NRA TD 19/02

SAFETY BARRIERS

AMENDMENT No. 1

April 2003

NRA Standard NRA TD 19/02 – Safety Barriers – dated April 2002 is amended as follows. The amendments clarify the requirements for safety barriers at parapets and adjacent to railways, and revise the requirements for Working Width on verges, Departure Lengths on dual carriageways and emergency crossovers.

1. Pages 5/3 to 5/8 (Paragraphs 5.6 to 5.55, Table 5/3 and 5/4 and Figure 5/2) dated April 2002 are replaced with the revised Pages 5/3 to 5/8 dated April 2003 as enclosed. **Table 5/4 and Paragraphs 5.24, 5.37, 5.38 and 5.51 have been revised and Paragraphs 5.52 and 5.53 deleted**.

2. This Amendment shall be implemented forthwith in accordance with Paragraph 1.8 of NRA TD 19/02.

3. All technical enquiries or comments on this Amendment or NRA TD 19/02 should be sent in writing to:

   Head of Project Management and Engineering
   National Roads Authority
   St Martin's House
   Waterloo Road
   Dublin 4

.....

E O'CONNOR
Head of Project Management and Engineering

INSTRUCTIONS FOR USE

1. Remove existing cover sheet, contents page and pages 5/3 to 5/8 inclusive.

2. Insert the replacement pages as enclosed.

3. Insert this Amendment sheet between the contents page and the cover sheet.

Volume 2 Section 2
Part 8A
NRA TD 19/02
and Amendment No. 1

National Roads Authority
An tÚdarás um Bóithre Náisiúnta

Safety Barriers

April 2003

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Summary:

This Standard gives the requirements for roadside Safety Barriers and their terminals and transitions on new roads.

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2003

VOLUME 2 HIGHWAY STRUCTURES: DESIGN (SUBSTRUCTURES AND SPECIAL STRUCTURES) MATERIALS

SECTION 2 SPECIAL STRUCTURES

PART 8A

NRA TD 19/02
and Amendment No. 1

SAFETY BARRIERS

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Chapter

Impact Severity Level

5.6 Impact Severity Level is measured as a function of the Acceleration Severity Index (ASI), the Theoretical Head Impact Velocity (THIV) and the Post-impact Head Deceleration (PHD). IS EN 1317-2 defines these terms and describes how they should be measured. The two levels given in the Standard are shown in Table 5/2.

5.7 Impact Severity Level A affords a greater level of safety for vehicle occupants than Level B (see Paragraph 5.11).

Working Width

5.8 Working Width (W) is the distance between the side facing the traffic before impact of the safety barrier and the maximum dynamic lateral position under test of any major part of the system. If the vehicle body deforms around the road restraint system, the maximum lateral position of any part of the vehicle shall be taken as an alternative. Examples of Working Width are illustrated in Figure 5/1.

5.9 Working Width is specified as one of the classes listed in Table 5/3.

Class of Working Width	Level of Working Width
W1	≤ 0.6 m
W2	≤ 0.8 m
W3	≤ 1.0 m
W4	≤ 1.3 m
W5	≤ 1.7 m
W6	≤ 2.1 m
W7	≤ 2.5 m
W8	≤ 3.5 m

(Source: IS EN 1317-2)

Table 5/3: Working Width Classes

Provision Criteria

5.10 On new roads with a Design Speed of 85km/h or more, a safety barrier shall be provided where there is a hazard within the Clear Zone. At the locations described in Table 5/4, the barrier shall have at least the Containment Level indicated.

5.11 Barriers on verges should have Impact Severity Level A and barriers on central reserves should have an Impact Severity Level no worse than B. However, on central reserves wider than 7.5m, provision of Impact Severity Level A is preferred. The use of Impact Severity Level B on verges or on central reserves wider than 7.5m shall constitute a Relaxation, for which justification will be required.

