

Design Standards Letter

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Section/Plan No.: **D4-09, D6-04, D6-05**

Subject: **Guard Rail Design**

Body

Attached for your use are advance copies of changes to Chapters 4 and 6 of the Policy Procedure and Design Manual. These revisions are necessary to implement updated guard rail design procedures and will be incorporated into the manual at such time as Chapters 4 and 6 are reissued.

Please advise if you have Questions concerning the above.

4-09.8 Guard Rail. Guard rail is used to protect traffic from roadside obstacles, or to restrict or prohibit traffic movements. The basic principal for the use of guard rail will be used when the severity of an accident involving the obstacle would be greater than the severity of an accident involving the protective guard rail.

(1) DEFINITIONS.

TYPES - Type A, single W beam rail with 6'-3" post spacing.

Type B, double W beam rail with 6'-3" post spacing generally for use in median

Type D, single W beam rail with 12'-6" post spacing for use at end of road or street.

Type E, single three beam rail with 3'-1 1/2" post spacing.

BREAKAWAY

CABLE

TERMINAL

(BCT) - The BCT is 37.5 feet in length, and is attached to a W-beam rail system as shown on Standard Plan 606.00. Redirection begins at the third post, or 12.5 feet from the approach end.

END

ANCHOR - A modified BCT without a buffer end to develop the full strength of the rail system.

EMBEDDED

END

ANCHOR - an end anchorage system for rail whereby the rail is embedded in a concrete block and buried in the backslope.

ROCK FACE

END

ANCHOR - an end anchorage system for rail whereby the rail is bolted to a rock face.

BLOCKOUT - spacer block to separate the guard rail beam from the post used on all types of guard rail.

(2) END TREATMENT. All approach ends of guard rail as illustrated by the Standard Plans are provided with a BCT and a separate payment is made for each BCT. All downstream ends shall be provided with an End Anchor or BCT to develop the strength of the rail.

(3) HIGH FILLS. Guard rail for embankments is specified on plans for roads with 400 ADT or more. For roads under 400 ADT, guard rail is optional, however, good design judgement should require guard rail when conditions warrant. Guard rail will not normally be warranted because of embankment height for projects where clear zones are utilized. However, guard rail may be warranted as shown on figure 5.1 in the AASHTO Roadside Design Guide. Combinations of embankment height and slope that plot above the curve indicate conditions are less severe without guard rail. However, other factors contributing to accident severity such as hazards located either on or at the toe of the slope should be taken into consideration.

(4) FIXED OBJECTS. Guard rail protection for fixed objects such as trees or utility poles may be necessary. If this protection is required, the protection is determined from the near lane on one direction roadways and from both lanes on a two direction roadway. Guard rail is warranted in advance of any fixed object located within the clear zone provided the object is potentially more damaging than the guard rail if struck by a vehicle and the object cannot be economically removed, relocated, or made crash worthy by means of breakaway type construction. The fixed object is termed the area of

concern and the required type and length guard rail depends on the size of the object, the distance from the travel way, the ADT, and the design speed. The length of need of guard rail is the length of the obstacle plus the length of the approach barrier adjacent to traffic (opposing lane, if needed). The length of need and the flare rate of the guard rail shall be determined in accordance with the procedures contained in Section 5.6.4 of the ASSHTO Roadside Design Guide utilizing an encroachment angle of 15 degrees. The general geometrics covering the length of need are illustrated on Figure 5.31 of the Roadside Design Guide.

(5) BRIDGE ENDS. Guard rail is placed at approach ends of bridges in accordance with typical locations shown in the Standard Plans for all roads with 400 ADT or more. For roads under 400 ADT guard rail is optional and should be provided when good design practices indicate guard rail is necessary. Projects which do not provide for bridge approach rail should be submitted as design exceptions to the 1989 AASHTO Guide Specifications for Bridge Railings. BCT sections are provided on guard rail placed for bridge end protection. Guard rail placed for bridge end protection is anchored to the bridge end by a Bridge Anchor Section. Where guard rail at the exit end of a one-way bridge is necessary because of a high fill or other conditions, the guard rail is connected to the Bridge Anchor Section. Guard rail is not generally used to protect traffic from the ends of bridges carrying a cross-road or street over the through lanes in developed areas where speed controls exist or sidewalks are provided. If however, at ends of such bridges the roadway is in a high fill or has sharp curvature, guard rail may be considered.

(6) BRIDGE PIERS AND SIGN TRUSSES. Guard rail is specified for protection of traffic from bridge piers and sign trusses with the exception of those piers and trusses where the pier or truss footing is located outside the clear zone. Typical treatments are indicated in the Standard Plans.

