Florida Department of Transportation

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SECRETARY

July 20, 2016

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section **536**
Proposed Specification: **5360000 Guardrail.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Richard Stepp of the State Roadway Design Office to include specification language previously included in Design Standards Index 400, to address new guardrail options, and provide clarification of old policy.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to dan.hurtado@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Signature on file

Dan Hurtado, P.E.
State Specifications Engineer

DH/ot
Attachment
cc: Florida Transportation Builders' Assoc.
State Construction Engineer

GUARDRAIL.
(REV ~~3-29~~ *~~4-11~~12567-20*-16)

SECTION 536 is deleted and the following substituted:

SECTION 536
GUARDRAIL

536-1 Description.

Construct guardrail*,* ~~on posts of timber, steel, or as specified in accordance with the Contract Documents and the Design Standards~~*including end treatments, transition connections to rigid barrier,* ~~*approach transitions,*~~ *and other associated hardware, as specified in the Plans and in accordance with the Design Standards,* ~~*Index*~~ *Index No. 400* ~~S~~*series*.

~~Also, remove~~*Remove* existing guardrail~~, construct guardrail anchorages, and replace guardrail posts,~~ as specified in the Plans.

536-2 Materials.

Use components for guardrail, including posts, offset blocks, steel panels, bolts, foundations, barrier delineators, end delineators, rub rail, pipe rail, and approach terminals, in accordance with Section~~-~~ 967.

~~536-2.1 General: Use steel products meeting the requirements of 967-1. Obtain steel products from plants that are currently on the list of Producers with Accepted Quality Control Programs.~~

~~Use timber meeting the requirements of Section 954 and treated in accordance with the requirements for posts in Section 955. Obtain timber products from plants that are currently on the list of Producers with Accepted Quality Control Programs.~~

~~Producers seeking inclusion on the list of Producers with Accepted Quality Control Programs shall meet the requirements of Section 105.~~

~~536-2.2 Guardrail: Construct guardrail of the standard W-beam or thrie beam type.~~

~~536-2.3 Posts:~~

~~536-2.3.1 General: Unless the Contract Documents designate a particular type of post, the Contractor may choose the type of post to use. Use posts of either timber or steel, and of the sizes and dimensions shown in the Plans. Use the particular type selected throughout a run of rail, except where special steel posts are required.~~

~~536-2.3.2 Timber Posts: Shape and drill the posts prior to treatment, and ensure that they do not vary more than 1 inch from the specified length in the Design Standards. Dress all timber posts on all four sides (S4S).~~

~~536-2.3.3 Steel Posts: Drill the steel posts prior to galvanizing.~~

~~The Contractor may use steel guardrail posts of either a rolled section or a welded structural shape with nominal dimensions as shown in the Design Standards.~~

~~For welded structural shapes, meet the following requirements:~~

~~1. Ensure that the design properties of the shape meet or exceed the design properties for a W 6 x 9 shape as contained in the AISC Manual of Steel Construction.~~

~~2. Weld in accordance with the requirements of ASTM A769.~~

~~3. After cutting steel posts to length, place a weld to seal the spaces between the web plate and flange plates.~~

~~4. Galvanize as specified above after completing all drilling and welding.~~

~~536-2.4 Anchor Blocks: Use anchor blocks of Class I concrete, and construct and place them in accordance with the requirements shown in the Plans or as directed by the Engineer.~~

~~536-2.5 Offset Blocks: Use guardrail offset blocks of either timber, steel, or composite material.~~

~~Provide timber offset blocks that are 6 inches wide, 8 inch offset and 14 inch elevation for w-beam application. Provide timber offset blocks that are 6 inches wide, 8 inch offset and 22 inch elevation for the thrie-beam applications. Dress all timber offset blocks on all four sides (S4S). Ensure that timber offset blocks do not vary more than 0.25 inch from the specified length.~~

~~Use composite offset blocks that are listed on the Department's Approved Product List, (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and shall furnish a drawing of the product, with the product name and dimensions identified suitable for posting on the APL, independent test reports that indicate the product meets all crash test requirements of National Cooperative Highway Research Program (NCHRP-350) or the Manual for Assessing Safety Hardware 2009 (MASH), per current FHWA directives and independent test reports that indicate the composite material meets all the following physical requirements:~~

~~Composite Block~~	~~Test Method~~	~~Requirement~~
~~Durometer Hardness~~	~~ASTM D2240 Shore D~~	~~Minimum 50~~
~~Durometer Hardness after UV exposure~~	~~ASTM D5870~~	~~< 15 points change from initial after exposure per ASTM D4329, 1000 hours, cycle C, type UVB 313 lamps~~

~~Provide composite blocks that are 7-3/8 inch to 8 inch in offset and 14 inch elevation for w-beam application. Provide composite blocks that are 7-3/8 inch to 8 inch in offset and 22 inch elevation for thrie-beam. Allow for dimensional tolerances of plus or minus 5/8 inch in elevation.~~

~~536-2.6 Barrier Delineator: Mount barrier delineators onto the guardrail post in accordance with the details shown in the Plans and the Design Standards. Provide delineators that meet the requirements of Section 705 and listed on the APL. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and Section 993.~~

~~536-2.7 Certification: Provide the Engineer a certification from the manufacturer confirming that all materials (timber posts, anchor and offset blocks, barrier delineators, and all other accessories) meet the requirements of this Section, Section 6 and the Design Standards. Provide the Engineer a copy of the certification at least ten days prior to guardrail construction.~~

~~For steel rail and rail elements, provide the Engineer with a certified mill analysis from the manufacturer meeting the requirements of Section 967.~~

~~For steel posts and steel offset blocks furnish the Engineer a certified mill analysis from the manufacturer showing the physical and chemical properties of each heat meeting the requirements of ASTM A36, the amount of spelter coating, and galvanization meeting the requirements of ASTM A123.~~

~~Also furnish the Engineer a Certificate of Compliance certifying that the guardrail system, materials and construction practices comply with applicable Design Standards and Specifications.~~

~~Acceptance of furnished material will be based on the Certificate of Compliance, material certification and visual inspection by the Engineer.~~

536-3 ~~Setting Posts~~*Construction*.

