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

SECTION 2 **SPECIAL STRUCTURES**

PART 8

TD 19/06

REQUIREMENT FOR ROAD RESTRAINT SYSTEMS

SUMMARY

This Standard describes the procedures to be followed by the various parties involved in the design and provision of various types of Road Restraint Systems. It also introduces a risk based framework to support designers in making optimal design choices at specific sites.

INSTRUCTIONS FOR USE

1. Remove Contents pages from Volume 2 and insert new Contents pages for Volume 2 dated August 2006.

2. Remove the following documents from Volume 2 which are superseded by this Standard and archive as appropriate:

   BA 48/93, Volume 2, Section 2
   BD 52/93, Volume 2, Section 3
   TA 45/85, Volume 2, Section 2
   TD 19/85, Volume 2, Section 2
   TD 32/93, Volume 2, Section 2

3. Insert TD 19/06 into Volume 2, Section 2, Part 8.

4. Please archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.

THE HIGHWAYS AGENCY

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THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

Requirement for Road Restraint Systems

Summary: This Standard describes the procedures to be followed by the various parties involved in the design and provision of various types of Road Restraint Systems. It also introduces a risk based framework to support designers in making optimal design choices at specific sites.

1.35 For any site where it is not possible to propose a solution that produces an 'acceptable' level of risk, the Design Organisation must consider if a Relaxation can be used. If a Relaxation cannot be used, a Departure from Standard must be applied for as outlined in Paragraphs 1.39 and 1.40.

Road Safety Audits

1.36 Road Safety Audits must be undertaken on all highway schemes involving removal, provision or improvement of RRS in accordance with **HD 19 [DMRB 5.2.2]**.

Relaxations

1.37 Where permitted in this document, Relaxations may be introduced at the discretion of the Design Organisation, having regard to the advice and guidance in this document and all relevant local factors. (Note: in Northern Ireland, Relaxations are not at the discretion of users, but can only be granted by the Overseeing Organisation).

1.38 Careful consideration must be given to layout options and the effects of incorporating Relaxations, having weighed the benefits and any potential disbenefits. Particular attention must be given to the environmental and safety aspects (including construction, maintenance, operation and demolition) that would result from the use of Relaxations. The preferred option must be compared against options that would meet full Standards. The Design Organisation must record in the RRRAP the fact that a Relaxation has been used in the design and the corresponding reasons and justification for its use. It is recommended that the details of the Relaxation and justification are copied to the relevant Overseeing Organisation prior to incorporation into the Works.

Departures from Standard

1.39 Where special circumstances arise and the straightforward application of the technical requirements cannot be achieved or justified for some reason, such as the environmental impact, exceptional layout situations or cost, users are encouraged to come forward with Departures which go beyond Relaxations from the criteria, or to propose additional criteria (for aspects not covered by existing documents) based on a reasoned assessment. Each Overseeing Organisation has procedures for considering and accepting or rejecting such proposals on their merits.

1.40 Full justification for the grounds of the proposed Departure must be forwarded to the relevant Overseeing Organisation at an early stage in design. The risk level (where known) and cost benefit analysis from the RRRAP for the proposed solution must form part of the Departure. The Departure must demonstrate that the risk level of the proposed solution is As Low as Reasonably Practicable (ALARP); further guidance is given in Chapter 2. Formal approval to the proposed Departure must be received BEFORE incorporation into the design and the commencement of construction. Departures from Standard are determined on an individual basis and a decision regarding a Departure for one location must not be assumed as the decision for any other, even similar, situations. Approval for a Departure from Standard after commencement of construction will only be given in exceptional circumstances; no Departure will be granted after completion of the works.

Terminology and Definitions

1.41 Many of the definitions set out below are not industry standard definitions and apply only in the context of this Standard.

1.42 Figure 1-2 shows the terminology and definitions for RRS included in the various Parts of BS EN 1317 and DD ENV 1317-4. For the definitions of other terms used in Paragraph 1.30, refer to the relevant parts of BS EN 1317. Additional definitions are included below.

Overseeing Organisation – The Highway or Roads Authority responsible for the road in England, Scotland, Wales or Northern Ireland.

Design Organisation/Designer – Any person who carries on a trade, business or other undertaking in connection with which he prepares a design or arranges for any person under his control (including, where he is an employer, any employee of his) to prepare a design.

Contractor – The Organisation undertaking the various phases of a scheme which might include design, construction and/or maintenance.

Adjoining Paved Surface – The paved area on the traffic side of a parapet immediately adjacent to the plinth or base of the parapet. This surface may be the raised verge and central reserve at underbridges described in **TD 27**.

Front Face of Parapet – The face nearest to vehicular traffic.

Hazard – Refer to Chapter 2 Paragraphs 2.1 and 2.2 of this Standard. Examples are given as 'drop downs' in the various worksheets in the RRRAP.

Length of Need – The total minimum length of full height, full containment VRS stipulated by the Designer, as a result of the RRRAP, as being required in advance of, alongside, and after a hazard or hazards to protect the hazard or hazards. The length over which various VRS reach full containment may vary and will need to be checked with the manufacturer. The overall length of safety barrier required will be the Length of Need plus the additional lengths that are declared by the manufacturer to be required before and after the Length of Need to ensure that the safety barrier attains full containment. For example: if the Length of Need is 38 m (30 m + 0.5 m + 7.5 m), but full containment cannot be achieved within the safety barrier in less than 20 m, then for a dual carriageway 58 m (i.e. 20 m + 38 m) and for a single carriageway 78 m (i.e. 20 m + 38 m + 20 m) of full height safety barrier must be used. Refer to Chapter 3 Figure 3-5.

Main Structure – Any part of the bridge, viaduct, retaining wall or similar structure upon which a pedestrian or vehicle parapet is mounted, including the plinth.

Medium Vehicle – A vehicle greater than 1.5 Tonnes and less than or equal to 3.5 Tonnes.

Others – A group or collection of people in a public place, such as a school, hospital or railway, that might be injured in numbers by an errant vehicle or by a hazard that is hit by an errant vehicle, or a high value asset or facility that might be adversely affected by such an event.

Outer Face of Parapet – The face remote from the vehicular traffic.

