
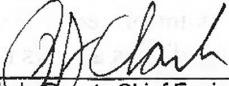


<p>MODIFIED BY EI 98-017 EFFECTIVE 6/25/98 & EB 00-052 EFFECTIVE 10/31/00 SUPERSEDED BY EB02-019 EFFECTIVE 9/12/02</p>		<p>New York State Department of Transportation ENGINEERING INSTRUCTION</p>	<p>EI 98-004</p>
<p>Title POINT-OF-NEED DETERMINATION AND RUN OUT LENGTH DETERMINATION FOR GUIDE RAIL RUNS THAT USE GATING END TERMINALS</p>			
<p>Distribution:</p> <p><input type="checkbox"/> Manufacturers (18) <input type="checkbox"/> Surveyors (33)</p> <p><input checked="" type="checkbox"/> Main Office (30) <input checked="" type="checkbox"/> Consultants (34)</p> <p><input type="checkbox"/> Local Govt. (31) <input type="checkbox"/> Contractors/AGC(39)</p> <p><input checked="" type="checkbox"/> Regions/Agencies (32) <input type="checkbox"/> ()</p>		<p>Approved:</p> <p> P. J. Clark, Deputy Chief Engineer, Design Division 02/03/98 Date</p>	

ADMINISTRATIVE INFORMATION. This instruction becomes effective 4/3/98. It modifies §10.2.2.1 of the *Highway Design Manual (HDM)*. Its contents will eventually be incorporated into the *HDM*. Nothing is transmitted.

PURPOSE. This instruction revises how points-of-need for guide rail are determined at the approach ends on one-way roads when “gating” type end terminals are used and at all four of the ends of guide rails installed on two-way roads when “gating” type end terminals are used there. Departure end point-of-need determinations on one-way roads, point-of-need determinations when customary turned-down end terminals are used, and run out lengths for non-bypassable hazards will continue to be made as indicated in the *HDM*. The term “gating” means that some portions of the end terminal are designed to break away and permit the impacting vehicle controlled penetration behind the end terminal.

BACKGROUND. Point-of-need, current definition. The *Highway Design Manual* defines the point-of-need for guide rail at the approach end as being the intersection of the line of guide rail and a line drawn from the rear most point of a protected object and angling upstream and toward the road. For interstates and other freeways, the angle is 10° and for other facilities it is 15°. The angle is measured at the edge of the traveled way.

Terminal Section at approach end. By reference to the Standard Sheets, the *Highway Design Manual* also requires terminal sections. As depicted on the Standard Sheets, terminal sections consist of sloped end terminals and certain indicated lengths of full height straight and/or shop curved guide rail. Terminal sections at the approach ends are placed immediately up stream of the point-of-need and their purpose is two-fold. First, they tension or strengthen the rail at the point of need thereby providing lateral rigidity at that point; and second, they help to close off the area behind the guide rail within the length of need so that errant vehicles are less likely to hit the protected object.

In the case of the heavy post blocked out guide rail, the terminal section at the approach end consists of 11.43 m of full height shop curved guide rail and the same length of full height straight guide rail connected to a 7.62 m sloped end terminal. The sloped end terminal varies in height from full rail height of 685 mm down to 100 mm. At the lower end, it is bolted to a concrete anchor.

In the case of the box beam guide rail, in the standard configuration, 21.95 m of full height shop curved guide rail is provided in the terminal section. This is connected to a sloped end terminal (Type I End Assembly) which is approximately 2 m long. Concrete anchors are not used with the box beam guide rail.

End terminals. NYSDOT guide rail standard sheets depict turned-down end terminals. As described above, end terminals are a component of terminal sections. End terminals are safety articles covered by the federal rule requiring that their crash worthiness be demonstrated through *National Cooperative Highway Research Report 350 (NCHRP 350)* crash

tests¹. The end terminals depicted on the Standard Sheets have not been tested to NCHRP 350 criteria. Except possibly for the Type II End Assembly used for box beam guide rail, there are no plans for any of the turned-down end terminals on our Standard Sheets to be crash tested to these criteria. There are, however, a number of proprietary end terminals which have been successfully crash tested. Generally, these end terminals are either 11.4 m (37.5 feet) long or 15.2 m (50 feet) long. Most have eight posts, some of which are breakaway posts installed in steel foundation tubes.

Problem. In the crash tests, most of the passing end terminals contained and redirected the impacting vehicle starting at the third post from the free end. Vehicles impacting upstream of post 3 easily broke through the first two posts, which are said to "gate." National literature and manufacturer's literature therefore have identified post number 3, which is located 3.8 m (12.5 feet) from the free end of the end terminal, as being the "beginning-length-of-need." Sometimes they also refer to that post as the "point-of-need". For us in New York, the latter national terminology is indeed unfortunate because the term "point-of-need" has always meant something different to us.