~~*Install components in accordance with the Plans and , the Design Standards, and the APL Drawings as applicable.*~~

536-3.1 Height Tolerance: *Install guardrail panels at the height shown in the Design Standards with a ~~general~~ tolerance of 1 inch above and 1/2 inch below the nominal height specified. Where unavoidable surface irregularities, including but not limited to across shoulder gutters, inlets, and roadway surface break lines, are encountered, a tolerance of 3 inches above and 1 inch below the nominal height is permissible ~~(e.g. across shoulder gutters, inlets, and roadway surface break lines)~~.*

536-3.2 Station Location Tolerance: *Where guardrail feature stationing is called out in the Plans, the longitudinal stationing tolerance is plus or minus 3 feet and 1-1/2 inch, unless otherwise restricted by field conditions as determined by the Engineer.*

For transition connections to rigid barrier, install the thrie-beam terminal connector at a 1/4 inch tolerance relative to the end of the ~~R~~rigid ~~B~~barrier as defined

in the Plans and Design Standards.

~~**536-3.2 Station Location Tolerance:** Where the centerline of the first post [Post (1)] bolt hole corresponds nominally to the required Beginbegin/End end Guardrail guardrail Stationstation, the longitudinal tolerance of guardrail placement is plus or minus 3 feet and 1-1/2 inches, unless otherwise restricted by field conditions as determined by the Engineer.~~

536-3.3 Setting Posts: Set posts plumb and to the soil depth shown in the Design Standards. Use the deep post option only where specified in the Plans. Place posts in excavations, backfill the space around the posts, and thoroughly tamp the backfilled soil. ~~-~~As an alternate method, use a post-driving machine meeting the approval of the Engineer.

For guardrail post replacement, backfill and tamp the existing soil hole prior to setting the replacement post.

If driving timber posts, either block out holes in the asphalt pavement during the asphalt paving operation or cut holes through the asphalt mat prior to the post installation. Blocked out or cut holes in the asphalt pavement must be at least 50% larger than the cross-sectional area of the timber post. After driving the posts, patch the area of asphalt around each post with ~~fresh,~~ hot bituminous mixture in accordance with Section 339.

If driving steel posts, drive the post directly through the asphalt mat. Fill asphalt depressions or cracks with ~~fresh,~~ hot bituminous mixture in a manner meeting the approval of the Engineer.

For ~~both timber and steel~~ post locations where subsurface miscellaneous rock or other solid material is obstructing the post placement, remove such material as follows:

1. If any part of an obstruction is located within 0 and ~~18~~ 18 inches in depth, excavate a minimum ~~24~~ 24 inch diameter hole around the post location for the full depth of the post, with the back edge of the excavated hole placed a minimum of ~~15~~ 15 inches behind the back face of the post.

2. If an obstruction is only located ~~below~~ below 18 inches in depth, excavate a minimum ~~12~~ 12 inch diameter hole around the post location, for the full depth of the post, with the back edge of the excavated hole placed a minimum of ~~3~~ 3 inches behind the back face of the post.

3. Backfill the holes with soil and thoroughly tamp.

536-3.4 Post Location Conflicts: When the construction of guardrail at the required post spacing results in post(s) conflicting with sidewalks, gutter, underground utilities, or other permanent obstacles which cannot be removed as determined by the Engineer, the following options are permitted with the approval of the Engineer:

1. Additional Offset Blocks – Up to ~~2~~ two additional ~~Offset~~ offset ~~Blocks~~ blocks (3 total) may be used where the resulting post placement, moved farther behind the face of guardrail, will avoid a post conflict.

Use button-head bolts of added length as needed to secure the panel system with the rear nut and washer. Where bolts greater than 25 inches are required, a 5/8 inch threaded rod meeting the same material requirements may be substituted and secured with steel hex nuts of over 1-1/8 inches in diameter. Use a steel washer against the post and not the panel. The rod is not permitted to extend beyond ~~¾~~ 3/4 inch from the face of the tightened nut on the panel side; trim the rod as needed and galvanize in accordance with Section 562.

Over a distance of one post spacing, linearly widen the miscellaneous asphalt pavement where required to maintain a minimum of 10 inches of material behind the post.

2. Special Steel Posts – Where post placement atop a concrete structure cannot be avoided, use ~~Special~~ special ~~Steel~~ steel ~~Posts~~ posts as defined in the Design Standards and 536-3.~~5~~6. ~~See Special Guardrail Post below.~~

3. Encased Posts – Where post placement results in a conflict with an underground utility or obstacle, use the shallower ~~E~~encased ~~P~~post ~~O~~option as defined in the Design Standards where the concrete encasement will not damage a utility. ~~See Special Guardrail Post below.~~

4. Frangible Leave-Out – Where post placement results in a conflict with a concrete slab, use the ~~F~~frangible ~~L~~leave-~~O~~out as defined in the Design Standards. Do not use posts through concrete slabs deeper than 8~~". ~~ inches~~. See Special Guardrail Post below~~.