Planned Maintenance – Planned work that is required due to those parts of the highway that have become unserviceable because of general wear or tear or due to a major upgrade or change to parts of the highway. (This excludes work associated with accident damage which is covered by routine maintenance).

Plinth – A continuous upstand on the edge of a structure upon which a vehicle or pedestrian parapet is mounted.

Practicable – Capable of being put into practice with the available resource at a reasonable price and within a reasonable period of time.

Risk – Refer to Chapter 2 Paragraphs 2.1 and 2.2 of this Standard.

Road Restraint System (RRS) – General name for VRS and Pedestrian Restraint System use on the road.

Routine Maintenance – Generally short term or cyclic work that is necessary to keep the highway in good working order, such as safety barrier repair due to accident damage. It does not deal with the replacement or renewal of those parts of the highway which, over a longer term, become unserviceable because of general wear and tear which would properly be dealt with by planned programmes of structural maintenance work.

Running Lane – That part of the trafficked carriageway nearest to the verge or central reserve that is under consideration. Under normal running conditions, the hardshoulder of a motorway would not be trafficked and would therefore not be classed as the running lane. It may however become a temporary running lane under 'Active Traffic Management' (ATM) or become a temporary running lane under a temporary traffic management regime, perhaps for instance with a reduced speed limit. The speed used in the RRRAP, when assessing whether the Length of Need and Containment Level are sufficient for the ATM and/or temporary situation, should be the controlled limit or temporary mandatory limit that will be in force.

Secondary Event – An incident that arises as a result of an initial incident. For instance, a lighting column is struck in the initial incident and falls onto another hazard, such as a carriageway or a railway, thus causing a secondary event or creating a hazard to that hazard.

Set-back – Is the distance defined in Chapter 3 Figure 3-4 which shows the typical relationship between the Set-back and available Working Width for a safety barrier in the verge or central reserve (See also Figures 3-1 to 3-3 inclusive and Figures 3-5 to 3-10 inclusive). Refer to **TD 27** for further details.

Sidelong Ground – Is ground that falls away from the carriageway, where the road is not on a formed embankment. It typically occurs where the road is cut into the side of a hill such that the road is effectively in cutting on one side and is similar to an embankment situation where the ground drops away from the carriageway on the other.

Vehicle Restraint System (VRS) – System installed on a road to provide a level of containment for an errant vehicle.

Working Width (W) – Is defined in BS EN 1317–2. Refer to the Guidance in this Section below for further information on application of Working Width in this Standard and Figure 1-1.

Working Width Class – Is the designation W1, W2, W3, etc for Classes of Working Width Levels as given in BS EN 1317-2.

1.43 For the definitions of the general highway terms used in this Standard such as "Highway Types" (e.g. Trunk Roads, motorway and all-purpose roads) and "components of the highway" (e.g. embankment and cutting), see BS 6100: Sub Section 2.4.1 and, for terms such as cross-section, central reserve, verge, see **TD 27**.

Abbreviations

1.44 A list of the abbreviations that have been used in the Standard and their meanings is given below.

AADT	Annual Average Daily Traffic (Two Way)
ALARP	As Low as Reasonably Practicable
ATM	Active Traffic Management
B/C	Benefit/Cost
BD	Overseeing Organisation Standards – Bridges and Structures
BS	British Standard
CBA	Cost Benefit Analysis
CCTV	Closed Circuit Television
CDM	Construction (Design and Management) Regulations
CEN	European Committee for Standardization or Comité Européen de Normalisation is the standards organisation responsible for producing and overseeing the development of standards. It is an association of the national standards bodies
D	Permanent Lateral Displacement (for crash cushions)
D&B	Design and Build

DBFO	Design, Build, Finance and Operate
DD	Draft for Development
DMRB	Design Manual for Roads and Bridges
ECI	Early Contractor Involvement
ECP	Emergency Crossing Point
EN	European norm or technical specification drafted by a technical committee and adopted as a national standard by members belonging to CEN
Et seq	And following
HA	Highways Agency
HD	Overseeing Organisation – Standard
IAN	Interim Advice Note
IRRRS	Interim Requirement for Road Restraint Systems
ISL	Impact Severity Level
LGV	Large Goods Vehicle (i.e. a vehicle over 3.5 Tonnes)
MCHW	Manual of Contract Documents for Highway Works
MCP	Maintenance Crossing Point
NI	Northern Ireland
NMU	Non-motorised User
OO	Overseeing Organisation
P	Performance Class (for terminals)
PLDZ	Permanent Lateral Displacement Zone characteristic (for terminals)
prEN	A draft European standard that is still in the process of being developed in preparation for publication as an EN
Psb	Point from which set-back is measured (refer to **TD 27 [DMRB 6.1.2]**)
QA	Quality Assurance
RRRAP	Road Restraint Risk Assessment Process
RRS	Road Restraint System
SI	Statutory Instrument
TD	Overseeing Organisation Standard relating to Traffic Engineering and Control
TRL	Transport Research Laboratory
TSM	Traffic Signs Manual
TSRGD	Traffic Signs Regulations General Directions (this is a Statutory Instrument)
WMCP	Winter Maintenance Crossing Point
VRS	Vehicle Restraint System
Z	Redirection Zone Class (for crash cushions)

3. CRITERIA AND GUIDANCE FOR THE PROVISION OF PERMANENT SAFETY BARRIERS

Performance Class Requirements

General

3.1 All safety barriers installed must be compliant with the Test Acceptance Criteria requirements of BS EN 1317-2 and the following criteria.

3.2 The Design Organisation must specify the required Performance Class for each safety barrier installation in terms of Containment Level (e.g. N1, N2, H1, H2 or H4a), Impact Severity Level (ISL) (e.g. ISL Class B) and the Working Width Class (W1 to W8).

3.3 The Design Organisation must identify any special requirements with regard to the provision of safety barriers which may affect the choice of system by the Contractor, such as the maximum height of safety barrier that allows sufficient visibility. Examples are given in Paragraph 3.110.