(7) SIGNS. Guard rail is specified to protect traffic from sign posts which cannot be equipped with a breakaway assembly. Typical treatments are indicated in the Standard Plan.

(8) OUTER ROADWAYS. Criteria for guard rail use on outer roadways is the same as for other roads except for the shoulder side adjacent to a thru lane. Guard rail is specified along outer roadways where the outer roadway is 10 feet or more above the main roadway, and the shoulder of the outer roadway is less than 25 feet from the top of the roadway backslope. Sometimes it is more economical to move the outer roadway back sufficiently to eliminate the requirement for guard rail. Guard rail along outer roadways is installed with

the face of the rail facing the outer roadway. Type B rail may be required if the guard rail is within the limits of the clear zone for the through lanes.

(9) HEADWALLS. Guard rail is not used to protect traffic from headwalls located outside of the shoulder line of roadways without clear zones unless warranted by high fills. An exception to this would be on an interstate safety modification project where clear zones are not added and where it may not be economically feasible to extend a large box culvert to locate the headwall outside the clear zone point.

(10) MEDIANS. See Subsection 4-04. Guard rail may be specified in medians to provide a positive barrier. Guard rail may also be specified to convert an existing raised curb median to a barrier median provided the guard rail is placed with the face at the face of the curb and the center of the rail 21" above the pavement elevation at the curb face. Type B guard rail may be used on a raised median width of 2' face to face. For greater widths, two single lines of Type A guard rail will be required. For medians of variable widths a detail in the standard plans provides for transitions from Type B to Type A guard rail. BCT sections are added only at the beginning and ending of a total run of guard rail and not at each break caused by intersections and crossovers. Breaks caused by intersections and crossovers will be closed by means of a crashworthy special end treatment. For Medians on divided pavements where grade differentail will not permit standard clear zones, the slope should be modified to provide as safe a slope treatment as possible. Guard rail will not be required except for exceptional or unusual conditions.

(11) RESTRICTED LATERAL CLEARANCE. When piers or other obstacles require guard rail treatment, the back of the guard rail post is to be placed 4' from the pier or obstacle. Where the clearance obtained is less than 4' but more than 2', 25' of Type E guard rail shall be used preceding and through the limits of the obstacle. There will be situations with narrow shoulders or with curbed medians when encroachments is not permitted. In such cases, Type E guard rail should be specified requiring 25' preceding the obstacle and extending through the limits of the obstacle as required. The minimum offset to the obstacle can be eliminated completely by attaching the rail to the obstacle by use of a bridge anchor section.

(12) BARRICADE OF EXISTING STREETS AND ROADS. Where a street or road which is essentially rural in nature is to be closed for a period of time not to exceed approximately five years, permanent barricades as shown on Standard Plan 612.10 are specified. Where the closing of the street or road is

anticipated to exceed approximately five years duration in essentially rural areas, and for closing streets or roads in essentially urban areas regardless of time, either Type IV Object Markers only or a combination of Type IV Object Markers and Type D guard rail is specified. Where no hazard exists beyond the end of the closed street or road for a reasonable distance, Type IV Object Markers are sufficient for delineation. Where a hazard exists beyond the end of the closed street or road which is considered equal to or greater than that created by the use of guard rail, a combination of both Type IV Object Markers and Type D guard rail is specified.

(13) PLANS. Guard rail details and typical locations for installation are shown in the Standard Plans. Guard rail is as shown by proper legend on the plan sheets and the station location and quantities are tabulated on the 2B sheets. Quantities are tabulated in 12.5 foot increments. Curved sections of guard rail are to be installed on curves with a radius of 150' or less. The plans specify the lengths of curved guard rail and the radius of curvature. Curved guard rail is not tabulated separately on the plans. Examples of guard rail delineation and tabulation is shown in the Sample Plans Section 4-10.

(14) URBAN SECTION, CURB AND CURB AND GUTTER. Where barrier curb is used, guard rail is placed with the face at the face of curb and the center of the rail 21" above the pavement elevation at the curb face. Where mountable curb is used, guard rail is placed with the face at the edge of the usable shoulder and the center of the rail 21" above shoulder elevation. Where curb and gutter is used, guard rail is placed with the face at the face of curb and the center of the rail 21" above the gutter line.

4-09.9 HANDLING TRAFFIC. The policy of the department is to provide adequate means for handling traffic around or over roadway construction without undue inconvenience, and always with safety. All plans provide a detail of handling traffic in accordance with Section 8-04.