***536-3.5 Deep Post:** Mark deep posts on the back face, centered 4 inches below the top edge, with a legible black letter 'D' approximately 2 inches vertical by 1 inch horizontal in size. Use a permanent black ink stamp or paint stencil.*

***536-3.~~5~~6 Special Steel Post:** Mount to ~~steel~~concrete structures using the following systems.*

***536-3.~~5.1~~6.1 Adhesive Bonded Anchors:** For concrete structures 9 inches deep and greater, mount the ~~Base~~ base ~~Plate~~ plate to the concrete using steel adhesive-bonded anchor bolts with a minimum tensile strength of 60 ksi and galvanized in accordance with ASTM A153. Stainless steel components may be substituted, but components plated in accordance with ASTM B-633 are not acceptable. Use adhesive-bonded anchors in accordance with Section- 937 and 416 (Type- HSHV) and in accordance with the manufacturer's specification.*

Drill holes in concrete, through reinforcing steel if encountered. Thoroughly clean and dry the holes immediately prior to setting anchors.

At a minimum, meet the following strength capacities:

	Approach Slabs	Other Structures
Min. Tensile Load (Each Anchor)	14,000 lbs	8,000 lbs
Min. Shear Load (Each Anchor)	15,000 lbs	7,800 lbs

***536-3.~~5.2~~6.2 Hex-Head Bolt:** For concrete structures less than 9- inches deep, use a ~~¾~~ 3/4 inch Hex-Head bolt passing through a 7/8 -inch drilled hole in the concrete structure and secured from underneath with a washer and nut. The threaded bolt must not protrude more than ~~¾~~3/4 -inches beyond the tightened nut; trim the threaded portion as needed and galvanize in accordance with Section- 562.*

***536-3.~~6~~7 Steel Panels:** Use straight panels to construct radii of 125- feet or greater. Use fabricated shop-bent panels to accommodate radii of less than- 125 feet.*

***536-3.~~7~~8 Panel Slots and Holes:** Use the ~~P~~panel's unaltered, prefabricated slots and holes as shown in the Design Standards. Do not drill, punch, ream, or otherwise alter the prefabricated slots and holes, ~~to accommodate basic connections~~except ~~for in the following conditions~~when~~.~~*

~~———————~~ *~~C~~creating new ~~P~~post ~~B~~bolt ~~S~~slots ~~is only permitted~~ for reduced post spacing (quarter spacing) and adjusting post spacing to avoid structure edge conflicts as shown in the Design Standards. Where required, punch new ~~P~~post ~~B~~bolt ~~S~~slots to the dimensions given in the Design Standards, spaced no closer than 4~~-~~ inches measured edge to edge from an existing slot. Galvanize new punched slots per Section~~-~~ 562.*

536-3.~~8~~9 Barrier Delineators: *Mount ~~B~~barrier ~~D~~delineators on top of the guardrail post by adhesive or mechanical means per the manufacturer's recommendations.*

536-3.~~9~~10 End Delineators: *Install the ~~R~~retroreflective ~~S~~sheeting ~~to~~on the approach face (nose) of ~~A~~approach ~~T~~terminals, ~~T~~trailing ~~A~~anchorages, and ~~C~~controlled ~~R~~release ~~T~~terminal (CRT) ~~E~~end ~~T~~treatments where indicated in the Design Standards. Mount the ~~R~~retroreflective ~~S~~sheeting vertically centered on the approach face by adhesive or mechanical means per the manufacturer's recommendations. Retroreflective ~~S~~sheeting must be a minimum 8~~-~~ inches in height with a minimum area of 160~~-~~ square inches for ~~A~~approach ~~T~~terminals and ~~T~~trailing ~~A~~anchorages and 240~~-~~ square inches for CRT ~~E~~end ~~T~~treatments.*

536-3.11 Rub Rail: ~~*Install where indicated in the Plans.*~~ *Treat field drilled holes in accordance with Section 562.*

Rub rail must terminate at the nearest post outside of the rub rail stationing range indicated in the Plans.

536-3.1~~0~~12 Pipe Rail: ~~*Install where indicated in the Plans or where required by the Engineer to meet the requirements of the Design Standards.*~~ *Treat field drilled holes in accordance with Section~~-~~ 562.*

Pipe rail must terminate at the nearest post outside of the pipe rail stationing range indicated in the Plans.

536-3.1~~12~~3 Existing Guardrail: *Stockpile guardrail, if specified, within the right-of-way at a location approved by the Engineer. Dispose of all remaining guardrail not specified for stockpiling.*

536-3.1~~23~~4 Approach Terminal Assemblies: *Install ~~A~~approach ~~T~~terminal ~~A~~assemblies as specified in the Plans and APL drawings and in accordance with the geometry and adjacent grading of the Design Standards. The APL number must be permanently marked on each assembly at a readily visible location using legible lettering at least 3/4 inch in height.*

If the Plans call for a "~~F~~flared" ~~A~~approach ~~T~~terminal ~~A~~assembly and do not identify the specific system to be used, the contractor has the option to construct any Department-approved "~~F~~flared" ~~T~~terminal ~~A~~assembly identified on the APL, subject to the conditions identified in the Plans or the APL drawings.

Likewise, if the Plans call for a "~~P~~parallel" ~~A~~approach ~~T~~terminal ~~A~~assembly and do not identify the specific system to be used, the contractor has the option to construct any Department-approved "~~P~~parallel" ~~T~~terminal ~~A~~assembly identified on the APL, subject to the conditions identified in the Plans or the APL drawings.