5.12 The Designer shall agree the provision of safety barriers with the National Roads Authority where:-

a) the Design Speed is less than 85 km/h; or

b) there are exceptional local hazards or conditions which are not identified in Table 5/4 or which are considered to warrant an increase in the containment level. Account shall be taken, for example, of an unusually high percentage of Heavy Commercial Vehicles in deciding whether to increase the containment level of the safety barrier at any particular location.

5.13 Where several hazards are in close proximity, the highest required Containment Level shall be provided throughout the safety barrier length.

Set-back

5.14 The Set-back is the dimension between the traffic face of the safety barrier and the edge of the road pavement. It should be noted that the road pavement includes any hard shoulder or hard strip.

5.15 The minimum Set-back on a verge shall be 1.2m. This may be reduced to 0.6m if a hard strip or hard shoulder is present or where the road Design Speed is 85km/h or less.

Location		Containment Level
1. Within the Clear Zone:		
Embankments:		
Slope Angle	Slope Height	
Steeper than 1:2 (see Note 3)	≥0.5	**N2**
Between 1:2 and 1:3 (inclusive)	>2m	**N2**
From 1:3 and up to 1:5	≥6m	**N2**
Cuttings:		
At steep sided cuttings or earth bunds (steeper than 1:2) within the Clear Zone.		**N2**
Verges and Central Reserves:		
a) At individual hazards such as bridge piers or abutments, sign posts, gantry legs and trees, etc. (see Chapter 3) (see Note 4).		**N2**
b) At lighting columns greater than 14.5m high.		**N2**
c) At substantial obstructions such as retaining walls which present a smooth traffic face for at least 1.5m above the carriageway level.		**N2**
d) At underbridges or at retaining walls >0.5m high supporting the road, where a vehicle parapet or vehicle/pedestrian parapet of the required performance class is not provided.		**N2**
Central Reserves:		
a) At central reserves up to 7.5m wide.		**H2**
b) At central reserves greater than 7.5m wide but not exceeding 15m wide.		**N2**
c) Where the difference in adjacent carriageway channel levels exceeds 1.0m and the slope across the reserve exceeds 1:4.		**H2**
Parapets (see BD 52)**:**		
For a minimum of 30m in advance of the approach end and 15m after the departure end of a vehicle parapet or vehicle/pedestrian parapet (see Note 5).		**N2** (but not less than the parapet)
For a minimum of 30m in advance of the approach end and 15m after the departure end of a vehicle parapet or vehicle/pedestrian parapet over a railway (see Note 5).		**H2** (but not less than the parapet)
2. Within or Beyond the Clear Zone		
Verges:		
a) At locations where an errant vehicle may encroach onto an adjacent road (but see Note 6) or impact another significant hazard		**H2**
b) At locations where an errant vehicle may encroach onto a railway running adjacent to or in close proximity to the road boundary		**H2**

Notes:

1. This Table provides minimum Containment Levels for particular situations. Higher Containment Levels may be justified in some situations.
2. Where there is more than one reason for a safety barrier (e.g. at a central reserve 6m wide with lighting columns >14.5m), the highest of the required Containment Levels shall be provided.
3. The use of 4m radius slope rounding will prevent the development of slopes steeper than 1:2 until the embankment height is greater than 0.85m.
4. Where the hazard is not designed to withstand collision loads and where impact may result in injuries to people other than those in the errant vehicle, a higher Containment Level may be required.
5. The Containment Level on the approach shall be equal to that of the parapet or the adjacent safety barrier, whichever is the greater.
6. A safety barrier is not required (unless there is another reason) where the adjacent road joins the road under consideration, e.g. at slip roads and junctions.

Table 5/4: Minimum Containment Levels

5.16 At central reserves the minimum Set-back shall be 0m (zero) where a hardstrip of width 0.6m or greater is present. If there is no hardstrip present, the minimum Set-back shall be 0.6m.

