust for curvature, lengthen the guardrail with the Begin/End Guardrail stations placed outside of the stationing limits shown here. Use CADD measurement to bring the final guardrail length to a multiple of 6’-3” panels.
**Guardrail Length of Need v1.0**

**“Part D”**

**Drawing:**

<table>
<thead>
<tr>
<th>Input:</th>
<th>Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction of Near Lane Traffic</td>
<td>for relative stationing calculations</td>
</tr>
<tr>
<td>AADT (Vehicles Per Day)</td>
<td></td>
</tr>
<tr>
<td>Design Speed (MPH)</td>
<td></td>
</tr>
<tr>
<td>Begin/End Rigid Barrier Sta. (@ guardrail connecting location)</td>
<td>enter as total feet (do not input a plus sign); located at the end of the 'Rigid Barrier' (not the Begin/End Guardrail Sta.)</td>
</tr>
<tr>
<td>Lateral Offset of Guardrail, ( L_O ) (Ft.)</td>
<td>the starting guardrail offset from the 'Edge of Near Traffic Lane' at the location where the guardrail connects to the 'Rigid Barrier' (determined by the designer)</td>
</tr>
<tr>
<td>Lateral Area Concern, ( L_A ) (Ft.)</td>
<td>the lateral distance from the 'Edge of Near Traffic Lane' to the far edge of the opposing 'Rigid Barrier' (i.e. Concrete Traffic Railing) across the median</td>
</tr>
<tr>
<td>Parallel Approach Trans. Length, ( L_{PI} ) (Ft.)</td>
<td>the length of the guardrail Approach Transition Connection prior to the start of the taper; per Index 400 options, TL-3=27.5 Ft. and TL-2=18.2 Ft. Note: This is measured from the end of the ‘Rigid Barrier’ (not the ‘Begin/End Guardrail Sta.’)</td>
</tr>
<tr>
<td>Parallel Approach Terminal Length, ( L_{P2} ) (Ft.)</td>
<td>the length of the parallel segment required for the Approach Terminal, just beyond the taper; Per Index 400, TL-3 = 56.3 Ft.</td>
</tr>
<tr>
<td>Length of Gating, ( L_G ) (Ft.)</td>
<td>“Gating” Terminals typically have a ‘Start LON’ at Post 3 or Post 4, per the APL Drawings. For “Non-Gating” Terminals, the ‘Start LON’ is at ‘Post 1’ (( L_G =0 )).</td>
</tr>
<tr>
<td>Taper Rate of Crossover, 1:TR (Ft.)</td>
<td>the linear taper rate for the Median Crossover Segment; 1:10 for Design Speeds ≤ 45 MPH and 1:15 for Design Speeds &gt; 45 MPH.</td>
</tr>
<tr>
<td>Rigid Barrier Skew, ( S ) (Ft.)</td>
<td>the longitudinal “skew” distance between the guardrail’s connecting Rigid Barrier end and the “Hazard” Rigid Barrier end (across the median). For the direction opposite the drawing dimension, use a negative value.</td>
</tr>
</tbody>
</table>
**Part D – Example - Median Crossover with Terminal:**

**Given:**
- Design Speed = 65 mph
- AADT = 10,000 veh/day
- Clear Zone = 36 feet
- Terminal Type = Gating

**BRIDGE RAILING SHIELDING EXAMPLE:**
*CROSSOVER GUARDRAIL*; *OPPOSING LANE'S CONCRETE RAILING WITHIN CLEAR ZONE* ('LON' Program Part 'D')

**Program Inputs:**
- Direction Traffic = **WB**
- AADT = **10,000**
- Rigid Barrier Sta. = **100+00.6**
- Original Offset, **L_o** = **10**
- Lateral Area of Concern, **L_A** = **32**
- Parallel Length1, **L_p1** = **27.5**
- Parallel Length 2, **L_p2** = **56.3**
- Length of Gating, **L_g** = **12.5**
- Taper Rate, **TR** = **15**
- Bridge Skew, **S** = **8**
Part D – Example - Median Crossover with Terminal:

Given:
Design Speed = 65 mph
AADT = 10,000 veh/day
Clear Zone = 36 feet
(TPM Table 4.2.1)
Terminal Type = Gating

PART D: OUTPUT SUMMARY:

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Stationing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>End Treatment Offset, Y (ft.)</td>
<td>0.0</td>
</tr>
<tr>
<td>2.</td>
<td>Runout Length, L (ft.)</td>
<td>330</td>
</tr>
<tr>
<td>3.</td>
<td>Length of Need, X (ft.)</td>
<td>171.0</td>
</tr>
<tr>
<td>4.</td>
<td>Begin/End Guardrail Sta.</td>
<td>100.00</td>
</tr>
<tr>
<td>5.</td>
<td>@ Connection to Rigid Barrier</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Offset from Edge of Near Traffic Lane (ft.)</td>
<td>10.0</td>
</tr>
<tr>
<td>7.</td>
<td>Begin/End Taper Sta.</td>
<td>100.281</td>
</tr>
<tr>
<td>8.</td>
<td>Offset from Edge of Near Traffic Lane (ft.)</td>
<td>10.0</td>
</tr>
<tr>
<td>10.</td>
<td>Offset from Edge of Near Traffic Lane (ft.)</td>
<td>16.7</td>
</tr>
<tr>
<td>11.</td>
<td>Begin/End Guardrail Sta.</td>
<td>101.841</td>
</tr>
<tr>
<td>12.</td>
<td>@ Post (1)</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Offset from Edge of Near Traffic Lane (ft.)</td>
<td>16.7</td>
</tr>
</tbody>
</table>

The outputs assume stationing is linear and are adjusted to bring tapered segment panel lengths to a multiple of 6'-3".

The stations provided here may be used directly in the Plans, assuming that roadway curvature does not cause a discrepancy of more than 3'-0" between the these output stations and the actual guardrail panel slot/post locations (Tolerance per Specification Section 536).

If adjustments for curvature are required to bring the stationing closer to the actual panel slot and post locations, use L_{x1} and L_{x2}, adjusted for curvature, and add additional length to the taper segment as needed.
For all future FDOT Roadway Design Training, sign up to receive notification e-mails at...

http://www.dot.state.fl.us/projectmanagement
office/ContactDatabase.shtm

(Google “FDOT Contact Mailer”)

Production Support

The Contact Management System/E-Updates is a "self service" area where FDOT, Consultants and others can register for information pertinent to their jobs. This replaces several smaller contact databases that are maintained by individual offices. User-ids are the email address one registers with and the passwords are set by the individuals when registering. The passwords never expire.
THANK YOU!

QUESTIONS?

For more information:
richard.stepp@dot.state.fl.us
derwood.sheppard@dot.state.fl.us
GUARDRAIL LENGTH OF NEED v1.0 –

“Paper Program”

FDOT Guardrail Training Supplement
**GUARDRAIL LENGTH OF NEED v1.0 - ROADSIDE HAZARD SHIELDING:**

### PART A: LENGTH OF NEED FOR NEAR LANE

![Diagram of guardrail length of need](image)

<table>
<thead>
<tr>
<th>Input:</th>
<th>Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction of Near Lane Traffic</td>
<td>Westbound</td>
</tr>
<tr>
<td>AADT (Vehicles Per Day)</td>
<td></td>
</tr>
<tr>
<td>Design Speed (MPH)</td>
<td></td>
</tr>
<tr>
<td>Approach Face of Hazard Station</td>
<td>enter as total feet (do not input a plus sign)</td>
</tr>
<tr>
<td>Length of Hazard, (L_H) (Ft.)</td>
<td></td>
</tr>
<tr>
<td>Lateral Area Concern, (L_A) (Ft.)</td>
<td>the lesser distance from the 'Edge of Traffic Lane' to the 'Clear Zone Limit' or 'Back of Hazard'</td>
</tr>
<tr>
<td>Lateral Offset of Guardrail, (L_G) (Ft.)</td>
<td>the typical guardrail offset from the 'Edge of Traffic Lane,' near the 'Hazard' location (outside of flare)</td>
</tr>
<tr>
<td>Length of Gating, (L_G) (Ft.)</td>
<td>12.5</td>
</tr>
<tr>
<td>Terminal Flare @ Post(1) (Ft.)</td>
<td>4</td>
</tr>
<tr>
<td>Flare's Taper Length (Ft.)</td>
<td>35</td>
</tr>
</tbody>
</table>

**Output:**

\[
X = \frac{L_A - Y}{L_A / L_R}
\]

