

## SECTION 614 SEMI-RIGID BARRIER SYSTEMS AND END TREATMENTS

### 614.1 Description

- (1) This section describes providing steel guardrail systems including rail, terminal and transition treatments, other roadside energy absorbing safety devices, and earthwork for barrier systems. This section also describes providing and removing temporary guardrail, adjusting existing guardrail, salvaging materials from existing installations.

### 614.2 Materials

#### 614.2.1 General

- (1) Furnish materials conforming to the following:

Asphaltic surface .....	<a href="#">465.2</a>
Structural steel and miscellaneous metals.....	<a href="#">506.2</a>
Steel reinforcement.....	<a href="#">505.2</a>
Wood posts and offset blocks.....	<a href="#">507.2</a>

**Revise 614.2.1(2) to require QMP testing for class I structure concrete if the crash cushion manufacturer specifies a concrete strength.**

- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#) as modified in [section 716](#). Provide QMP for class II ancillary concrete as specified in [section 716](#). **If crash cushion manufacturer details specify concrete strength for pads or blocks, provide QMP for class I structure concrete as specified in [section 715](#). Define class I structure sublots for each crash cushion location, apply the small quantity exceptions specified in [715.1.1.2](#), base acceptance on individual subplot average strength, and adjust pay under [715.5.3](#) as specified for lots with less than 4 sublots.**
- (3) Furnish zinc dust/zinc oxide paint conforming to Federal specification TT-P-641.
- (4) Furnish steel nuts conforming to ASTM A563, washers conforming to ASTM F436, grade 1, and bolts conforming to ASTM A307. Ensure that the nuts, washers, and bolts are either hot-dip coated according to AASHTO M232 class C or mechanically coated according to AASHTO M298 Class 50.
- (5) Before installation store galvanized components above ground level and away from surface run off. The department may reject material if the zinc coating is physically damaged or oxidized.
- (6) Provide manufacturer's drawings, and installation and maintenance instructions when providing proprietary systems.

#### 614.2.2 Controlled Low-Strength Backfill

- (1) Provide controlled low-strength backfill consisting of a contractor-designed cementitious mixture of fine aggregate, fly ash, portland cement, water, and optional admixtures. Ensure that the resulting mixture hardens with 24 hours to the degree that it will support foot traffic and conforms to the following:

TEST	METHOD	VALUE
Strength	ASTM D4832	40-80 psi in 28 days

- (2) Submit design mix along with strength test results to the engineer at least 10 business days before placing material.

#### 614.2.3 Steel Rail and Fittings

- (1) Furnish galvanized steel rail conforming to AASHTO M180 class A, type II beam except galvanize after fabrication and conform to the single-spot test coating requirements. Furnish plates, anchor plates, post mounting brackets, and other structural steel components conforming to [506.2.2.1](#) and hot-dip galvanized according to AASHTO M111.
- (2) For rail requiring bends with a radius less than 150 feet, ensure that the required bends are made in the manufacturer's fabrication shop.
- (3) Furnish steel tubes for breakaway posts conforming to ASTM A500, grade B and hot-dip galvanized according to AASHTO M111.

#### 614.2.4 Energy Absorbing Terminal

- (1) Furnish energy absorbing terminals (EAT's) from the department's approved products list.
- (2) Furnish reflective sheeting panels constructed from sheet aluminum conforming to the plan details with shop-applied type H reflective sheeting. Ensure that materials conform to [637.2](#) and that the sheeting is attached to the aluminum panels as specified in [637.3.2](#).

- (3) Furnish EAT marker posts from the department's approved products list with shop applied type H reflective sheeting conforming to [637.2](#).