~~———————~~ ***~~Provide Supervisory Personnel including an On-site Construction SupervisorRoadside Safety Hardware Installation Supervisor in accordance with Section 105.~~***

~~———~~ **~~Set standard length posts vertically to the depth shown in the Design Standards. Set special length posts vertically to the depth shown in the Plans. Align and realign posts as necessary, until final acceptance. Where the posts are not set in concrete or mounted on structures, backfill the post holes and thoroughly tamp material. As an alternate method,~~**

~~the Contractor may use a post-driving machine, meeting the approval of the Engineer and capable of driving the posts without damaging them.~~

~~For guardrail post replacement, backfill and compact the existing hole prior to setting the new post.~~

~~If driving timber posts, the Contractor may either block out holes in the asphalt for the posts during the asphalt paving operation or cut holes through the asphalt mat prior to the post installation. Blocked out holes or cut holes in the asphalt pavement shall be at least 50% larger than the sectional area of the timber post. After completing driving of the posts patch the area of asphalt around each post with fresh hot bituminous mixture.~~

~~If driving steel posts, drive the post directly through the asphalt mat. Fill depressions or cracks with fresh, hot bituminous mixture in a manner meeting the approval of the Engineer.~~

~~For either timber or steel post locations, in which rock, concrete or asphalt thicker than 2 inches exist, remove such material and backfill with suitable material, thoroughly tamped as detailed in the Design Standards.~~

536-4 ~~End Anchorage Assemblies~~*Certification and Acceptance*.

Submit to the Engineer a certification letter from the manufacturer confirming that all materials used meet the requirements of this Section along with Section- 6 and the Design Standards. This letter must list all of the APL items used on the project along with the device-specific APL numbers. Provide this certification at least ten days prior to guardrail construction.

For steel panels and panel components, submit to the Engineer a certified mill analysis meeting the material requirements of Section- 967.

For steel posts and steel offset blocks, submit to the Engineer a certified mill analysis from the manufacturer showing the physical and chemical properties of each heat meeting the requirements of ASTM- A36, the amount of spelter coating, and galvanization meeting the requirements of ASTM- A123.

Submit to the Engineer a ~~C~~certificate of ~~C~~compliance verifying that the guardrail system, materials, and construction practices comply with applicable Design Standards and Specifications.

Acceptance of submitted material will be based on the material certifications, ~~C~~certificate of ~~C~~compliance, and visual inspection by the Engineer.

~~Use End Anchorage Assemblies listed on the APL and obtained from plants that are currently on the list of Producers with Accepted Quality Control Programs~~

~~Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6, include a product drawing showing that the product meets the requirements of this Section, and is signed and sealed by a registered Florida P.E., also furnish independent test reports that indicate the product meets all crash test requirements of the National Cooperative Highway Research Program Report 350 (NCHRP 350) or the Manual for Assessing Safety Hardware 2009 (MASH-09) and current FHWA directives.~~

~~Producers seeking inclusion on the list of Producers with Accepted Quality Control Programs shall meet the requirements of Section 105.~~

~~536-5 Erection of Rail.~~

~~Erect the guardrail panels, supports, anchors, etc., as shown in the Design Standards.~~

~~536-6 Existing Guardrail.~~

~~Stockpile guardrail, so specified, within the right-of-way at a location approved by the Engineer. Dispose of all remaining guardrail not specified for stockpiling.~~

536-~~7~~ *5* Method of Measurement.

536-~~7~~*5*.1 Guardrail: The quantity ~~to be~~ paid for will be the plan quantity, in *linear* feet, constructed, in place and accepted.

The ~~plan~~ length ~~for~~of ~~basic~~ guardrail is measured end-to-end following the centerline of the panels, between the ~~B~~begin/~~E~~end ~~G~~guardrail ~~S~~stations as defined in the Design Standards and the Plans, including the full lengths of the adjoining ~~E~~end ~~T~~treatments and ~~A~~approach ~~T~~transition ~~C~~connections ~~tabulated as the basic guardrail type~~to rigid barrier.~~The plan length of a run of guardrail will be the end to end measurement including panels (thrie-beam, nested, and W-thrie beam transition panels) directly associated with anchorage assemblies and guardrail transitions.~~

***536-5.2 Rub Rail:** The quantity paid for will be the plan length, in linear feet, constructed, in place and accepted.*

***536-5.3 Pipe Rail:** The quantity paid for will be the plan length, in linear feet, constructed, in place and accepted.*

***536-5.4 Special Guardrail Post:** The quantity paid for will be the number of each, constructed, in place and accepted. Special guardrail posts include deep posts, special steel posts, encased posts, and frangible leave-outs as defined in the Design Standards and indicated in the Plans.*

***536-5.5 Bridge Anchorage Assembly~~/~~Approach Transition Connection to Rigid Barrier:** The quantity ~~to be~~ paid for will be the number of each, constructed, in place and accepted.*

~~*536-5.6 Removal of Existing Guardrail: The quantity paid for will be the length, in linear feet, measured, and accepted prior to removal.*~~

536-5.~~7~~6 Guardrail Post Replacement: *The quantity paid for will be the number of each, replaced.*

536-5.~~8~~7 Guardrail End Treatment: *The quantity paid for will be the number of each type as designated, constructed, in place, and accepted. Guardrail end treatment types may include parallel or flared approach terminals, Type II trailing anchorages, CRT end treatments, and double faced approach terminals as defined in the Design Standards.*

~~**536-7.2 End Anchorage Assembly: The quantity to be paid for will be the number of each type as designated, constructed, in place and accepted.**~~

~~**536-7.3 Special Guardrail Post: The quantity to be paid for will be the number of each, constructed, in place and accepted.**~~

~~**The designation "Special Guardrail Post" will include only such posts as require special fabrication, for installation at locations where the normal setting would conflict with concrete structures, such as approach slabs, culvert slabs, footings, inlets, etc. Special posts, however, will not include posts for double-face median guardrail, regardless of whether they are embedded in or attached to concrete.**~~

~~**536-7.4 Bridge Anchorage Assembly: The quantity to be paid for will be the number of each, constructed, in place and accepted.**~~

~~**536-7.5 Concrete Barrier Wall Anchorage Assembly: The quantity to be paid for will be the number of each, constructed, in place and accepted.**~~

~~**536-7.6 Guardrail Post Replacement: The quantity to be paid for will be the number of each, replaced.**~~

~~**536-7.7 Removal of Existing Guardrail: The quantity to be paid for will be the length, in feet, measured prior to removal.**~~

~~**536-7.8 Other Rail:**~~

~~**536-7.8.1 Rub Rail: The quantity to be paid for will be the plan quantity, in feet, constructed, in place and accepted.**~~

~~**536-7.8.2 Pipe Rail: The quantity to be paid for will be the plan quantity, in feet, constructed, in place and accepted.**~~

536-~~8~~ *6* Basis of Payment.