Containment Levels

3.4 The containment levels requirements for safety barrier are:

Permanent Deformable and Rigid Safety Barriers:

(i) **On roads with a speed limit of 50 mph or more**:

(a) Normal Containment Level = N2

(b) Higher Containment Level = H1 or H2

(c) Very High Containment Level = H4a

(ii) **On roads with a speed limit of less than 50 mph:**

(a) Normal Containment Level = N1

3.5 Where the Road Restraint Risk Assessment Process (RRRAP) or the requirements below indicate a containment level that is higher than the minimum, as indicated in Paragraphs 3.4(i)(a) or (ii)(a), is required, the higher containment level must be specified.

Impact Severity Levels (ISL)

3.6 The ISL for safety barriers must not normally exceed Class B as stipulated in BS EN 1317-2.

3.7 At specific locations where the containment of an errant vehicle (such as a heavy goods vehicle) is the prime consideration, or where there is limited space available, a Vehicle Restraint System (VRS) may need to be installed with an ISL greater than Class B. The use of VRS with an ISL greater than Class B must be with the agreement of the Overseeing Organisation and justified by the RRRAP. Where an ISL level greater than Class B is to be used, the limits ASI ≤ 1.9 and THIV ≤ 33 km/h shall apply.

Working Width Class

3.8 The Working Width Class for each safety barrier installation must be the same as or less than that specified by the Design Organisation.

3.9 The Design Organisation must specify the greatest Working Width Class that the local highway geometry will allow. (See Paragraph 3.93 for Guidance).

3.10 Where the Working Width Class for a proposed System is based on an update to EN 1317:1998, a check must be carried out to ensure that there is sufficient clearance between the hazard being protected and the restraint system that is proposed, to ensure that the hazard will not be hit by a vehicle intruding beyond the restraint system (see Chapter 1 Paragraph 1.49 et seq.).

General Requirements

General

3.11 Permanent Deformable or Rigid Safety Barriers must be provided where the outcome of the RRRAP indicates that a VRS is necessary.

3.12 The Design Organisation must identify local hazards, within or immediately adjacent to the highway, that need to be examined through the RRRAP. These are hazards that may cause a danger to the occupants of an errant vehicle or give rise to a secondary event were the vehicle to reach the hazard. In addition, the risk of an errant vehicle to Others must also be examined.

The following is a list of hazards that must be identified within the RRRAP. This list is not exhaustive and other hazards should be considered.

(i) Above ground structural supports, bases or foundations which are positioned less than 3 m above the adjacent paved carriageway. The chance of reaching a hazard that is greater than 3 m above the paved carriageway is thought to be very low, but if there are any reasons or conditions at the site that the Designer believes will make it possible for the hazard to be reached, the hazard should also be identified.

(ii) Drainage culvert headwall.

(iii) Restricted headroom at a Structure or part of a structure (See Figure 3-10 and **TD 27 [DMRB 6.1.2]**).

(iv) A retaining wall which does not have a smooth face adjacent to the traffic extending for at least 1.5 m above the adjacent carriageway level. A ‘smooth’ face may include a surface that may have an irregular surface finish subject to the maximum amplitude of the steps and undulations in the surface not exceeding 30 mm when measured with respect to a plane through the peaks. The plane must be broadly parallel to the road alignment. A structure that has a 25 mm wide chamfered construction joint in its surface would be regarded as smooth.

(v) An exposed rock faced cutting slope, rock filled gabions, crib walling or similar structures (See **BD 68 [DMRB 2.1.3]**).

(vi) Soil cutting slopes and earth bunds greater than 1 m high and with a side slope gradient of 1:1 or steeper.

(vii) Embankments and vertical drops.

(viii) Strengthened or geotextile reinforced slopes.

(ix) Environmental noise barriers or screens.

(x) Highway boundary fences and walls.

(xi) Dwarf retaining walls surrounding hazards such as drainage access manholes and communication cabinets.

(xii) Permanent or expected water hazard with depth of water 0.6 m or more, such as a river, reservoir, stilling pond or lake or other hazard which, if entered, could cause harm to the vehicle occupants.

(xiii) Road lighting columns, though see further guidance in Paragraphs 3.123 to 3.125 below.

(xiv) High mast road lighting columns.

(xv) Sign and signal gantry supports.

(xvi) Sign posts not meeting the requirements of BS EN 12767 which exceed the equivalent section properties of a tubular steel post having an external diameter of 89 mm and a nominal wall thickness of 3.2 mm.

(xvii) Large signs (typically those higher than 2 m) located in a position where the fascia could be struck by an errant vehicle.

(xviii) Above ground communications control cabinets, pillars and equipment (other than emergency telephones), CCTV Masts (See **BD 83 [DMRB 2.2.1],** Telephone Masts (See **TA 77 [DMRB 9.5.1]**).

(xix) Stores for emergency/diversion signs and similar permanent structures.

(xx) A tree or trees having, or expected to have, trunk girths of 250 mm or more (measured at a height of 0.3 m above ground level) at maturity (see Guidance Paragraph 3.130 et seq.).

Hazards where Others could be affected:

(i) Non-motorised User (NMU) subway entrance or agricultural underbridge passing under the highway.

(ii) A railway, canal or separate road or carriageway.

(iii) Public meeting places where a number of people would be present for some time such as schools, hospitals, recreational, retail facilities or factories.

(iv) Chemical works, petroleum storage tanks or depots, facilities manufacturing or storing hazardous materials in bulk.

3.13 The RRRAP must be used to determine if a safety barrier is required to protect each single hazard identified or, where there are a number of hazards that are in close proximity, the group; and, if a safety barrier is required, then to determine the Length of Need for the single hazard, or group thereof to produce a risk that is 'broadly acceptable'. Note that some safety barrier systems may require additional lengths to function as intended.

3.14 Road furniture and equipment must not be positioned in front (i.e. within the set-back) of a new or existing Road Restraint System (RRS) and, in general, it should not be placed immediately in advance of nor within the available Working Width of a new or existing RRS (as it can affect the way the RRS performs) unless the road furniture or equipment has been designed to be passively safe and, if hit, will not be displaced into the adjacent carriageway or give rise to a secondary event, and the circumstances outlined in Paragraphs 3.66 to 3.69 dealing with Relaxations and Departures are met.