AASHTO RDG (5-3)

*NOTE:* If the Trailing Anchorage shown herein is in the Clear Zone of an opposing Traffic Lane, use an Approach Terminal in its place.
PART B: LENGTH OF NEED FOR FAR LANE - OPPOSING DIRECTION (IF APPLICABLE)
('Part A' Extension, If Required For 2-Lane, 2-Way Road with Hazard in Far Lane's Clear Zone)

<table>
<thead>
<tr>
<th>PART B Required? (User Input Needed)</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is this a 2-lane, 2-way road with the Hazard in the Far Lane's Clear Zone limit? If &quot;No&quot; Part B will be excluded from the placement calculation output below.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lateral Area Concern, L_A (ft.)</th>
<th>the lesser distance from the 'Edge of Traffic Lane' (Far Lane) to the 'Clear Zone Limit' or 'Back of Hazard'</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Lateral Offset of Guardrail, L_G (ft.)</th>
<th>the typical guardrail offset from the 'Edge of Traffic Lane' (Far Lane), near the 'Hazard' location (outside of flare)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Length of Gating, L_G (ft.)</th>
<th>12.5 per the APL Drawings, &quot;Gating&quot; Terminals typically have a 'Start LON' at Post 3 or Post 4. For &quot;Non-Gating&quot; Terminals, the Start LON is at 'Post 1' (L_G =0). NOTE: The flare rate effect on L_g, assumed parallel to the roadway, is negligible and may be omitted.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Terminal Flare @ Post(1) (ft.)</th>
<th>4 ft. Max. per Index 400 detail; measured to Post(1); enter zero for 'Parallel' Terminals</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Flare's Taper Length (ft.)</th>
<th>default value is acceptable at 35°-0&quot;, but this may be refined per specific APL drawing (input used to calculate Y)</th>
</tr>
</thead>
</table>

\[ x = \frac{L_A - Y}{L_A/L_G} \]

AASHTO RDG (5-3)

Output:

<table>
<thead>
<tr>
<th>Input:</th>
<th>Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PART B Required? (User Input Needed)</td>
<td>No</td>
</tr>
<tr>
<td>Lateral Area Concern, L_A (ft.)</td>
<td>the lesser distance from the 'Edge of Traffic Lane' (Far Lane) to the 'Clear Zone Limit' or 'Back of Hazard'</td>
</tr>
<tr>
<td>Lateral Offset of Guardrail, L_G (ft.)</td>
<td>the typical guardrail offset from the 'Edge of Traffic Lane' (Far Lane), near the 'Hazard' location (outside of flare)</td>
</tr>
<tr>
<td>Length of Gating, L_G (ft.)</td>
<td>12.5 per the APL Drawings, &quot;Gating&quot; Terminals typically have a 'Start LON' at Post 3 or Post 4. For &quot;Non-Gating&quot; Terminals, the Start LON is at 'Post 1' (L_G =0). NOTE: The flare rate effect on L_g, assumed parallel to the roadway, is negligible and may be omitted.</td>
</tr>
<tr>
<td>Terminal Flare @ Post(1) (ft.)</td>
<td>4 ft. Max. per Index 400 detail; measured to Post(1); enter zero for 'Parallel' Terminals</td>
</tr>
<tr>
<td>Flare's Taper Length (ft.)</td>
<td>default value is acceptable at 35°-0&quot;, but this may be refined per specific APL drawing (input used to calculate Y)</td>
</tr>
</tbody>
</table>

**DESIGN OUTPUT SUMMARY: GUARDRAIL ROADSIDE HAZARD SHIELDING**

**Limit:**

<table>
<thead>
<tr>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Begin/End Guardrail Sta. @ PRIMARY Approach Terminal (From Part A)</td>
</tr>
</tbody>
</table>

Guardrail Offset from Nearest Edge of Traffic Lane (ft.) :

<table>
<thead>
<tr>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Begin/End Guardrail Sta. @ Trailing Anchorage (Type II) (From Part A, If Applicable)</td>
</tr>
</tbody>
</table>

Guardrail Offset from Nearest Edge of Traffic Lane (ft.) :

<table>
<thead>
<tr>
<th>Output:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Begin/End Guardrail Sta. @ SECONDARY Approach Terminal (From Part B, If Applicable)</td>
</tr>
</tbody>
</table>