536-6.1 Guardrail: *Price and payment will be full compensation for all work specified under this Section, except those items specified in 536-6.2 through 536-6.~~8~~7. Price and payment includ*es *furnishing and installing posts, panels, barrier delineators, offset blocks, and all other materials as defined in the Plans and the Design Standards. The price and payment will include any reduced post spacing, nested panels, shop-bent panels, trailing end transition connections ~~(~~to rigid barrier~~)~~, and CRT posts as ~~segments as specified~~required in the Plans.*

The type of guardrail specified will be that which comprises the ~~basic~~ guardrail run between end treatments and ~~approach transitions~~transition connections to rigid barrier

(including, but not limited to, ~~W~~w-~~B~~beam general, ~~W~~w-~~B~~beam double face, ~~W~~w-~~B~~beam low-speed, modified ~~T~~thrie-~~B~~beam). For guardrail systems with direct connections between end treatments and ~~approach transitions~~transition connections to rigid barrier, the type of guardrail specified will be ~~W~~w-~~B~~beam ~~general~~ for single face~~d~~ guardrail applications or double faced ~~Ww-Bbeam~~ for double face guardrail applications.

~~*Payment will be made under the Ppay iItems as follows:*~~

~~*1. Where the Contractor furnishes all materials for the guardrail and the Engineer does not require shop-bent panels, payment will be made under the basic Ppay Iitem of Gguardrail.*~~

~~*2. Where the radius of the guardrail installation is such as to require shop bending of the guardrail panels per this Section (see Ssteel Ppanel requirements), payment will be made under the pPay Iitem of Gguardrail with Sshop-Bbent Ppanels for the installed length of Sshop-Bbent Ppanels segments only.*~~

536-6.2 Rub Rail: *Price and payment will include all components specified in the Plans and Design Standards.*

536-6.3 Pipe Rail: *Price and payment will include all components specified in the Plans and Design Standards. Pipe ~~R~~rail will be shown and tabulated in the Plans for the condition that steel posts are installed at the indicated ~~P~~pipe ~~R~~rail location, however the ~~P~~pipe ~~R~~rail is not required if the timber post option is selected and installed at the indicated ~~P~~pipe ~~R~~rail location.*

536-6.4 Special Guardrail Post: *Price and payment will include all costs for furnishing and installing ~~the S~~special ~~G~~guardrail ~~P~~posts that are in addition to the cost of items included in 536-6.1~~over and above the costs for Sstandard Pposts~~, where ~~S~~special ~~G~~guardrail ~~P~~posts are installed instead of ~~S~~standard ~~P~~posts. ~~Special Gguardrail Pposts include Ddeep Pposts, Sspecial Ssteel Pposts, Eencased Pposts, and Ffrangible Lleave-Oouts as defined in the Design Standards and indicated in the Plans.~~*

536-6.5 Bridge Anchorage Assembly~~-~~/Approach Transition Connection to Rigid Barrier: *Price and payment will include all costs~~, over and above the adjacent basic guardrail type of the same length,~~ for furnishing and installing all hardware for approach transition~~s and~~ connections to rigid barrier per the Design Standards that are in addition to the cost of items included in 536-6.1. This includes costs for the concrete alignment curb and its transition where shown in the Design Standards and ~~B~~barrier ~~D~~delineators for ~~E~~existing ~~P~~post and ~~B~~beam ~~B~~bridge railings.*

536-6.6 Removal of Existing Guardrail: *Price and payment will include all labor and equipment required for removal and disposition of the existing guardrail as specified in the Plans. No additional payment will be made for the removal of transition connections, ~~D~~double ~~F~~faced ~~G~~guardrail, ~~T~~thrie-~~B~~beam ~~G~~guardrail, nested panels, ~~P~~pipe ~~R~~rail, ~~R~~rub ~~R~~rail, or ~~E~~end ~~T~~terminals.*

~~***536-6.7 Guardrail Post Replacement:*** *Price and payment will include all labor, materials, and equipment required for the removal and disposal of existing posts in areas provided by the Contractor. Price and payment will also include the backfilling and compaction of existing holes and the post replacement with new posts.*~~

536-6.~~8~~7 Guardrail End Treatment: *Price and payment will ~~be full compensation~~include all costs for ~~include all costswork specified under this Section, including above and beyond basic guardrail of the same length, for~~ furnishing and installing all ~~G~~guardrail ~~E~~end ~~T~~treatment ~~components~~assemblies specified in the Plans that are in addition to the cost of items included in 536-6.1. ~~Guardrail Eend Ttreatment typess may include parallel or flared Aapproach~~*

~~*Tterminals, Type II Ttrailing Aanchorages, CRT Eend Ttreatments, and Ddouble Ffaced Aapproach Tterminals as defined in the PlansDesign Standards.*~~