3.15 The safety barrier layout must be carefully planned to minimise the number of approach ends of safety barriers, as the ends themselves are a hazard. Where new safety barriers are required and gaps of 50 m or less arise between two separate safety barrier installations, where practicable, the gap must be closed and the safety barrier made continuous. Further Guidance is given in Paragraph 3.107 and 3.108.

3.16 The treatment and positioning of the ends of safety barriers must also be carefully considered to minimise the risk they impose. For further guidance on the end treatment of safety barriers, see Chapter 5, Guidance on Terminals.

3.17 The Design Organisation must ensure that the site is inspected prior to carrying out the RRRAP.

3.18 The Design Organisation must ensure that during construction works the original design assumptions are valid. If the original design assumptions are not valid, the Design Organisation must carry out the RRRAP again and ensure that the new requirements are provided. This is particularly important at embankment side slopes, at the transitions between cut and embankment or start of sidelong ground, at locations where there are hazards present that may affect Others, and on curves where there may be subtle details present that are not apparent from drawings and which are difficult to model in the RRRAP.

Visibility

3.19 The requirements stipulated in **TD 9 [DMRB 6.1.1]** in respect of visibility, sightlines over and in front of safety barriers and Stopping Sight Distances must be complied with.

3.20 In difficult situations where the horizontal and/or the vertical alignments or other physical features prevent the establishment of the appropriate Stopping Sight Distance requirements stated in **TD 9**, the Design Organisation must apply to the Overseeing Organisation for a Departure from **TD 9**.

Set-Back

3.21 Set-back at permanent systems must be in accordance with **TD 27.** The relationship between set-back and Working Width at hazards in verge and central reserve is given in Figure 3-4.

3.22 Any proposal to reduce set-back from the values required in **TD 27** must be accompanied by a Risk Assessment identifying the factors considered, their likely combined effects and justification for the proposal and be included in an application for a Departure from Standard to the Overseeing Organisation.

3.23 Some terminals protrude proud of the traffic face of the general run of the VRS and, therefore, set-back should be measured to the part of the VRS closest to the traffic face. Further guidance is given in Paragraph 3.96.

3.24 On central reserves where there are no hazards and there is only one double-sided deformable safety barrier, or rigid safety barrier between the carriageways, the set-backs on both sides of the safety barrier must not be less than as stipulated in **TD 27** nor less than the Working Width Class of the safety barrier minus the actual width of the safety barrier (See also Figure 3-3). This is to ensure that the safety barrier will not encroach into the opposing carriageway if hit.

3.25 Set-back greater than the minimum values stipulated in **TD 27** should be provided where space allows and as described in that document.

Minimum Lengths of Safety Barrier

3.26 If the Length of Need determined using the RRRAP is less than the minimum length of "full height" safety barrier in advance given in Table 3-1, then the minimum length must be provided. In addition, at least the corresponding minimum length of "full height" safety barrier beyond the single hazard, or group thereof, given in Table 3-1 must also be provided.

3.27 Where the traffic can travel in both directions along the same carriageway, either under normal conditions or under temporary traffic management such as contraflow (either now or at some future time), the RRRAP must be used to determine whether the minimum Length of Need of safety barrier beyond that given in Table 3-1 is sufficient under these conditions. The greatest of the lengths of need so determined must be used; however, where the Length of Need for the temporary situation is longer than the Length of Need for normal conditions, the extra Length of Need may be provided only for the period that the temporary situation is operative, or it may be provided as a permanent solution.

3.28 The safety barrier provided to protect a single hazard, or group thereof, must be a continuous length that may or may not be made from one type of product (e.g. a metal safety barrier – concrete safety barrier – metal safety barrier would constitute a continuous length).

Safety Barrier Containment Level	MINIMUM "full height" lengths of safety barrier[1]	
	In advance of hazard	Beyond hazard
Normal (N2 or N2)	30 m	7.5 m
Higher (H1 or H2)	30 m	10.5 m
Very High (H4a)	45 m	18 m

TABLE 3-1

Notes: 1. These are minimum lengths. Manufacturers may require longer lengths than specified above. (Refer to Chapter 1 Paragraph 1.42 Length of Need.)

3.29 Where the constraints of the site make it physically impossible to install the required lengths of safety barrier, the maximum achievable lengths must be recorded together with the results of the RRRAP relating to the actual situation and full details of the alternatives examined together with the justification for the proposed lengths, must be forwarded to the Overseeing Organisation for their consideration as a Departure from Standard.

Provision at Vehicle Parapets

3.30 Where a vehicle parapet is required, a safety barrier must be provided to prevent direct impact with each approach end of the vehicle parapet. The Performance Class of the parapet and VRS may differ. At each approach end of the vehicle parapet, the safety barrier must be full height for at least the minimum length in advance for the Containment Level of the safety barrier stated in Table 3-1 and must continue the line of the traffic face of the vehicle parapet. The minimum length may include the length of any transition between the parapet and safety barrier.

3.31 Where traffic can travel in both directions, either under normal conditions or under temporary traffic management such as contraflow, a safety barrier must be provided at each end of the parapet in accordance with Paragraph 3.30. If traffic can only flow in both directions under temporary traffic management, then the safety barrier provided at the end that is normally the departure end of the parapet may either be permanent or only installed for the duration of the Works. When the temporary situation ceases, the minimum length beyond the hazard specified in Table 3-1 shall remain.

3.32 A transition must be provided between the safety barrier and the vehicle parapet. The parapet must be capable of resisting forces applied from the safety barrier or transition. Refer to Chapter 6 for details of requirements for transitions.

3.33 The RRRAP must be used to determine whether the minimum Length of Need of safety barrier in advance given in Table 3-1 is sufficient under the conditions stated in Paragraphs 3.30 and 3.31. If the Length of Need determined from the RRRAP is greater than the minimum length given, then the Length of Need from the RRRAP must be provided. See also Chapter 4 Paragraph 4.37 relating to provision at railways.

Provision at Sign or Signal Gantry

3.34 Sign and/or signal gantries are not generally designed to withstand full vehicle impact and, therefore, may collapse on impact by an errant vehicle and cause a secondary event including falling into the carriageway. Therefore, unless the RRRAP indicates, due either to the offset of the sign gantry or signal gantry or to other factors, such as the gantry being passively safe, that Normal Containment Level (N2) is sufficient or that no safety barrier is required, then the minimum containment level must normally be Higher Containment Level (H1). Details of the containment level required in given situations are shown in Figure 3-9.