If we were to place the nationally defined "point-of-need" of the end terminal coincident with the state defined "point-of-need" for the approach end of the guide rail, determined by either the 10° or 15° rules, a hazardous design could result if the protected object were compact and close to the guide rail. This instruction is to address that problem.

Obstacle free rectangular area. Because the impacting vehicle easily breaks through the "gating" portions of gating end terminal and easily passes into the area behind the barrier, the Federal Highway Administration (FHWA) directs that there be an obstacle free, reasonably traversable "rectangular" area provided in back of the end terminal. This reasonably traversable² area extends 6 m behind the end terminal and 23 m downstream from the free end. FHWA cautions however that this obstacle free rectangular area will not necessarily accommodate all impacts that might occur.

POLICY. On projects without reduced design clear zone widths, or without other restrictions, whenever using gating end terminals³, it will be policy to adjust guide rail runs to provide the obstacle free area behind the end terminal as a general minimum. In specific cases the dimensions of the obstacle free area may be reduced depending on the type of end terminal and project conditions. The 23 m is measured from the free end of the end terminal and, after the effect of the two gating posts is considered, will provide 19 ± m "run out" distance measured between the third post (the demonstrated beginning length-of-need under the federal definition) and the upstream face of the protected object. Because it is recognized that the obstacle free rectangular area, and therefore the associated 19 ± m "run out" distance, may not be sufficient to accommodate all errant vehicles, a longer "run out" length of guide rail is desirable and should be provided whenever conditions permit.

There are a variety of acceptable methods that can be used to determine how much "run out" should desirably be provided. The simplest of these acceptable methods would be to provide enough full height rail upstream of the protected object so that the total amount of full height rail provided as "run out", measured between the upstream face of the protected object and the third post from the free end of the gating type end terminal, matches the amounts of

¹ See EI 97-014 and 97-016 for discussion of this rule. The rule is a result of ISTE A and now indicates that all safety articles included in contracts advertised after 9-30-98 or installed under force account work after that date must be of a type that passed the crash tests described in NCHRP 350. The information in this footnote is updated from the information provided in the referenced EIs.

² See HDM §10.2.1.2 for definition of traversable. Basically "traversable" means 1:3 or flatter, smooth, and without obstacles.

³ ET 2000, Slotted Rail Terminal, and Wyoming Box Beam End Terminal(WYBET) are all gating end terminals.

guide rail presently being provided under our present methods. For example, using the 10° rule⁴ from the *HDM* with heavy post blocked-out corrugated beam guide rail, the amount of rail we would presently provide is indicated by the formulae:⁵

$$\begin{aligned}\text{Run out length (meters)} &= 23 \text{ m} + 5.67L_{OD}, \\ \text{Run out length (feet)} &= 75 \text{ ft} + 5.67L_{OD}\end{aligned}$$

where: L_{OD} is the lateral distance between the face of the guide rail and the rear of the protected object; the 23 m (75 ft) is the length of the full height portion of the terminal section exclusive of the end terminal; and the 5.67 coefficient is cotangent (10°).

The formulae that would provide the same amount of full height rail as our present 15° rule with HPBO guide rail is given below:

$$\begin{aligned}\text{Run out length (meters)} &= 23 \text{ m} + 3.7 L_{OD}, \\ \text{Run out length (feet)} &= 75 \text{ ft} + 3.7 L_{OD}.\end{aligned}$$

Where the 3.7 coefficient is cotangent (15°) and the desirable amount of additional runout length is 4 m + 3.7 L_{OD} . For box beam subtract one meter (1 m) or three feet (3 ft.) from the lengths calculated above.

The 6 m distance behind the end terminal may be reduced on projects with reduced design clear zone widths. On such projects, the cleared distance behind the end terminal need not be any greater than the design clear zone width established for that project. For example, if the design clear zone width of the project has been established as five meters (5 m) because that is the distance from the traveled way to a line of aged and stately trees that cannot be removed, the obstacle free area behind the gating end terminal may be reduced to become five meters (5 m).

Also, a minor reduction in the 23 m longitudinal distance, while not desirable and not approved as a general practice, is also tolerable in special cases. The actual length depends upon what kind of end terminal has been chosen. If larger reductions are needed, consider a different type end terminal or an impact attenuator. If none of these things are feasible, treat the matter as constituting a provision of or retention of a substandard feature.

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⁴ See HDM§10.2.2.. 10° applies on freeways and interstates. 15° applies elsewhere.

⁵ These formulae agree very closely with the graphs given in TRR 1528 "Guardrail Run out Lengths Revisited" by Dan Wolford and Dean Sicking. These graphs may be used as well.