4-09.16 CLEAR ZONES. Appropriate typical sections are selected for a project using Figure 4-04.1 General Design Data and recommendations from the Reconnaissance Report.

(1) DEFINITIONS. The clear zone is defined as the roadside border area measured from the edge of the pavement that is available for the safe use by errant vehicles as determined in accordance with Chapter 3 of the AASHTO

(2) THE USE OF CLEAR ZONES IS ADMINISTERED AS FOLLOWS. Clear zones are

provided where the design speed of the roadway is 50 mph or more. For less than 50 mph, clear zones should be considered if economically feasible. Non-traversable slopes or fixed objects should be removed, relocated, or shielded by a barrier if they are within the indicated minimum clear zone width and if it is cost effective to do so. Higher speeds will result in vehicles traveling further before recovery. Horizontal curvature will increase the likelihood of a vehicle leaving the travel way and will increase the distance it will travel. Steeper fill slopes will also increase the distance the vehicle travels off the travel way. It is important in the implementation of the clear zone concept that the clear zone distances should not be used as boundaries for introducing roadside hazards such as bridge piers or trees. These should be far from the travel way as is practical. The clear zone width should be applied with good judgment. If an obstacle lies just beyond the clear zone, it should be removed or shielded if costs are reasonable. Conversely the clear zone should not be obtained at all costs. Limited right of way or high construction costs may lead to the installation of a barrier or possibly no protection at all. As may be noted, roadside slopes play an important part in the clear zone width determination. For example, changing from a 3:1 to a 4:1 slope will reduce the required clear zone width by approximately 50% in most cases. If feasible, the flattening of slopes is preferable to installation of guard rail. In cut sections, the ditch configuration must be considered if clear zones are provided. Figure 3.7 in the Guide should be checked for preferred ditch cross sections. Ditch sections must be within the shaded portions of the guides for use with clear zones. A computer program for computing the required clear zone width has been furnished to the districts. The computer diskette also contains a cost-effectiveness selection procedure to be used when obstacles are encountered within the clear zone width. Background for this procedure is contained in Appendix A of the Roadside Design Guide.

(a) FOR BRIDGES AND CULVERTS:

- 1. Clear zones, when used, shall be carried full width to bridge ends. Where the existing roadway is to be incorporated into completed facility as part of the main roadway, the use of clear zones will be considered on an individual project basis.**
- 2. The use of the clear zone typical sections is not applicable for small culvert replacement projects where the intent is to continue the service of the road without upgrading it. In this case, the typical sections used in the original construction should be used except that**

the roadbed width should not be less than 24 feet.

3. In shallow fills and in cuts where box or pipe culvert normally require a head wall to be located in the clear zone, the structure should be extended to place the head wall at the outer edge of the clear zone. The slope of the clear zone will then require modification to provide cover over the entire surface.

(b) UNUSUAL CONDITIONS

1. Where Steep sidehill conditions exist and standard clear zone slopes will not catch the ground steeper slopes must be used. In these cases, the clear zone may be omitted and guard rail used at the shoulder line. Desirable minimum length for elimination of clear zone is 500 feet but no case less than 250 feet.

2. For long fill section through a reservoir project, clear zones can be eliminated and guard rail used at the shoulder lines.

3. Speed change lanes adjacent to main roadways are to be placed within main roadway clear zone with no further widening of clear zone. The clear zone is always located adjacent to and measured from the normal edge of the pavement of the main roadway including climbing or continuous auxiliary lanes.

SECTION 6-05.9 (d) Wherever the resurfacing of the travel way and the shoulders affects the height characteristic of the existing rail by more than 3 inches, such rail will be brought fully up to the present standards. Height variations to a maximum of 3 inches plus or minus from standard will not require adjustment. Deviations from the Standard Plans such as not being able to obtain the two foot distance behind the post to the break point will be considered to constitute a special case and justification recommendations should be submitted to the Headquarters Office.

SECTION 6-04.2 Stabilized shoulders are provided for rigid pavements with a design traffic 1700 ADT or more; and with a design traffic less than 1700 ADT if clear zones are used or in urban areas. Stabilized shoulders are provided for flexible pavements from Design Curves 2 through 5; and for Design Curve 1 if clear zones are used or in urban areas. Stabilized shoulders for flexible pavements from Design Curves 2 through 5 are an integral and necessary part of the pavement structure and are, therefore, considered together as a design configuration. Shoulder stabilization is illustrated on Figures 6-04.1 thru 6-04.7. Widening necessary for guard rail placement shall consist of earth or

other suitable fill material.