Non-motorised Users

3.35 Consideration must be given to the movement of NMUs, e.g. pedestrians, cyclists, equestrians and farm animals, along the verge on all-purpose roads, and pedestrians (e.g. broken down motorists) on hardshoulders of motorways.

3.36 At some locations on all-purpose roads, there may be a defined movement of equestrians/farm animals along the verge and the Design Organisation must ensure any proposed safety barrier installation allows for such movement (See **TA 90 [DMRB 6.3.5] and TA 91 [DMRB 5.2.4]**).

3.37 A staggered overlapped gap for NMUs must be provided where possible in any verge safety barrier at emergency telephones (see **TA 73 [DMRB 9.4.2]**) as shown in Figure 3-11 and opposite a central reserve NMU crossing gap as shown in Figure 3-14. Any such gap must have a full height overlap, of at least 9.5 m between the two adjacent safety barriers, such that an errant vehicle cannot impact the leading terminal of the downstream safety barrier. A clear width as given in **TA 90** must be maintained through the staggered gap to allow the free movement of NMUs.

3.38 The face of a safety barrier adjacent to NMUs should not present a hazard for NMUs, including the visually or mobility impaired. A light non-participating guardrail, post and rail end caps, etc may be required to protect the NMUs from sharp edges where possible, etc where a designated NMU route is present. The Design Organisation should check with the safety barrier manufacturer that any such proposed protection will not invalidate the tests on the safety barrier.

3.39 It should be noted that, unless there is a very significant risk, for instance, at a point where large numbers may congregate regularly for significant periods of time, it is not normally the case that a safety barrier is provided for protection of pedestrians and other NMUs. Whilst it is preferable for NMU routes to be located completely beyond the Working Width of the safety barrier, it will often be the case that there is insufficient space available. The NMU route should, therefore, be located as far from the rear of the safety barrier as is reasonably practicable.

3.40 Where there is a significant pedestrian movement and the need to channel the movements has been established, consideration should be given to the provision of a separate pedestrian guardrail behind the safety barrier (See Chapter 9 and **TA 91**).

Motorcyclists

3.41 At sites identified, e.g. through accident records, to be high risk to powered two-wheel vehicles, such as tight external bends, consideration must be given to the form of VRS chosen to minimise the risk to this category of driver. Any special requirements must be stated in the contract.

3.42 At such high risk sites, it is recommended to use an 'add on' motorcycle protection system to post and rail type safety barriers to minimise the risk of injury to motorcyclists. The Design Organisation must check with the safety barrier manufacturer that any such proposed protection will not invalidate the tests on the safety barrier. Such 'add on' products must be approved by the Overseeing Organisation and be compatible with the safety barrier to which it is being attached as these products are not included within BS EN 1317.

Drainage and Kerbs

3.43 Consideration must be given to the form and design of the carriageway, verge and central reserve drainage and its maintenance and to the interaction of the drainage with the safety barrier systems to ensure satisfactory performance of both.

3.44 When considering the use of surface water drainage channels and or kerbing, the Design Organisation must evaluate the safety aspect in relation to the position of any safety barriers and the relevant set-backs (see **HA 37 [DMRB 4.2], HA 83 [DMRB 4.2.4]** and **HA 119 [DMRB 4.2.9]**and **MCHW-3 Series B and F**). Consideration must be given to their placement in terms of the safety of two-wheeled powered vehicles (see **HA 83**).

Verges and Central Reserves

Provision in Verges and Central Reserves – General

3.45 The verge and central reserve below and immediately adjacent to the safety barrier should be nominally flat.

Provision in Verges – General

3.46 Figures 3-4 to 3-10 show the general layout of safety barriers adjacent to hazards.

3.47 Figure 3-12 shows the minimum taper lengths required at changes of horizontal alignment of verge and central reserve safety barriers. Advice should be sought from the VRS manufacturer about the particular systems to confirm that these lengths are adequate.

3.48 Figure 3-10 shows the requirements where there is restricted headroom at a structure. (See **TD 27 [DMRB 6.1.2])**

3.49 Where the RRRAP indicates that a safety barrier will be required and the safety barrier will be placed adjacent to a slope, reference should be made to Figures 3-1 and 3-2 which show the relationship of the safety barrier to the top of embankments and sidelong ground and toe of cuttings in verge and central reserve situations.

3.50 On carriageways that are divided/separated (e.g. when one carriageway has been constructed a distance from the other to take advantage of the ground profile to minimise cut/fill or to improve alignment) the Design Organisation must assess the need for safety barriers and record any findings using the RRRAP, and agree the provision of safety barriers with the Overseeing Organisation.

3.51 Any safety barrier installation in the vicinity of a Motorway Police Observation Platform should be in accordance with the requirements of **TA 66 [DMRB 6.3.2]**. Where the Police have agreed that the Observation Platform is no longer required it should be removed.

3.52 At exposed rock faced cuttings slopes, additional rock netting may be required behind a safety barrier to prevent falling rocks from reaching the hardstrip, hardshoulder and or carriageway, see Paragraph 3.104 et seq. of the Guidance section.

Provision at Nosings

3.53 Nosings, where one carriageway diverges from another, are areas that are particularly prone to runoff accidents. There is always a balance to be struck between (a) the need to place signs, lighting columns or other street furniture in the vicinity of a nosing and protect them from errant vehicles, (b) keeping the area free of all hazards (including safety fencing), whilst discouraging deliberate overrunning of the nosing area, and (c) keeping within the physical horizontal and vertical constraints of the location.

3.54 A flat area, ideally free of all hazards, of around 10m length should be maintained at the back of nosing. (See **TD 22 [DMRB 6.2.1]** and Figure 3-13).

3.55 Where it is necessary to install street furniture or other hazards, these should be kept to a minimum and ideally be passively safe in accordance with **TA 89 [DMRB 8.2.2]**. They should be placed as far from the point of the physical nose as practicable. Where passive safety is not possible and safety barrier protection is required to protect the hazards (including the level difference between the adjacent carriageways), sufficient space along and across the nosing area should be allowed for any safety barriers, terminals and the required Working Widths and set-back.

