UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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02/15, CHG 1: 05/17

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SECTION 34 71 13.16

VEHICLE CRASH BARRIERS
02/15, CHG 1: 05/17

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NOTE: This guide specification covers the requirements for roadside barriers.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 30	(2002; R 2010) Standard Specification for Zinc-Coated Steel Wire Rope and Fittings for Highway Guardrail
AASHTO M 180	(2012; R 2017) Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail
AASHTO MASH	(2016) Manual for Assessing Safety Hardware - Second Edition

ASTM INTERNATIONAL (ASTM)

ASTM A1	(2000; R 2018) Standard Specification for Carbon Steel Tee Rails
ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A242/A242M	(2013; R 2018) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A449	(2014) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

ASTM A499	(2015, R 2020) Standard Specification for Steel Bars and Shapes, Carbon Rolled from "T" Rails
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A588/A588M	(2019) Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A615/A615M	(2020) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A709/A709M	(2018) Standard Specification for Structural Steel for Bridges
ASTM A1035/A1035M	(2020) Standard Specification for Deformed and Plain, Low-carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM B695	(2004; R 2016) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C94/C94M	(2020) Standard Specification for Ready-Mixed Concrete
ASTM D4956	(2013) Standard Specification for Retroreflective Sheeting for Traffic Control
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

NCHRP 350	(1993) Recommended Procedures for the Safety Performance Evaluation of Highway

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

FHWA Acceptance Letter

SD-08 Manufacturer's Instructions

End Anchorage

Submit at least 14 days prior to installation.

Crash Cushion

Submit at least 14 days prior to installation.

PART 2 PRODUCTS

2.1 GUARDRAIL POSTS

Guardrail posts must be either wood or steel and of the dimensions indicated. Unless otherwise indicated, use only one type of post throughout the project.

2.1.1 Sawn Wood Posts and Offset Blocks

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NOTE: Include reference to applicable State DOT specification for wood posts and offset blocks.
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Except as otherwise specified herein, provide wood posts and offset blocks as specified in [_____]. Posts and offset blocks must be of stress grade and capable of resisting a working stress of 11 MPa 1600 psi on the extreme fibers when subjected to bending. Posts and blocks must be double end trimmed with the mounting bolt hole in each being drilled 2 mm 1/16 inch oversize and within 13 mm 1/2 inch of the specified location on either side of the post or block. All wood posts and offset blocks must be rough, free of wane, squarecut, and fully sawn to the dimensions indicated. Drill post bolt holes before preservative treatment is applied. Unless otherwise approved, use only one preservative on the project.

2.1.2 Steel Posts

Fabricate "H" beam sections from steel conforming to either ASTM A36/A36M, ASTM A588/A588M or ASTM A242/A242M and conforming to the size, weight and dimensions indicated. Use bolts must be of the diameters indicated. Bolts used with galvanized ASTM A36/A36M steel must conform to ASTM A307. ASTM F3125/F3125M, Type 3 bolts may be used with ASTM A588/A588M or ASTM A242/A242M steel without galvanizing. Galvanize bolts, posts, and all necessary hardware fabricated from ASTM A36/A36M steel in accordance with ASTM A123/A123M.

2.1.3 Polymer and Polymer Composite Offset Blocks

Pprovide polymer and polymer composite offset blocks certified by the Federal Highway Administration (FHWA) to meet the requirements of either NCHRP 350 or AASHTO MASH. Submit a copy of the FHWA Acceptance Letter.

2.2 W-BEAM GUARDRAIL

Provide galvanized steel beam guard rail elements and fittings of the indicated design and details. The finished steel beam elements must be Class A (base metal nominal thickness 2.67 mm 0.105 inch and conform to the requirements of AASHTO M 180. Galvanizing of steel beam elements must be Type 1 (zinc coated 550 grams per square meter 1.80 ounces per square foot, minimum single spot) and must conform to the requirements of AASHTO M 180.

2.3 "W' BEAM END SECTION

Provide "W" beam end sections of the same or greater thickness of metal and the same type as the beam to which it is attached.

2.4 GUARDRAIL HARDWARE

All fittings (bolts, nuts, washers, etc.) for guardrail must conform to the requirements of AASHTO M 180.

Bolt Use	Bolt Size and Configuration	
Rival Splices	16 mm 5/8 inch diameter	Button head type with oval shoulder conforming to alternative No. 1 or 2 configuration of AASHTO M 180
Fastening Rail to Steel or Timber Blocks	16 mm 5/8 inch diameter	Button head type with oval shoulder conforming to alternative No. 1 or 2 configuration of AASHTO M 180
Rail Splices	35 mm 1.25 inches long	
Fastening Rail to Steel Block	50 mm 2 inches long	Minimum thread length of 45 mm 1.5 inches
Fastening Rail to Timber Block and Post	460 mm 18 inches long	Minimum thread length of 100 mm 2.5 inches
Fastening Steel Block to Post	50 mm 1.5 inches long	16 mm 5/8 inch diameter hex head type

2.5 TERMINAL FOR W-BEAM GUARDRAIL

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NOTE: Guardrail terminals must meet the crashworthiness criteria of NCHRP 350 or the Manual for Assessing Safety of Hardware (MASH). FHWA acceptance letters for various end treatments are available on the FHWA Safety Program webpage.