**614.2.5 Wood Posts and Offset Blocks**

- (1) Furnish sawed posts and offset blocks of one of the following species:

Douglas fir	Southern pine	Ponderosa pine	Jack pine	White pine
Red pine	Western hemlock	Western larch	Hem-fir	Oak

- (2) Ensure that posts are the size the plans show and conform to the nominal and minimum dimensions tabulated in [507.2.2.3](#). The contractor does not have to surface the posts. Provide posts of the net length the plans show after setting and cut off.
- (3) Use stress graded posts rated at 1200 psi  $f_b$  or higher. Determine the stress grade rating for douglas fir, western larch, and southern pine as specified in [507.2.2.4](#).
- (4) For hem-fir, hemlock, red pine, white pine, jack pine, ponderosa pine, and oak conform to the following:

SPECIES		WESTERN HEMLOCK, HEM-FIR, RED PINE, WHITE PINE, JACK PINE, PONDEROSA PINE		OAK		
MAXIMUM SLOPE OF GRAIN		1 in 15		1 in 12		
NOMINAL WIDTH OF FACE		6"	8"	6"	8"	
SHAKES, CHECKS, AND SPLITS	GREEN	1"	1 3/8"	2 3/8"	3 1/8"	
	SEASONED	1 1/2"	2"	2 5/8"	3 1/2"	
MAXIMUM WANE		1"	1 3/8"	1 1/8"	1 5/8"	
MAXIMUM ALLOWABLE KNOTS	NARROW FACE	MIDDLE 1/3 OF LENGTH	1 3/8"	1 5/8"	2 1/8"	2 3/8"
		END <sup>[1]</sup>	2 3/4"	3 1/4"	4 1/4"	4 3/4"
		SUM IN MIDDLE 1/2 OF LENGTH <sup>[2]</sup>	11"	13"	17"	19"
	WIDE FACE	EDGE KNOT N MIDDLE 1/3 OF LENGTH	1 3/8"	1 5/8"		
		EDGE KNOT AT END <sup>[1]</sup>	2 3/4" 7	3 1/4"		
		CENTERLINE	1 3/8"	1 7/8"	2 1/4"	2 7/8"
		SUM IN MIDDLE 1/2 OF LENGTH	5 1/2"	7 1/2"	9"	11 1/2"

<sup>[1]</sup> But do not exceed the maximum allowable knot on the centerline of the wide face of the same piece.

<sup>[2]</sup> But do not exceed 4 times the maximum allowable knot on the centerline of the wide face of the same piece.

- (5) Pressure treat posts and offset blocks as specified in [507.2.2.6](#). Use one of the oil-soluble preservatives or chromated copper arsenate conforming to [507.2.3](#). Use the same material for offset blocks and posts and treat material used in each continuous installation with the same type of preservative.

**614.2.6 Sand Barrel Arrays**

- (1) Furnish sand barrels from the department's approved products list. Use sand conforming to [501.3.6.3](#) mixed with sodium chloride conforming to AASHTO M143.

**614.2.7 Crash Cushions**

- (1) Furnish permanent and temporary crash cushions from the department's approved products list. Submit manufacturer design details to engineer before installing.

**614.3 Construction**

**614.3.1 General**

- (1) Paint the ends of cut-off galvanized bolts, cut or drilled surfaces of galvanized components, and areas of damaged zinc coating with 2 coats of zinc dust/zinc oxide paint. Clean the damaged and adjacent areas thoroughly before applying paint.

## **614.3.2 Guardrail**

### **614.3.2.1 Installing Posts**

- (1) Set posts at the required plan locations with the front faces in a straight line or, if on a curve, at a uniform distance from the centerline. Ensure that they are installed plumb, to the required depth, and with adequate lateral stability. The contractor may drive posts or set them in excavated post holes. If rock is encountered, install as the plans show.
- (2) If the required plan depth cannot be achieved by driving, set posts in excavated holes. Replace posts damaged during driving. Ensure driving does not damage the shoulders and adjacent slopes.
- (3) If installing posts in excavated post holes, excavate to the plan depth and compact the bottom of the holes to provide a stable foundation. Set posts to firm bearing and backfill with engineer-approved material compacted in layers.
- (4) Cut post tops to the finished elevation the plans show. Apply 2 coats of wood preservative to the cut surfaces. Use the same preservative originally used to treat the posts or use a 2-percent solution of copper naphthenate conforming to AWWA Standard P8 or P36.