Taper Lengths at Changes in Horizontal Alignment of Verge and Central Reserve Safety Barrier

3.56 Taper lengths should be greater than the minimum wherever practicable. Taper lengths, as described in Figure 3-12, are required to ensure that:

(i) there is a flowing alignment along the length of safety barrier;

(ii) any changes in angle of the safety barrier presented to oncoming traffic (i.e. the approach angle) are not going to be significantly different in effect on an errant vehicle or on the safety barrier to the angle(s) of approach at which the safety barrier has been tested;

(iii) the safety barrier change in direction does give rise to a ‘pocketing’ effect (see Chapter 6 Paragraphs 6.9 to 6.13);

(iv) changes in profile of a safety barrier do not occur abruptly.

Provision in Central Reserves – General

3.57 A safety barrier must be provided on dual carriageway roads where the width of the central reserve measured between opposing edges of carriageway road markings (or kerb faces where no markings) is 10 m or less. Where the central reserve is wider than 10 m, the Design Organisation must assess the need for safety barriers and record any findings using the RRRAP, and agree the provision of safety barriers with the Overseeing Organisation.

3.58 The placement and nature of hazards in the central reserve and form of safety barrier must be chosen to minimise the need for operatives to work in the central reserve.

3.59 On motorways or roads constructed to motorway standard with a two-way AADT greater or equal to 25,000 vehicles/day where a VRS is required in accordance with Chapter 1 Paragraph 1.18(i), the safety barrier must be a rigid concrete safety barrier with an H1 or greater Containment Level. This is to minimise cross-over accidents and reduce the need for safety barriers to be repaired or maintained and hence, minimise the costs and congestion arising from temporary traffic management and reduce the risk to maintenance workers. Where the Overseeing Organisation agrees that road lighting columns, signals or signs may be mounted on the rigid concrete safety barrier, the Working Width Class must be increased to reflect the additional width of safety barrier required to accommodate the column or post and its fixings. In Scotland and in Wales the specific use of rigid concrete safety barriers, in such circumstances, is not mandatory and any proposals for the use of such safety barriers in central reserves must be referred to Transport Scotland or the Welsh Assembly Government for consideration.

3.60 Where the provision of a rigid concrete safety barrier to meet the requirements of Paragraph 3.59 is considered impracticable, a Departure from Standard with full justification must be provided. Examples of when a Departure from Standard is needed are: if a structure cannot support a rigid concrete safety barrier system, or where a Departure from **TD 9** for reduced visibility has not been approved.

3.61 The use of an H1 rigid concrete safety barrier may not be practicable for lengths of 500 m or less. Therefore, where the provision of a rigid concrete safety barrier to meet the requirements of Paragraph 3.59 would, in total, be 500 m or less and where the Exception in Chapter 1 Paragraph 1.18(iii)(b) cannot be applied, Normal Containment Level N2 safety barrier may be used.

3.62 A safety barrier must be provided on both sides of a hazard except where road lighting columns, signals, gantry legs or signs are to be mounted on a rigid concrete safety barrier. Figure 3-6 shows the layout of central reserve safety barriers adjacent to hazards where single sided safety barrier is provided. Figure 3-7 shows the layout of central reserve safety barrier adjacent to hazards where a double-sided safety barrier is provided. See Paragraphs 3.98 and 3.130 to 3.132 for further guidance on trees.

3.63 Where a safety barrier is required in accordance with Paragraph 3.57 and there is a difference in the opposing edge of carriageway levels of 200 mm or more and there are no hazards in the central reserve or sightline requirements, the safety barrier must be installed adjacent to the higher carriageway. A separate safety barrier adjacent to the lower carriageway may also be required due to the height difference between the carriageways, the ground profile across the central reserve and the type/design of safety barrier chosen (See Figure 3-2).

3.64 Other than under Paragraph 3.57 where it has been agreed with the Overseeing Organisation that no safety barrier is required, there must be no gaps in the central reserve safety barrier on Motorways. Gaps in central reserve safety barriers on the Trunk Road network must be closed wherever possible and, on other dual carriageway roads, gaps in an otherwise continuous central reserve safety barrier must be restricted to the absolute minimum necessary for the efficient operation and management of the road.

3.65 Paragraphs 3.70 to 3.92 identify a number of situations where gaps may be required in central reserve safety barriers.

Relaxations and Departures

Relaxation for Locating a Hazard Within the Working Width or in Front of a Vehicle Restraint System

3.66 Where space is limited and it can be shown that the requirements of Paragraphs 3.67 and 3.68 have been followed, the following Relaxations may be applied.

3.67 A Relaxation may be used to locate furniture meeting the requirements of **TA 89 [DMRB 8.2.2]** within the Working Width of a single-sided VRS in the verge, as long as it is demonstrated that:

(i) furniture cannot be located outside the Working Width of the existing VRS; and

(ii) a VRS with a sufficiently small Working Width cannot be used; and

(iii) passively safe furniture cannot be used without a safety barrier (for instance when a safety barrier is required to protect other hazards as well); and

(iv) if the furniture were to be hit it would not be displaced into the running lane or a position that could cause a secondary incident.

3.68 A Relaxation may be used to permit the location of signposts (excluding signposts with slip bases) meeting the requirements of **TA 89** within the Working Width of a single sided VRS in the central reserve as long as it is demonstrated that:

(i) the sign cannot be placed outside the Working Width of the system; and

(ii) a system with a smaller Working Width cannot be used; and

(iii) a passively safe sign cannot be used without a safety barrier; and

(iv) if the sign were to be hit or contacted by the safety barrier, it would not be displaced into the running lane of either carriageway or a position that could cause a secondary incident.

3.69 Where the above Relaxations cannot be used, a Departure from Standard may be considered to locate furniture meeting the requirements of BS EN 12767 in front of a single sided VRS in the verge (see Paragraph 3.100 of the Guidance section for further information), as long as it is demonstrated that:

(i) furniture cannot be located behind a VRS and outside the Working Width of the system; and

(ii) a VRS with a sufficiently small Working Width cannot be used; and

(iii) the furniture does not/would not touch the safety barrier if hit or act as a ramp over the VRS (see Guidance Paragraph 3.100); and

(iv) the furniture cannot be displaced into the running lane; and

(v) the setback to the furniture is not less than 600 mm.