Guardrail Offset from Nearest Edge of Traffic Lane (ft.) :

**Outputs assume linear stationing:**

To adjust for curvature, lengthen the guardrail with the Begin/End Guardrail stations placed outside of the stationing limits shown here. Use CADD measurement to bring the final guardrail length to a multiple of 6'-3" panels.
PART C: CROSSOVER GUARDRAIL WITH 'CRASH CUSHION' -
SHIELDING CONCRETE RAILING ACROSS MEDIAN (WITHIN CLEAR ZONE)

<table>
<thead>
<tr>
<th>Direction of Near Lane Traffic</th>
<th>Westbound</th>
<th>for relative stationing calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>AADT (Vehicles Per Day)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Speed (MPH)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Begin/End Rigid Barrier Sta.</td>
<td></td>
<td>enter as total feet (do not input a plus sign); located at the end of the 'Rigid Barrier' (not the Begin/End Guardrail Sta.)</td>
</tr>
<tr>
<td>Lateral Offset of Guardrail, L_s (Ft.)</td>
<td>the starting guardrail offset from the 'Edge of Near Traffic Lane' at the location where the guardrail connects to the 'Rigid Barrier' (determined by the designer)</td>
<td></td>
</tr>
<tr>
<td>Lateral Area Concern, L_a (Ft.)</td>
<td>the lateral distance from the 'Edge of Near Traffic Lane' to the far edge of the opposing 'Rigid Barrier' (i.e. Concrete Traffic Railing) across the median</td>
<td></td>
</tr>
<tr>
<td>Parallel Approach Trans. Length, L_pp (Ft.)</td>
<td>the length of the guardrail Approach Transition Connection prior to the start of the taper; per Index 400 options, TL 3=27.5 Ft. and TL 2=18.2 Ft. Note: This is measured from the end of the 'Rigid Barrier' (not the Begin/End Guardrail Sta.)</td>
<td></td>
</tr>
<tr>
<td>Parallel C.C. Segment Length, L_cc (Ft.)</td>
<td>the length of the parallel segment required for Guardrail Transition, just beyond the taper. This is the length between Post (1) and Post (10) per Index 430, 21.9 Ft.</td>
<td></td>
</tr>
<tr>
<td>Design Length of Crash Cushion, L_d (Ft.)</td>
<td>the length between Post (1) and the 'Start LON' (or Departure Line intersection) per the manufacturer's APL Drawing</td>
<td></td>
</tr>
<tr>
<td>Taper Rate of Crossover, 1:TR (Ft.)</td>
<td>the linear taper rate for the Median Crossover Segment; 1:10 for Design Speeds ≤ 45 MPH and 1:15 for Design Speeds &gt; 45 MPH.</td>
<td></td>
</tr>
<tr>
<td>Rigid Barrier Skew, S (Ft.)</td>
<td>the longitudinal &quot;skew&quot; distance between the guardrail's connecting Rigid Barrier end and the 'Hazard' Rigid Barrier end across the median. For the direction opposite the drawing dimension, use a negative value.</td>
<td></td>
</tr>
</tbody>
</table>

PART C: OUTPUT SUMMARY:

| End Treatment Offset, Y (Ft.) | The outputs assume stationing is linear and are adjusted to bring tapered segment panel lengths to a multiple of 6'-3". |
| Runout Length, L_r (Ft.) | The output stations may be used directly in the Plans, assuming that roadway curvature does not cause a discrepancy of more than 3'-0" between the these output stations and the actual guardrail panel slot & post locations (Tolerance per Specification Section 536). |
| Length of Need, X_s (Ft.) | If adjustments for curvature are required to bring the stationing closer to the actual panel slot & post locations, use X_s, L_r, and L_s adjusted for curvature, and add additional length to the taper segment as needed. |
| Begin/End Guardrail Sta. @ Connection to Rigid Barrier |                                     |
| Offset from Edge of Near Traffic Lane (Ft.) |                                     |
| Begin/End Taper Sta. |                                     |
| Offset from Edge of Near Traffic Lane (Ft.) |                                     |
| Begin/End Taper Sta. |                                     |
| Offset from Edge of Near Traffic Lane (Ft.) |                                     |
| Begin/End Guardrail Sta. @ Connection Post (1) |                                     |
| Offset from Edge of Near Traffic Lane (Ft.) |                                     |
GUARDRAIL LENGTH OF NEED v1.01 - BRIDGE CONCRETE RAILING SHIELDING