536-6.98 Payment Items: *Payment will be made under:*

Item No. 536- 1-	*Guardrail - per foot.*
~~*Item No. 536- 2-*~~	~~*Guardrail with Shop-Bent Panels - per foot.*~~
Item No. 536- 5-	*Rub Rail - per foot.*
Item No. 536- 6-	*Pipe Rail - per foot.*
Item No. 536- 7-	*Special Guardrail Post - each.*
Item No. 536- 8-	*Bridge Anchorage Assembly~~/~~Approach Transition Connection to Rigid Barrier - each.*
Item No. 536- 73-	*Removal of Existing Guardrail - per foot.*
~~*Item No. 536- 83-*~~	~~*Guardrail Post Replacement - each.*~~
Item No. 536- 85-	*Guardrail End Treatment - each.*

~~**536-8.1 Guardrail:** Price and payment will be full compensation for all work specified under this Section, including furnishing and installing barrier delineators, posts, all panels, and all other materials as specified. Payment will be made under the items as follows:~~

~~1. Where the Contractor furnishes all materials for the guardrail, and the Engineer does not require shop-bent rails, payment will be made under the basic item of guardrail.~~

~~2. Where the radius of the guardrail installation is such as to require shop bending of the guardrail panels, payment will be made under the item of Guardrail (Shop-bent Panels).~~

~~**536-8.2 End Anchorage Assembly:** Price and payment will include furnishing and installing all components specified in the Plans and Design Standards.~~

~~**536-8.3 Special Guardrail Post:** Price and payment will include all costs for furnishing and installing the special posts that are over and above the costs for the normal posts, which are replaced by such special posts.~~

~~**536-8.4 Bridge Anchorage Assembly:** Price and payment will include furnishing and installing the special end shoes, wood blocks or retrofit wing posts, concrete anchor posts, thrie-beam terminal connectors, backup plates, filler plates, barrier delineators for the entire bridge length, transition blocks, and other necessary hardware.~~

~~**536-8.5 Concrete Barrier Wall Anchorage Assembly:** Price and payment will include furnishing and installing connections to concrete barrier walls, as shown on the Design Standards, Index Nos. 400 and 410.~~

~~**536-8.6 Guardrail Post Replacement:** Price and payment will include all labor, materials, and equipment required for removal and disposal of existing posts in areas provided by the Contractor, backfilling and compacting existing holes, and replacement with new posts.~~

~~**536-8.7 Removal of Existing Guardrail:** Price and payment will include all labor and equipment required for removal and disposition of the existing guardrail, as specified in the Plans. No additional payment will be made for the removal of the back rail on double face guardrail, thrie beam guardrail, nested rail, safety pipe rail, rub rail or end anchorages.~~

~~**536-8.8 Other Rail:**~~

~~**536-8.8.1 Rub Rail:** Price and payment will include all components specified in the Plans and Design Standards, Index No. 400.~~

~~**536-8.8.2 Pipe Rail:** Price and payment will include all components specified in the Plans and Design Standards, Index No. 400.~~

~~**536-8.9 Payment Items:** Payment will be made under:~~

~~Item No. 536- 1-~~	~~Guardrail - per foot.~~

~~Item No. 536- 2- Guardrail (Shop Bent Panels) - per foot.~~
~~Item No. 536- 5- Rub Rail - per foot.~~
~~Item No. 536- 6- Pipe Rail - per foot.~~
~~Item No. 536- 7- Special Guardrail Post - each.~~
~~Item No. 536- 8- Bridge Anchorage Assembly - each.~~
~~Item No. 536- 73- Removal of Existing Guardrail - per foot.~~
~~Item No. 536- 76- Special Length Guardrail Post - each.~~
~~Item No. 536- 82- Concrete Barrier Wall Anchorage Assembly - each.~~
~~Item No. 536- 83- Guardrail Post Replacement- each.~~
~~Item No. 536- 85- End Anchorage Assembly - each.~~

GUARDRAIL.
(REV 7-20-16)

SECTION 536 is deleted and the following substituted:

SECTION 536
GUARDRAIL

536-1 Description.

Construct guardrail, including end treatments, transition connections to rigid barrier, and other associated hardware, as specified in the Plans and in accordance with the Design Standards, Index No. 400 series.

Remove existing guardrail as specified in the Plans.

536-2 Materials.

Use components for guardrail, including posts, offset blocks, steel panels, bolts, foundations, barrier delineators, end delineators, rub rail, pipe rail, and approach terminals, in accordance with Section 967.

536-3 Construction.

536-3.1 Height Tolerance: Install guardrail panels at the height shown in the Design Standards with a tolerance of 1 inch above and 1/2 inch below the nominal height specified. Where unavoidable surface irregularities, including but not limited to across shoulder gutters, inlets, and roadway surface break lines, are encountered, a tolerance of 3 inches above and 1 inch below the nominal height is permissible.

536-3.2 Station Location Tolerance: Where guardrail feature stationing is called out in the Plans, the longitudinal stationing tolerance is plus or minus 3 feet and 1-1/2 inch, unless otherwise restricted by field conditions as determined by the Engineer.

For transition connections to rigid barrier, install the thrie-beam terminal connector at a 1/4 inch tolerance relative to the end of the rigid barrier as defined in the Plans and Design Standards.

536-3.3 Setting Posts: Set posts plumb and to the soil depth shown in the Design Standards. Use the deep post option only where specified in the Plans. Place posts in excavations, backfill the space around the posts, and thoroughly tamp the backfilled soil. As an alternate method, use a post-driving machine meeting the approval of the Engineer.

For guardrail post replacement, backfill and tamp the existing soil hole prior to setting the replacement post.

If driving timber posts, either block out holes in the asphalt pavement during the asphalt paving operation or cut holes through the asphalt mat prior to the post installation. Blocked out or cut holes in the asphalt pavement must be at least 50% larger than the cross-sectional area of the timber post. After driving the posts, patch the area of asphalt around each post with hot bituminous mixture in accordance with Section 339.