### **614.3.2.2 Installing Rail**

- (1) Install rail with lap splices in the direction of traffic. Make all splices, including splices of existing rail to new rail, at posts. Ensure that the number and dimensions of holes and bolts conforms to the plan details for new splices. Place the round head of bolts on the traffic side.
- (2) Cut rails to length by shearing or sawing and drill bolt holes. Do not use cutting torches. After installation, cut off all anchor bolts that project more than one inch from the nut to 1/2 inch from the nut. Deburr the threaded end of cut bolts.

### **614.3.2.3 Guardrail Terminals and Transitions**

- (1) Attach rail ends to cast in place concrete anchorages, energy absorbing terminals (EAT's) or other terminal types, or transition between rail types at structure approaches as the contract requires for each guardrail system installation.
- (2) If concrete anchorages are specified, place concrete without forms filling the entire excavation with concrete to the elevation the plans show. Ensure that steel reinforcement and the rail are secured at their plan locations before placing concrete. Do not apply forces to the rail element embedded in the concrete anchor until after the concrete develops adequate strength to open it to service under [415.3.15](#).
- (3) If anchoring to structures, attach guardrail to the parapets of structures using anchor assemblies cast into the parapets or drill through the parapet whichever the plan details show.
- (4) Install EAT's according to the manufacturer's instructions and as the plans show. Attach reflective panels to the EAT head with stainless steel self-tapping screws and install EAT markers as the plans show.

### **614.3.2.4 Mow Strips**

- (1) Provide mow strips with blockouts for guardrail posts as the plans show. Construct concrete as specified for concrete sidewalk under [section 602](#) and construct asphalt as specified for asphaltic surface under [section 465](#). Backfill post blockouts after post installation with controlled low-strength backfill.

### **614.3.2.5 Grading, Shaping, and Finishing for Barrier Systems**

- (1) Grade, shape, and finish embankment slopes for barrier systems at the locations the plans show. Furnish materials and construct as the plans show and engineer directs conforming to the following:
  - Common excavation and material disposal ..... [section 205](#)
  - Borrow ..... [section 208](#)
  - Topsoil ..... [section 625](#)
  - Mulching ..... [section 627](#)
  - Fertilizer ..... [section 629](#)
  - Seeding ..... [section 630](#)
  - Construction Staking ..... [section 650](#)

### **614.3.2.6 Temporary Guardrail**

- (1) Provide and maintain temporary guardrail and associated terminals and transitions conforming to the requirements for permanent installations except the contractor may furnish used materials. Replace guardrail components damaged during construction immediately. Remove and dispose of temporary guardrail components when no longer needed.

### **614.3.3 Sand Barrel Arrays**

- (1) Provide sand barrel arrays and foundation at each location the plans show. Have the sand barrel manufacturer design the barrel array layout and determine the sand weights for each individual barrel. Ensure that the manufacturer's design at each plan location conforms to the design speed, shields the required obstruction width, and is appropriate for the traffic direction. Submit a copy of the manufacturer's design details stamped and sealed by a professional engineer to engineer before installation.
- (2) Fill the barrels with a homogeneous mixture of 3 parts dry sand to one part granular sodium chloride by volume. Do not use pre-packaged sand. Do not place the mixture into the barrels in a wet condition.
- (3) Construct concrete foundation pads as specified for concrete sidewalk under [section 602](#) conforming to dimensions the sand barrel manufacturer specifies. For permanent installations, paint the foundation pad to indicate the manufacturer, date of installation, and barrel locations and weights.

### **614.3.4 Crash Cushions**

- (1) Provide and maintain permanent crash cushions at the locations the plans show. Conform to the contract design criteria and to manufacturer's specifications. Certify that the installation was done according to manufacturer's recommendations. Ensure that the upstream ends of crash cushions have reflective sheeting applied before opening to public traffic. Replace parts of crash cushions damaged during construction immediately.
- (2) Provide and maintain temporary crash cushions conforming to the requirements for permanent installations. Remove and dispose of crash cushions when no longer needed.
- (3) Provide concrete backup blocks and either concrete or asphalt foundation pads conforming to the crash cushion manufacturer's design. Construct concrete components as specified for concrete sidewalk under [602.3](#) and construct asphalt components as specified for asphaltic surface under [section 465](#).