PART D: Crossover Guardrail with 'Approach Terminal' - Shielding Concrete Railing Across Median (Within Clear Zone)

**Direction of Near Lane Traffic**: Westbound

**AADT (Vehicles Per Day)**

**Design Speed (MPH)**

**Begin/End Rigid Barrier Sta.** (guardrail connecting location)

**Lateral Offset of Guardrail, Lv0 (ft.)**

**Lateral Area Concern, L4 (ft.)**

**Parallel Approach Trans. Length, Lp1 (ft.)**

**Parallel Approach Terminal Length, Lp2 (ft.)**

**Length of Gating, Lg (ft.)**

**Taper Rate of Crossover, 1:TR (ft.)**

**Rigid Barrier Skew, S (ft.)**

**PART D: OUTPUT SUMMARY:**

The outputs assume stationing is linear and are adjusted to bring tapered segment panel lengths to a multiple of 0'-3".

The stations provided here may be used directly in the Plans, assuming that roadway curvature does not cause a discrepancy of more than 3'-0" between the these output stations and the actual guardrail panel slot/post locations (tolerance per Specification Section 536).

If adjustments for curvature are required to bring the stationing closer to the actual panel slot and post locations, use Lp1 and Lp2, adjusted for curvature, and add additional length to the taper segment as needed.
DESIGN TOOL PARTS C or D – How to find variable $L_{p1}$:

From Index 400...
Sheet 13 (Sheet 14 Similar)

**TL-3:** ‘LA’ = 30’-7¾”

$L_{p1} = ‘LA’ – \frac{1}{4} \text{ Panel} =

L_{p1} = (30’-7¾”) – (\frac{1}{4})(12’-6”) =

L_{p1} = 27.5’

**TL-2:** ‘LA’ = 21’-3¼”

$L_{p1} = ‘LA’ – \frac{1}{4} \text{ Panel} =

L_{p1} = (21’-3¼”) – (\frac{1}{4})(12’-6”) =

L_{p1} = 18.2’

Taper Begins Here per Plan View...
**DESIGN TOOL PART C, CRASH CUSHIONS – How to find variables $L_{p2}$ and $L_{d}$:**

From Index 430...

- **“Location Station”** is Begin/End Guardrail length measurement point.
- $L_{p2}$ is the distance between Post(1) and Post(10). The “Taper” Begins at Post (10). $L_{p2} = 21’-10\frac{1}{2}’’$
- $L_{d}$ is the Crash Cushion’s Design Length per the chosen APL Drawing. This is the distance from Post(1) to manufacturer’s Begin Length of Need point (outside of the Guardrail length measurement).
DESIGN TOOL PART C, CRASH CUSHIONS – How to find $L_D$:

From APL Drawing...

Post (1) on Standard - Begin Guardrail Measurement (to left)

Begin ‘LON’

$L_D = \text{Design Length}$

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Unit Width</th>
<th>Unit Length</th>
<th>Foundation Width</th>
<th>Foundation Length</th>
<th>Design Length</th>
<th>Workzone Speeds</th>
<th>Test Level Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCI70GM</td>
<td>36”</td>
<td>164”</td>
<td>48”</td>
<td>180”</td>
<td>236”</td>
<td>$\leq 45$ mph</td>
<td>TEST LEVEL 2</td>
</tr>
<tr>
<td>SCI100GM</td>
<td>37”</td>
<td>260”</td>
<td>48”</td>
<td>276”</td>
<td>332”</td>
<td>$\geq 50$ mph</td>
<td>TEST LEVEL 3</td>
</tr>
</tbody>
</table>

Note: For Low Speed Facilities with Workzone Speed of $\leq 45$ mph Use a TL-2 System
For High Speed Facilities with Workzone Speed of $\geq 50$ mph Use a TL-3 System
How to find variable $L_{P2}$:

From Index 400,
Sheet 8...

```
Taper Begins
Here...

‘LE’ = 53’-1½”
$L_{P2}$ = ‘LE’ + ½ Span =
$L_{P2}$ = (53’-1½” ) + (3’-1½”) =
$L_{P2}$ = 56’-3”
```