5.17 The performance of the safety barrier system must not be compromised by the presence of a filter drain, cables or the like close to the barrier foundations. The clear distance required between the barrier and any feature which may affect the safety barrier performance shall be ascertained. Alterations to the Set-back may be required in some circumstances although the minimum Set-back shall never be compromised.

Lateral Positioning

5.18 For normal containment barriers, the Working Width should be **W6** where space is available. However, the Set-back should also be as large as practicable in order to provide the maximum width in which errant vehicles can regain control. Within the limited verge or central reserve widths available with many road cross-sections, it will be necessary to provide a reasonable compromise between a large Working Width and a generous Set-back. It must also be ensured that the detailing of the drainage and services within the verge does not restrict the selection of safety barrier unduly.

5.19 Design decisions regarding the lateral position of the barrier and its Working Width are further complicated by factors such as the barrier Set-back required to achieve the required stopping sight distance. In some cases, additional verge width may need to be provided in order to accommodate a higher Working Width barrier or a larger Set-back.

5.20 For isolated hazards, the safety barrier should be placed as close to the obstruction as possible and hence a small Working Width (normally **W2** to **W4**) should be selected. This provides the maximum available Set-back and maximises the space available for the errant vehicle to be brought under control.

5.21 For high containment barriers with small Working Widths, it is considered preferable to keep the Set-back distance as small as possible as this will minimise the angle of impact and consequently reduce the severity of impact on the occupants of the errant vehicle.

5.22 Where combinations of hazards are to be protected by a single length of safety barrier, the Set-back of the barrier should be established by assessing the obstruction nearest to the road as if this was an isolated hazard. This Set-back should be retained for the remaining obstructions although the Working Width can be varied to suit each obstruction. Changes in Working Width, however, along the length of a barrier are subject to suitable transitions being available.

5.23 Where objects are being protected, the Working Width of the safety barrier must be such that under design conditions the hazard is not impacted. There must also be full headroom in the Working Width zone.

5.24 On verges, the Working Width of the safety barrier shall not allow the traffic face of the barrier, when deflected to the full Working Width, to extend beyond the intersection of the embankment or cut slope and the verge.

5.25 On central reserves, the safety barrier position and Working Width shall be such that under design impact conditions no part will deflect into the opposing traffic lane. On wide central reserves with anti-dazzle hedges, the centre of the safety barrier should, where practicable, be at least 2.4m from the centre of the hedge.

Examples of Safety Barrier Requirements

5.26 Examples of the parameters of safety barriers in typical situations – in terms of Containment Level, Impact Severity Level, Working Width and Set-back – are indicated in Appendix A.

Length of Need (LoN)

5.27 The length of safety barrier shall be derived from a detailed consideration of each location. The total length of barrier will normally comprise the Length of Need plus, at each end, the length of the terminal and an intermediate length over which the barrier attains full performance.

5.28 The Length of Need consists of the Approach Length, the length of the hazard and the Departure Length. It is dependent on the location and geometry of the hazard, direction(s) of traffic,

design speed, traffic volume, and type and location of safety barrier.

5.29 Gaps of 100m or less between barrier lengths should be avoided. However, short gaps are acceptable when the barriers are terminated in a cut slope. If the end of the Length of Need is near the end of another barrier, it is recommended that the barriers be connected to form a continuous barrier. Maintenance access should be considered when determining whether to connect barriers.

Approach Length

5.30 The calculation of the Approach Length is based on the premise that the errant vehicle should not be able to leave the carriageway and get behind the barrier and thereby hit the obstacle. The calculations are based on an impact angle of about 8^0 (1:7).

Embankments and Level or Falling Ground

5.31 Where the ground behind the barrier is level or falling away from the road (e.g. road on embankment), the Approach Length (AL) shall be at least 30m and not less than:

$$AL = 7xD_E$$

where D_E = distance from traffic face of the safety barrier either to the rear of the hazard or to the edge of the Clear Zone, whichever is the less.

A typical example is illustrated in Figure 5/2.

5.32 Where the hazard is the embankment slope itself, the Length of Need begins and ends at the points where the hazard starts and finishes. There is no need for Approach and Departure Lengths.