If driving steel posts, drive the post directly through the asphalt mat. Fill asphalt depressions or cracks with hot bituminous mixture in a manner meeting the approval of the Engineer.

For post locations where subsurface miscellaneous rock or other solid material is obstructing the post placement, remove such material as follows:

1. If any part of an obstruction is located within 0 and 18 inches in depth, excavate a minimum 24 inch diameter hole around the post location for the full depth of the post, with the back edge of the excavated hole placed a minimum of 15 inches behind the back face of the post.

2. If an obstruction is only located below 18 inches in depth, excavate a minimum 12 inch diameter hole around the post location, for the full depth of the post, with the back edge of the excavated hole placed a minimum of 3 inches behind the back face of the post.

3. Backfill the holes with soil and thoroughly tamp.

536-3.4 Post Location Conflicts: When the construction of guardrail at the required post spacing results in post(s) conflicting with sidewalks, gutter, underground utilities, or other permanent obstacles which cannot be removed as determined by the Engineer, the following options are permitted with the approval of the Engineer:

1. Additional Offset Blocks – Up to two additional offset blocks (3 total) may be used where the resulting post placement, moved farther behind the face of guardrail, will avoid a post conflict.

Use button-head bolts of added length as needed to secure the panel system with the rear nut and washer. Where bolts greater than 25 inches are required, a 5/8 inch threaded rod meeting the same material requirements may be substituted and secured with steel hex nuts of over 1-1/8 inches in diameter. Use a steel washer against the post and not the panel. The rod is not permitted to extend beyond 3/4 inch from the face of the tightened nut on the panel side; trim the rod as needed and galvanize in accordance with Section 562.

Over a distance of one post spacing, linearly widen the miscellaneous asphalt pavement where required to maintain a minimum of 10 inches of material behind the post.

2. Special Steel Posts – Where post placement atop a concrete structure cannot be avoided, use special steel posts as defined in the Design Standards and 536-3.6.

3. Encased Posts – Where post placement results in a conflict with an underground utility or obstacle, use the shallower encased post option as defined in the Design Standards where the concrete encasement will not damage a utility.

4. Frangible Leave-Out – Where post placement results in a conflict with a concrete slab, use the frangible leave-out as defined in the Design Standards. Do not use posts through concrete slabs deeper than 8 inches.

536-3.5 Deep Post: Mark deep posts on the back face, centered 4 inches below the top edge, with a legible black letter ‘D’ approximately 2 inches vertical by 1 inch horizontal in size. Use a permanent black ink stamp or paint stencil.

536-3.6 Special Steel Post: Mount to concrete structures using the following systems.

536-3.6.1 Adhesive Bonded Anchors: For concrete structures 9 inches deep and greater, mount the base plate to the concrete using steel adhesive-bonded anchor bolts with a minimum tensile strength of 60 ksi and galvanized in accordance with ASTM A153. Stainless steel components may be substituted, but components plated in accordance with ASTM B-633

are not acceptable. Use adhesive-bonded anchors in accordance with Section 937 and 416 (Type HSHV) and in accordance with the manufacturer's specification.

Drill holes in concrete, through reinforcing steel if encountered. Thoroughly clean and dry the holes immediately prior to setting anchors.

At a minimum, meet the following strength capacities:

	Approach Slabs	Other Structures
Min. Tensile Load (Each Anchor)	14,000 lbs	8,000 lbs
Min. Shear Load (Each Anchor)	15,000 lbs	7,800 lbs

536-3.6.2 Hex-Head Bolt: For concrete structures less than 9 inches deep, use a 3/4 inch Hex-Head bolt passing through a 7/8 inch drilled hole in the concrete structure and secured from underneath with a washer and nut. The threaded bolt must not protrude more than 3/4 inches beyond the tightened nut; trim the threaded portion as needed and galvanize in accordance with Section 562.

536-3.7 Steel Panels: Use straight panels to construct radii of 125 feet or greater. Use fabricated shop-bent panels to accommodate radii of less than 125 feet.

536-3.8 Panel Slots and Holes: Use the panel's unaltered, prefabricated slots and holes as shown in the Design Standards. Do not drill, punch, ream, or otherwise alter the prefabricated slots and holes, except when creating new post bolt slots for reduced post spacing (quarter spacing) and adjusting post spacing to avoid structure edge conflicts as shown in the Design Standards. Where required, punch new post bolt slots to the dimensions given in the Design Standards, spaced no closer than 4 inches measured edge to edge from an existing slot. Galvanize new punched slots per Section 562.

536-3.9 Barrier Delineators: Mount barrier delineators on top of the guardrail post by adhesive or mechanical means per the manufacturer's recommendations.

536-3.10 End Delineators: Install the retroreflective sheeting on the approach face (nose) of approach terminals, trailing anchorages, and controlled release terminal (CRT) end treatments where indicated in the Design Standards. Mount the retroreflective sheeting vertically centered on the approach face by adhesive or mechanical means per the manufacturer's recommendations. Retroreflective sheeting must be a minimum 8 inches in height with a minimum area of 160 square inches for approach terminals and trailing anchorages and 240 square inches for CRT end treatments.

536-3.11 Rub Rail: Treat field drilled holes in accordance with Section 562.

Rub rail must terminate at the nearest post outside of the rub rail stationing range indicated in the Plans.

536-3.12 Pipe Rail: Treat field drilled holes in accordance with Section 562.

Pipe rail must terminate at the nearest post outside of the pipe rail stationing range indicated in the Plans.

536-3.13 Existing Guardrail: Stockpile guardrail, if specified, within the right-of-way at a location approved by the Engineer. Dispose of all remaining guardrail not specified for stockpiling.