### **614.3.5 Adjusting Guardrail**

- (1) Adjust existing guardrail to the plan height. The contractor may raise offset blocks up to 3 inches, and only if that is not sufficient to reach the plan elevation, may raise posts an additional 3 inches if the engineer deems that stability is not compromised. Adjustments over 6 inches require placing new posts.
- (2) Use the existing serviceable guardrail beam, bolts, posts, and offset blocks. Replace existing rail components that are either unserviceable or missing. Straighten existing posts out-of-plumb by 6 inches or more. Straighten existing blocks and reinstall the galvanized nail as the plans show. Replace unstable or deteriorated posts and blocks.

### **614.3.6 Replacing Material**

- (1) Remove and replace unserviceable posts, blocks, rail, and rail hardware at locations within existing guardrail systems where the contract or engineer designates. Take care to avoid damage to adjacent materials remaining in place.

### **614.3.7 Salvaging Material**

- (1) Dismantle and remove the rail, guardrail end treatment, or other component the salvaged bid item indicates from the locations the contract designates. Minimize damage to reusable materials. Do not cut material that would be otherwise reusable. Replace contractor-damaged materials that are to remain in place. Remove and dispose of all wooden component parts and unwanted or damaged materials. Restore the site.
- (2) Sort by component part and load reusable materials onto separate pallets for each component part. The contractor may place hardware and smaller parts in clearly labeled crates or plastic buckets. Stockpile reusable material in engineer-approved locations on the project.
- (3) The contractor may use salvaged materials for temporary installations under the contract.

### **614.4 Measurement**

- (1) The department will measure bid items under this section with EACH as the unit of measure as each individual unit acceptably completed except as follows:
  - The department will measure Sand Barrel Arrays as each individual sand barrel array, including foundation, measured individually for each required plan location.
  - The department will measure Salvaged Sand Barrels as each individual barrel.
  - The department will measure Replacing Guardrail Posts and Blocks as each individual post/block unit whether the post, block, or both are replaced.

- The department will measure Barrier System Grading Shaping Finishing as each individual plan location acceptably completed.
- (2) The department will measure bid items under this section with LF as the unit of measure by the linear foot acceptably completed, measured along the face of the rail element except; the department will measure Steel Plate Beam Median Guard along the centerline of the completed installation.
- (3) The department will measure the mow strip bid items by the square yard acceptably completed, measured without reduction for the area of the post blockouts.