Cuttings and Environmental Bunds

5.33 Where the ground behind the barrier rises (i.e. road in cutting or by an environmental bund), an errant vehicle may pass around the end of the barrier and alter direction towards the obstacle or hazard. At such locations, the Approach Length shall be at least 30m and not less than:

$$AL = 7xD_C$$

where D_C = distance from traffic face of the safety barrier to the edge of the Clear Zone.

5.34 Additional protection of the obstacle could be provided by the use of dense vegetation or gravel beds behind the barrier to provide a deceleration force on the vehicle. Terminals should be returned to the cutting face wherever practicable, as this will minimise the risk of end impact by an errant vehicle.

5.35 For obstacles which are only a hazard due to a face parallel to the road, such as a rock cutting or a retaining wall with buried ends, both Approach and Departure Lengths shall be at least 10m and not less than:

$$AL = 7xD_F$$

where D_F = distance from traffic face of the safety barrier to the face of the hazard.

Horizontal Curvature

5.36 The equations given in paragraphs 5.31, 5.33 and 5.35 are applicable to all normal road curvatures. For particularly onerous circumstances, the Designer should discuss the provision of a safety barrier with the National Roads Authority.

Departure Length

5.37 The length of barrier beyond the hazard is termed the Departure Length. For two-way carriageways, it shall generally be determined using the same equations as for the Approach Length, but shall be at least 15m long (except where Paragraph 5.35 applies). The Clear Zone for the Departure Length commences at the divide between the opposing traffic flows; this will normally result in a Departure Length considerable shorter than the Approach Length (see Figure 5/2).

5.38 For dual carriageways and motorways, the Departure Length shall be at least 15m long (except where Paragraph 5.35 applies).

Minimum Length

5.39 An appropriate system must be provided whose minimum length is equal to or less than the length of barrier to be installed, thus ensuring effective operation in service.