536-3.14 Approach Terminal Assemblies: Install approach terminal assemblies as specified in the Plans and APL drawings and in accordance with the geometry and adjacent grading of the Design Standards. The APL number must be permanently marked on each assembly at a readily visible location using legible lettering at least 3/4 inch in height.

If the Plans call for a "flared" approach terminal assembly and do not identify the specific system to be used, the contractor has the option to construct any Department-approved "flared" terminal assembly identified on the APL, subject to the conditions identified in the Plans or the APL drawings.

Likewise, if the Plans call for a "parallel" approach terminal assembly and do not identify the specific system to be used, the contractor has the option to construct any Department-approved "parallel" terminal assembly identified on the APL, subject to the conditions identified in the Plans or the APL drawings.

536-4 Certification and Acceptance.

Submit to the Engineer a certification letter from the manufacturer confirming that all materials used meet the requirements of this Section along with Section 6 and the Design Standards. This letter must list all of the APL items used on the project along with the device-specific APL numbers. Provide this certification at least ten days prior to guardrail construction.

For steel panels and panel components, submit to the Engineer a certified mill analysis meeting the material requirements of Section 967.

For steel posts and steel offset blocks, submit to the Engineer a certified mill analysis from the manufacturer showing the physical and chemical properties of each heat meeting the requirements of ASTM A36, the amount of spelter coating, and galvanization meeting the requirements of ASTM A123.

Submit to the Engineer a certificate of compliance verifying that the guardrail system, materials, and construction practices comply with applicable Design Standards and Specifications.

Acceptance of submitted material will be based on the material certifications, certificate of compliance, and visual inspection by the Engineer.

536-5 Method of Measurement.

536-5.1 Guardrail: The quantity paid for will be the plan quantity, in linear feet, constructed, in place and accepted.

The length of guardrail is measured end-to-end following the centerline of the panels, between the begin/end guardrail stations as defined in the Design Standards and the Plans, including the full lengths of the adjoining end treatments and transition connections to rigid barrier.

536-5.2 Rub Rail: The quantity paid for will be the plan length, in linear feet, constructed, in place and accepted.

536-5.3 Pipe Rail: The quantity paid for will be the plan length, in linear feet, constructed, in place and accepted.

536-5.4 Special Guardrail Post: The quantity paid for will be the number of each, constructed, in place and accepted. Special guardrail posts include deep posts, special steel posts, encased posts, and frangible leave-outs as defined in the Design Standards and indicated in the Plans.

536-5.5 Bridge Anchorage Assembly/Approach Transition Connection to Rigid Barrier: The quantity paid for will be the number of each, constructed, in place and accepted.

536-5.6 Guardrail Post Replacement: The quantity paid for will be the number of each, replaced.

536-5.7 Guardrail End Treatment: The quantity paid for will be the number of each type as designated, constructed, in place, and accepted. Guardrail end treatment types may include parallel or flared approach terminals, Type II trailing anchorages, CRT end treatments, and double faced approach terminals as defined in the Design Standards.

536-6 Basis of Payment.

536-6.1 Guardrail: Price and payment will be full compensation for all work specified under this Section, except those items specified in 536-6.2 through 536-6.7. Price and payment includes furnishing and installing posts, panels, barrier delineators, offset blocks, and all other materials as defined in the Plans and the Design Standards. The price and payment will include any reduced post spacing, nested panels, shop-bent panels, trailing end transition connections to rigid barrier, and CRT posts as required in the Plans.

The type of guardrail specified will be that which comprises the guardrail run between end treatments and transition connections to rigid barrier (including, but not limited to, w-beam general, w-beam double face, w-beam low-speed, modified thrie-beam). For guardrail systems with direct connections between end treatments and transition connections to rigid barrier, the type of guardrail specified will be w-beam for single face guardrail applications or double faced for double face guardrail applications.

536-6.2 Rub Rail: Price and payment will include all components specified in the Plans and Design Standards.

536-6.3 Pipe Rail: Price and payment will include all components specified in the Plans and Design Standards. Pipe rail will be shown and tabulated in the Plans for the condition that steel posts are installed at the indicated pipe rail location, however the pipe rail is not required if the timber post option is selected and installed at the indicated pipe rail location.

536-6.4 Special Guardrail Post: Price and payment will include all costs for furnishing and installing special guardrail posts that are in addition to the cost of items included in 536-6.1, where special guardrail posts are installed instead of standard posts.

536-6.5 Bridge Anchorage Assembly/Approach Transition Connection to Rigid Barrier: Price and payment will include all costs for furnishing and installing all hardware for approach transition connections to rigid barrier per the Design Standards that are in addition to the cost of items included in 536-6.1. This includes costs for the concrete alignment curb and its transition where shown in the Design Standards and barrier delineators for existing post and beam bridge railings.

536-6.6 Removal of Existing Guardrail: Price and payment will include all labor and equipment required for removal and disposition of the existing guardrail as specified in the Plans. No additional payment will be made for the removal of transition connections, double faced guardrail, thrie-beam guardrail, nested panels, pipe rail, rub rail, or end terminals.

536-6.7 Guardrail End Treatment: Price and payment will include all costs for furnishing and installing all guardrail end treatment assemblies specified in the Plans that are in addition to the cost of items included in 536-6.1.

536-6.8 Payment Items: Payment will be made under:

Item No. 536- 1-	Guardrail - per foot.
Item No. 536- 5-	Rub Rail - per foot.
Item No. 536- 6-	Pipe Rail - per foot.
Item No. 536- 7-	Special Guardrail Post - each.

Item No. 536- 8-	Bridge Anchorage Assembly/Approach Transition Connection to Rigid Barrier - each.
Item No. 536- 73-	Removal of Existing Guardrail - per foot.
Item No. 536- 85-	Guardrail End Treatment - each.