TL-1, TL-2 and TL-3 are conducted at speeds of 50 km/h, 70 km/h, and 100 km/h respectively. The tests conducted depend on whether the terminal is a gating or nongating device. A gating device is one designed to allow controlled penetration of the vehicle when impacted between the end and the beginning of the length of need of the device. A nongating device is designed to contain and redirect a vehicle when impacted downstream from the end of the device.

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Provide a [flared] [Eccentric Loader Terminal (ELT)] [Modified Eccentric Loader Terminal (SRT)] [Flared Energy-Absorbing Terminal (FLEAT)] [Slotted Rail Terminal (SRT-350)] [tangent] [Extruder Terminal (ET-Plus)] [Sequential Kinking Terminal (SKT-350)] terminal for w-beam guardrail. Provide terminal certified by the Federal Highway Administration (FHWA) to meet the requirements for Test Level [2] [3] of NCHRP 350 or AASHTO MASH. Submit a copy of the FHWA Acceptance Letter.

2.6 CABLE BARRIER

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NOTE: See the AASHTO "Roadside Design Guide" and NCHRP Report 711 "Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems" for information on cable barrier systems.

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2.6.1 Cable

Provide 19 mm 3/4 inch, Type I, Class A coating in accordance with AASHTO M 30.

2.6.2 Cable Splices, Ends, Fittings

Design cable splices and ends capable of developing the full breaking strength of the cable (110 kN) (25,000 lbs). Cable ends must be cast steel or malleable iron. Cable wedges must be malleable iron and not be galvanized. Conform cast steel fittings to ASTM A27/A27M, grade 485-250 70-36. Conform maleable iron fittings to ASTM A47/A47M. Galvanize cable splices, ends, and fittings in accordance with ASTM A123/A123M.

2.6.3 Compensating Device

Provide compensating devices with a spring rate of 78.8 newtons 450 lbs plus or minus 8.8 newtons 50 lbs per millimeter inch and a minimum total available travel of 150 mm 6 inches. Galvanize all parts in accordance with ASTM A153/A153M.

2.6.4 Hook Bolts

Provide hook bolts conforming to ASTM A307 Grade A with a tensile strength of 400 MPa 60 ksi and a yield strength of 240 MPa 36 ksi. Provide corrosion-resistant bolts manufactured from ASTM F3125/F3125M Type 3 material, with a tensile strength of 830 MPa 120 ksi and a yield strength of 660 MPA 92 ksi. Hook bolts must develop an ultimate pull open strength, applied in a direction normal to the longitudinal axis of the post, from 2 to 4.5 kN 500 to 1000 pounds. Use galvanized nuts conforming to ASTM A563M Class 5 ASTM A563 Grade A. Use corrosion-resistant nuts conforming to ASTM A563M Grade 8S3 ASTM A563 Grade C3. Finish galvanized bolts and nuts according to ASTM A153/A153M for Class C or ASTM B695 for Class 50. If galvanized, overlap the threads as specified in ASTM A563M ASTM A563.

2.6.5 Steel Posts

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NOTE: Cable guardrail designs typically include either structural steel I beam posts or flanged channel steel posts.

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2.6.5.1 Structural Steel Posts

Provide structural steel posts and anchor plates conforming to ASTM A36/A36M. Galvanize in accordance with ASTM A123/A123M.

2.6.5.2 Flanged Channel Posts

Fabricate flanged channel posts from rerolled rail steel bars conforming to ASTM A499, Grade 415 60 except that the minimum yield strength must be 480 Mpa 70,000 psi. The post must meet the chemical properties of ASTM A1 for rails 44.56 kg/m 30 pounds per foot and heavier.

2.6.6 Anchor Assembly

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NOTE: Cable is typically anchored to a concrete foundation with steel rods or hook or J bolts.

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Provide steel cable anchor brackets conforming to ASTM A709/A709M Grade 250 36 or ASTM A36/A36M.[Provide anchor posts and anchor post plates conforming to ASTM A36/A36M.] Galvanize cable anchor brackets[, anchor posts, and anchor post plates] after fabrication in accordance with ASTM A123/A123M. Provide steel [rods] [hook or J bolts] conforming to ASTM A449 or ASTM A568/A568M and galvanize the top 150 mm 6 inches in accordance with ASTM A123/A123M. Provide hex nuts conforming to ASTM A563M ASTM A563.

2.6.7 Concrete

ASTM C94/C94M, using 19 mm 3/4 inch maximum aggregate, and having minimum compressive strength of 28 MPa 4000 psi at 28 days. Reinforcing steel must be deformed bars conforming to ASTM A615/A615M, ASTM A706/A706M, or ASTM A1035/A1035M grade 280 40.