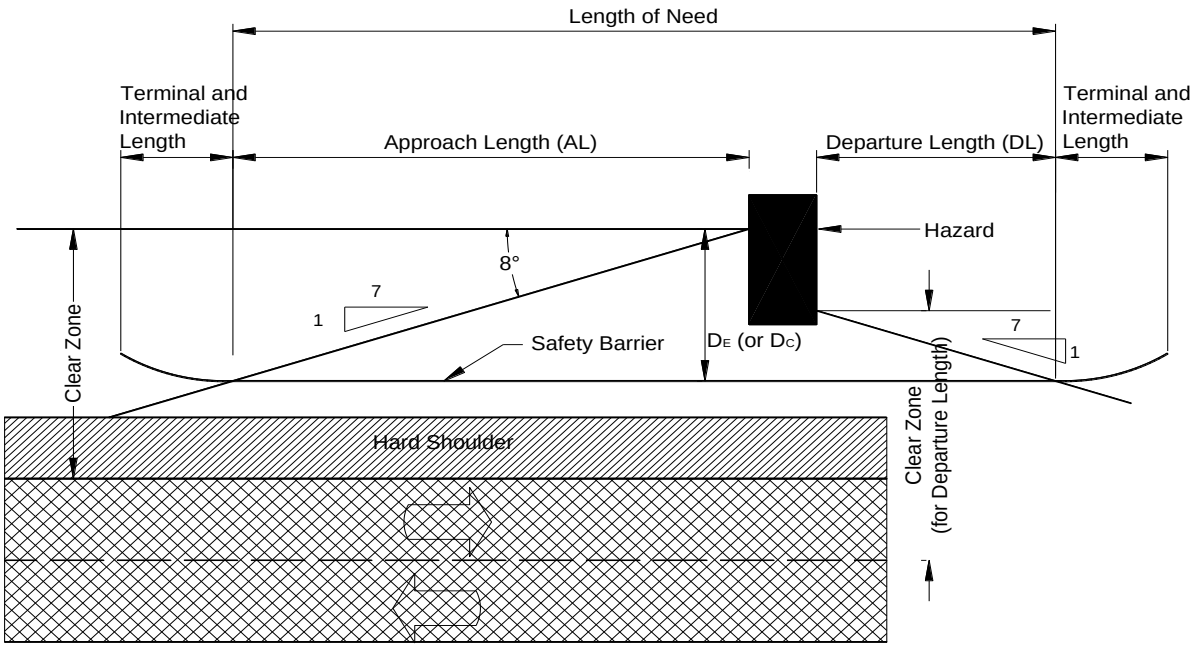

Figure 5/2: Example of Approach and Departure Lengths

Height of Safety Barrier

5.40 Safety barriers shall be set at the height specified for the system, within the specified tolerances. Particular care shall be taken to ensure that the barrier is at the correct height following resurfacing or overlay works.

5.41 Where the Set-back is less than 1.5m, the height of the barriers shall be related to the edge of the road pavement. Elsewhere, the height shall be measured from the general ground level in close proximity to the front of the barrier.

Kerbs

5.42 Kerbs in front of a safety barrier can contribute to the vehicle overturning or ascending the safety barrier. If kerbs in front of the safety barrier cannot be avoided on roads with a Design Speed of 85 km/h or more, the kerbs should be chamfered and not higher than 80 mm.

Flare

5.43 The ends of safety barriers should be flared wherever practicable. There are three functions of the flare:

- To locate the barrier and its terminal as far from the carriageway as is feasible.
- To minimise a driver's reaction to the introduction of an object near the carriageway.
- To reduce the Length of Need.

5.44 It has been shown that an object (or barrier) close to the carriageway may cause a driver to shift laterally, slow down, or both. The flare reduces this reaction by gradually introducing the barrier so that the driver does not perceive the barrier as a hazard. However, a flare increases the angle at which a vehicle will impact the barrier. A compromise between flare and impact angle is needed. Flares rates steeper than 1:20 should, therefore, not be used.

5.45 The following general principles apply:

- Vehicles should not be able to pass easily behind the approach flare;
- Anchorages and concrete ramps on central reserves should not be located so they protrude into the deflection space of the opposite fence.

5.46 Where parts of the Approach and/or Departure Lengths are flared, these lengths may be calculated in accordance with Appendix B. In some circumstances this will lead to shorter barriers.

5.47 Flare rates of up to 1:20 may also be used where it is necessary to change the Set-back of a barrier (e.g. at the approaches to bridge piers in the central reserve).

Ground Conditions

5.48 Most safety barrier systems rely on certain ground conditions in order to function satisfactorily. Where this is the case, a test regime, as described in the Series 400 clauses of the NRA Specification for Road Works, shall be established to ensure that the system performs as intended.

In-Situ Concrete Barrier

5.49 The diagrams detailing the In-situ Concrete Barrier are contained in the NRA Road Construction Details. This barrier design is 900mm in height with a small step 250mm above road surface level. It requires a hardened foundation into which the barrier is rebated.

5.50 This barrier has been approved by the National Roads Authority for use in situations which require an H2 Containment Level, an Impact Severity Level B and a Working Width of W2.

Emergency Crossovers

5.51 Emergency crossovers will not normally be provided across the central reserve. Designers should consult with the National Roads Authority concerning the need for emergency crossovers.

5.52 and 5.53 (not used)

Safety Barriers at Junctions

5.54 At junctions, safety barrier layouts should be adjusted to suit the requirements of both roads. In general, the safety barrier on the main road should be flared back, so as to avoid encroaching on the visibility splays. Consideration should be given to any hazards close to the junction which lie within the clear zone of the main road. It may be appropriate to provide a safety barrier in front of such a hazard, even though the barrier will follow the line of the adjacent edge of pavement and may not be parallel to the main road.

5.55 At roundabouts, safety barriers will rarely be needed, since the design speed of the circulatory carriageway is normally less than 85 km/h.