### 614.5 Payment

*Revise 614.5(1) to delete the anchorages for steel plate beam guard bid items.*

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
614.0010	Barrier System Grading Shaping Finishing	EACH
614.0115 - 0149	Anchorage for Steel Plate Beam Guard (type)	EACH
614.0150	Anchor Assemblies for Steel Plate Beam Guard	EACH
614.0200	Steel Thrie Beam Structure Approach	LF
614.0220	Steel Thrie Beam Bullnose Terminal	EACH
614.0230	Steel Thrie Beam	LF
614.0250	Steel Thrie Beam Structure Approach Temporary	LF
614.0300 - 0339	Steel Plate Beam Guard (class)	LF
614.0340	Steel Plate Beam Guard Over Low-Fill Culverts Class A	LF
614.0345	Steel Plate Beam Guard Short Radius	LF
614.0355	Steel Plate Beam Median Guard	LF
614.0360	Steel Plate Beam Guard Temporary	LF
614.0370	Steel Plate Beam Guard Energy Absorbing Terminal	EACH
614.0380	Steel Plate Beam Guard Energy Absorbing Terminal Temporary	EACH
614.0390	Steel Plate Beam Guard Short Radius Terminal	EACH
614.0395 - 0399	Guardrail Mow Strip (material)	SY
614.0400	Adjusting Steel Plate Beam Guard	LF
614.0500 - 0599	Guardrail Stiffened (type)	LF
614.0700	Sand Barrel Arrays	EACH
614.0800	Crash Cushions Permanent	EACH
614.0805	Crash Cushions Permanent Low Maintenance	EACH
614.0905	Crash Cushions Temporary	EACH
614.0920	Salvaged Rail	LF
614.0925	Salvaged Guardrail End Treatments	EACH
614.0930 - 0939	Salvaged (component)	EACH
614.0950	Replacing Guardrail Posts and Blocks	EACH
614.0951	Replacing Guardrail Rail and Hardware	LF
614.1000	MGS Guardrail Temporary	LF
614.1100	MGS Guardrail Temporary Transition	LF
614.1200	MGS Guardrail Temporary Terminal EAT	EACH
614.2300	MGS Guardrail 3	LF
614.2310	MGS Guardrail 3 HS	LF
614.2320	MGS Guardrail 3 QS	LF
614.2330	MGS Guardrail 3 K	LF
614.2340	MGS Guardrail 3 L	LF
614.2500	MGS Thrie Beam Transition	LF
614.2610	MGS Guardrail Terminal EAT	EACH
614.2620	MGS Guardrail Terminal Type 2	EACH

- (2) Payment for the Anchorages for Steel Plate Beam Guard bid items is full compensation for providing concrete anchorages, including concrete and reinforcement; and for excavating, backfilling, and disposing of excess material.

- (3) Payment for Anchor Assemblies for Steel Plate Beam Guard is full compensation for providing anchors in parapet walls.
- (4) Payment for the Steel Thrie Beam, Steel Plate Beam Guard, Guardrail Stiffened, MGS Guardrail, and various transition bid items is full compensation for providing rail, posts and offset blocks, terminal connectors, fittings, and hardware; for repairing damaged zinc coatings; for setting and driving posts; and for excavating, backfilling, and disposing of surplus material.
- (5) Payment for the terminal bid items is full compensation for providing terminals required under the selected system; for EAT reflective sheeting panels and marker posts; for setting and driving posts; and for excavating, backfilling, and disposing of surplus material.
- (6) Payment for the Guardrail Mow Strip bid items is full compensation for providing the paved strip adjacent to the guardrail installation; for concrete or asphaltic surface material; and for controlled low-strength backfill including mix design and testing.
- (7) Payment for Adjusting Steel Plate Beam Guard is full compensation for adjusting existing guardrail. The department will pay separately for replacing unserviceable posts, blocks, rail, and rail hardware under the replacing guardrail bid items.
- (8) Payment for Sand Barrel Arrays is full compensation for providing manufacturer design details for each sand barrel array; for the foundation pad; and for providing each system at the plan location including barrels, sand, and sodium chloride.
- (9) Payment for the Crash Cushions bid items is full compensation for providing crash cushions; for the foundation pads and backup blocks.
- (10) In addition to the work elements enumerated for the various permanent bid items, payment for the temporary bid items also includes removing and disposing of materials when no longer needed.
- (11) Payment for the salvaged bid items is full compensation for dismantling and stockpiling reusable rail, guardrail end treatments, or system elements; for replacing contractor-damaged material remaining in place; for removing and disposing of wooden components and unwanted or damaged materials; and for restoring the site.
- (12) Payment for Replacing Guardrail Posts and Blocks is full compensation for replacing posts and blocks; and for excavating, backfilling, and disposing of surplus material.
- (13) Payment for Replacing Guardrail Rail and Hardware is full compensation for replacing rail and associated hardware.
- (14) Payment for Barrier System Grading Shaping Finishing is full compensation for providing embankment at each barrier system plan location including required construction staking, excavation, borrow, topsoil, mulch, fertilizer, and seeding when the barrier system is outside the contract grading limits. If the work specified in [614.3.2.5](#) falls within the contract grading limits, the department will pay separately for that work under the construction staking, excavation, borrow, topsoil, mulch, fertilizer, and seeding bid items.