Requirements for Gaps in Central Reserve

Emergency Crossing Points

3.70 Overseeing Organisation policy is that Emergency Crossing Points (ECPs) are generally deprecated unless it is demonstrated that there is an overwhelming need. Justification for a new ECP on Highways Agency Trunk Roads must be in accordance with the criteria set out in **IAN 68** 'Emergency Access to and Egress from the HA network'.

3.71 On motorways meeting the requirements of Paragraph 3.59 where rigid concrete Higher Containment Level H1 or H2 or Very High Containment Level H4a safety barrier is provided, a VRS with a minimum Containment Level of H1 must be used for any ECP. The provision of an ECP increases the need for maintenance and repair in an otherwise continuous rigid concrete safety barrier and, therefore, their use must be minimised. Designers must ensure that that the transition from the rigid concrete safety barrier to the 'gate' or other system is acceptable in terms of safety and containment and that the working width of the ECP does not encroach into the opposing carriageway. A Departure from Standard is not required for the installation of any such system in an H2 or H4a rigid concrete safety barrier.

3.72 Where an ECP exists on a road which is to be improved or will be subjected to major maintenance, the Design Organisation, in conjunction with the Overseeing Organisation, must discuss with the relevant Emergency Services, the need for the ECP to be retained.

3.73 The ECP must be designed to a minimum length of 16 m and maximum length of 25 m. Greater lengths may create operational difficulties. To determine the dimensional requirements of the crossing point, a location specific swept path analysis should be undertaken during the design stages. The same layout as for tunnels may be adopted, (see Figure 3-16).

"Open" Emergency Crossing Points

3.74 All essential "open" ECPs, which are retained following discussions with the Emergency Services, should preferably be gated and must be closed with a row of traffic cylinders of at least 600 mm in height which comply with Diagram 7103 of the Traffic Signs Regulations and General Directions (TSRGD) and of the Traffic Signs Regulations (Northern Ireland). Cylinders must be spaced at a maximum of 1.0 m centres between the end terminals of the safety barriers.

3.75 To enable an "open" ECP to be identified, special verge marker posts and central reserve reflectors must be erected on each approach at approximately 300 m, 200 m and 100 m from the ECP (See **MCHW-3**: Highway Construction Details Section 1, Series 'E' Drawings).

3.76 The general layout of an "open" ECP must be in accordance with Figure 3-15. At all "open" gaps in the central reserve safety barrier, the alignment of the two opposing sections of safety barrier and their end terminals must be such that an errant vehicle impacting the safety barrier prior to the gap is directed away from and not towards the leading terminal of the downstream safety barrier wherever practicable.

3.77 See Guidance section Paragraphs 3.112 to 3.122 for further information on ECPs and Maintenance Crossing Points (MCPs).

Maintenance Crossing Points and Maintenance Access

3.78 To facilitate contraflow traffic flows during schemes and tunnel maintenance, it may be necessary to establish MCPs in the central reserve and create gaps in the safety barrier (see **TA 92 [DMRB 8.4.6]**). The temporary end terminations to the existing safety barrier installation must satisfy the Performance Class requirements detailed in this Chapter whilst the gap is open.

3.79 For tunnels, which are an unusual situation, the routine maintenance regime may require the MCP to be regularly opened, contraflow operated and the MCP closed within a short period. The safety barrier used to close the gap must have a minimum Containment Level equal to that of the adjacent safety barrier, the layout in Fig 3-16 applies. Further guidance is given in Paragraphs 3.112 to 3.117.

3.80 For other situations, on completion of the works, any MCP gap(s) must be closed by re-instating the original safety barrier(s) or a replacement system of an equivalent Containment Level and Working Width Class to that which was removed (see Chapter 5 of **TA 92**). Any 'above ground' elements of the temporary end termination(s) of the safety barrier must be removed. Suitable transitions must be used between the permanent sections of safety barrier and 'removable' sections and temporary end termination(s).

3.81 At some locations such as at a grade separated interchange, there may be a requirement for maintenance vehicles or plant to gain access behind a safety barrier. In such cases, a staggered overlapped gap in the safety barrier installation (i.e. in the direction of traffic flow) may be justified.

Requirements for an ECP/MCP

3.82 The safety barrier system for an ECP/MCP must be specified in terms of Containment Level and Working Width Class.

3.83 For motorways, where concrete H1, H2 or H4a Containment Level safety barrier is used, the safety barrier system used for an MCP/ECP must be H1 Containment Level or greater.

3.84 For all other roads, the Containment Level at the ECP/MCP must be equal to or greater than that of the adjacent safety barrier e.g. if the safety barrier is N2, then the ECP/MCP must also have a minimum N2 Containment Level.

3.85 Suitable transitions of the same Containment Level as the normal VRS will be required between the VRS and the ECP/MCP system.

3.86 The Working Width Class of the ECP/MCP must not be greater than the highway geometry will allow, (see Paragraph 3.24).

3.87 The maximum acceptable time for opening and closing the MCP must be agreed with the Overseeing Organisation. See Guidance Section for further information.

Winter Maintenance Crossing Points

3.88 At locations which are frequently subject to severe winter weather conditions (e.g. heavy snowfalls), the provision of a Winter Maintenance Crossing Point (WMCP) in the central reserve should be considered. A lockable gate or barrier should be provided across the gap to preclude unauthorised use of the WMCP (See Figure 3-17 as an example of an existing facility).

3.89 A WMCP should only be considered where the width of central reserve is such that the largest type of maintenance vehicle and associated equipment that is likely to be deployed can be safely positioned transversely between the carriageway and the gate, and the gate opened without encroaching into the set-back of either carriageway.

3.90 It will be necessary to erect the appropriate signs and provide traffic cylinders (complying with Diagram 7103 of The Traffic Signs Regulations and General Directions 2002 (S.I. 2002 No. 3113) and of the Traffic Signs Regulations (Northern Ireland) 1997) at 1.0 m (maximum) centres adjacent to each carriageway edge to limit misuse of the WMCP by non-maintenance vehicle drivers.