2.7 CRASH CUSHION

Provide redirective, non-gating, bi-directional type crash cushion as indicated. Crash cushion must be certified by the Federal Highway Administration (FHWA) to meet the requirements for Test Level [2] [3] of NCHRP 350 or AASHTO MASH. Submit a copy of the FHWA Acceptance Letter.

2.8 RETROREFLECTIVE SHEETING

Provide retroreflective sheeting conforming to ASTM D4956, Type III, IV, V, VII, VIII, IX or XI. All retroreflective sheeting must have a precoated adhesive which will permanently adhere to the metal surface.

PART 3 EXECUTION

3.1 POSTS

Posts may be placed by driving or by setting in excavated holes. Post holes for guardrail posts must be round and at least 100 mm 4 inches larger, in diameter, than the greater dimensions (not the diagonal) of the posts, and must be backfilled around the posts with material removed or other suitable soil, placed in lifts not exceeding 100 mm 4 inches, each lift thoroughly tamped. When placed by driving, drive the posts plumb, to the depth and in the position indicated. Remove posts which are broomed, split or damaged in any other way and replace with a sound post. Carry on driving operations in such manner that nearby structures, shoulders, or pavements are not damaged. Cuts and abrasions in preservative-treated posts and blocks must have the newly exposed surfaces treated with at least three applications of the same type of preservative with which the

material was originally treated. Each application must be reasonably dry before the succeeding coat is applied. At the time a timber post is installed, any seasoning check which extends the full length of the piece cannot exceed 6 mm 1/4 inch in width. Adjust posts used for vertical transition in length so that a minimum of 1550 mm 60 inches will be buried. Where guardrail cross buried structures and 1550 mm 60 inches of bury is not obtainable, install the guardrail post as deep as possible and with a 610 mm 24 inch diameter concrete encasement for the full depth of bury.

3.2 GUARDRAIL BEAM ELEMENTS

Place and fasten the beam elements, fittings, and other parts of the guardrail as indicated. Erect the elements to produce a smooth, even rail, closely conforming to a line and grade parallel to the pavement. Bolt the beam elements to each post, and make splices by lapping in the direction of traffic. Splice only at posts. Where the rail is on a curve, the beams at the splice must make contact throughout the area of the splice, forming a continuous beam before erection. On curves of 45 m 150 foot radius or less, install shop bent beam elements, bent to the radius indicated. Tighten all bolts in the finished rail.

3.3 GUARDRAIL DELINEATOR REFLECTOR TABS

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NOTE: This paragraph is applicable for metal guardrail delineator tabs with retroreflective sheeting. Delete paragraph if other types of delineators are used.

****

Clean, degrease and etch the face of metal tabs using methods recommended by the retroreflective sheeting manufacturer. After cleaning and degreasing, apply retroreflective sheeting material to the metal tabs as recommended by the manufacturer. Perform shearing, cutting and punching prior to preparing the blanks for application of reflective material.

3.4 GUARDRAIL END ANCHORAGE

Install flared and non-flared end anchorages in accordance with the manufacturer's instructions. Submit a copy of the manufacturer's end anchorage installation instructions prior to installation.

3.5 THREE CABLE GUARDRAIL

3.5.1 Posts

Set all posts plumb and firm and spaced as indicated. Posts may be power driven or set by hand. Protect the top of steel posts by a suitable driving cap if power driven.

3.5.2 Cable Splices, Compensating Devices and Turnbuckle Cable End Assemblies

Stagger cable splices. Provide a minimum of 6 m 20 feet between any pair. Provide a minimum of 30 m 100 feet between cable splices on the same cable. For length of cable runs up to 305 m 1000 feet, use a compensating device on one end and a turnbuckle on the other end of each individual cable. For length of cable runs from 305 m 1000 feet to 610 m

2000 feet, use a compensating device on the ends of each individual cable. For length of cable runs over 610 m 2000 feet, start a new stretch by interlacing at the last parallel post.

3.5.3 Pretension of Cable

Install and tension the cable barrier as follows:

a. Properly seat the spring in the compensator device and permanently mark the unloaded spring position on the compensator rod.

b. Install spring end assemblies at one end of the barrier and secure to the anchor.

c. With cable strung through the hook bolts, introduce tension into the cable at the opposite end of the barrier to compress the installed springs approximately 90 mm 3.5 inches.

d. Clamp this tension in the cable while the end assemblies are installed at the second anchor.

e. Remove the slack between the clamp point and the second anchor by taking up the turnbuckle. If springs are also used at this end, compress them approximately 90 mm 3.5 inches.

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NOTE: The cable barrier detail drawing should include a table indicating the required spring compression from the unloaded position for various temperatures.

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f. After two weeks at this setting, reset the spring compression as indicated based on the temperature at the time of adjustment.

3.6 CRASH CUSHION

Assemble and install crash cushions as indicated and in accordance with the manufacturer's instructions. Submit a copy of crash cushion manufacturer's installation instructions.

-- End of Section --