Other Gaps in the Central Reserve

3.91 On the immediate approaches to Major/Minor side road junctions (see **TD 42 [DMRB 6.2.6]**), the width of the central reserve will often be reduced to allow the provision of a turning lane. This narrowing to the central reserve width, together with the requirement to provide essential visibility sight lines on all approaches of the junction, may preclude the installation of safety barriers over part, or all, of the length where the central reserve width has been reduced. The Design Organisation should seek to avoid omission of safety barrier at junctions on new roads and minimise the omission on existing roads. The siting of street furniture should be carefully considered to ensure that either it is adequately protected by the safety barrier, or not in a location to cause a hazard to the road users, or that it is made passively safe in these situations. (See Paragraph 3.66 et seq.).

3.92 Where a safety barrier is to be installed on an existing all-purpose Trunk Road, the Design Organisation must establish and agree with the Overseeing Organisation, whether there is a need to provide a gap in the central reserve safety barrier (e.g. for a farmer to gain access to an adjacent field). The use of such gaps must be minimised and alternative means of vehicular access must be examined. See **TD 41 [DMRB 6.2.7]**.

Guidance

General Guidance

Working Width Class

3.93 As an example of the greatest Working Width Class that the local highway geometry will allow, if the room available is 1.6 m, this falls in between Classes W4 and W5 (where W4 is ≤ 1.3 m and W5 ≤ 1.7 m), so the greatest Working Width Class that the geometry will allow is W4.

Containment Levels

3.94 At certain high risk locations the use of a Higher Containment Level (H1/H2) or Very High Containment Level (H4a) VRS may be justified. Such high risk locations will be identified through the RRRAP (see Chapter 2 Paragraph 2.17 et seq.). The Design Organisation should demonstrate within the RRRAP how the risk at such locations could be mitigated, the steps taken to reduce the risk to a 'broadly acceptable' level and the required containment level.

3.95 Factors such as the cost of a hazard, and its replacement and the safety implications of the loss if the hazard under assessment should not be available or out of action for a period of time, should be taken into consideration. Examples might be an MS4 sign (a variable message sign) that displays safety messages, if it was removed from service as a result of an impact, would this cause an increased safety risk? If so, then a higher containment VRS may be required to protect it. The RRRAP cannot determine such risks and therefore, any increase in Containment Level should be justified and specified by the Designer. Note that some above ground communications equipment controls significant amounts of automatic signing, such as Active Traffic Management, loss of which due to an accident could

have very severe consequences over a wide area. Loss of other above ground communications equipment may have a relatively limited effect. The Design Organisation should, therefore, ascertain the significance of these items of equipment to ensure that adequate protection is provided.

Set-back

3.96 Hazards immediately adjacent to the edge of the paved carriageway result in drivers reducing speed and positioning their vehicles away from the hazard. The purpose of the set-back is to provide a lateral distance between the VRS, such as a safety barrier, and the carriageway which reduces the effect of the VRS on driver behaviour and edge shyness. Further guidance is given in **TD 27 [DMRB 6.1.2]**. Some P4 energy absorbing terminals protrude proud of the traffic face of the general run of the VRS and, therefore, set-back should be measured from the part of the VRS closest to the traffic face. Where space is tight, a shallow flare of the terminal may be necessary to ensure that the set-back requirements are achieved to all parts of the VRS. The Contractor should check with the VRS manufacturer and ensure that the proposed flare is acceptable and will not invalidate the VRS's 'certified' performance.

3.97 Reducing set-back can exacerbate the likelihood of impacts and side-swipes between vehicles in adjacent lanes; give rise to dangers to any pedestrians, cyclists, etc; difficulty with opening doors on broken down vehicles; and reduced space for maintenance vehicles and operatives.

Location of Hazards Relative to the Carriageway or Running Lane

3.98 The distance of a hazard from the running lane and the nature and profile of the intervening ground will influence the probability of an errant vehicle or struck reaching the hazard. For example, a hazard on or beyond a shallow embankment will be more likely to be reached than one at a similar distance in a cutting. Shallow dished open channels in the verge will tend to slow errant vehicles and direct them back towards, or parallel with, the carriageway rather than towards hazards that are beyond the channel. The roughness of the intervening ground and nature of vegetation on it may have a limited effect on probability of a hazard being reached. Bushes and trees are subject to maintenance regimes and may be thinned, cut back or even removed; there is also the possibility of fire damage, so their presence cannot necessarily be relied on.

3.99 It should be noted that movement of a hazard further from the running lane will give drivers more chance of recovering the situation, avoiding collision and decreasing the severity of a collision. If the gap between the hazard and the safety barrier provided to protect it increases correspondingly, there will be a greater chance of an errant vehicle passing behind the safety barrier, increasing the Length of Need required to provide adequate protection. Movement of both the safety barrier and hazard further from the running lane reduces the likelihood of an impact with the safety barrier, and generally minimises the Length of Need to provide adequate protection to the hazard, although the offset also influences the range of angles of impact which can affect the severity of the impact against the safety barrier. The amount of movement available for the safety barrier will depend on its Working Width, the verge width and the slope profile beyond the back of verge, (refer to Figure 3-1 and Figure 3-2 for details of the allowable proximity of safety barrier to top or toe of slopes). The location of the hazard, set–back, available verge width, and Working Width of the RRS are, therefore, closely interlinked. The optimum solution in terms of hazard location and safety barrier location, Length of Need and Working Width is assessed through the RRRAP.

Location of Road Furniture or Hazards Relative to Safety Barrier

3.100 Placing hollow section posts or columns in front of a safety barrier will interfere with the correct redirectional operation of the safety barrier if impacted by an errant vehicle. It will also increase the probability of collision with the posts or columns. As detailed in Paragraph 3.69 relating to Departures from Standard, a post that has been designed to be passively safe may be positioned in front of a safety barrier if the furniture does not/would not touch the safety barrier if hit, or act as a ramp over the VRS. However, most conventional passively safe posts and lighting columns do not meet this requirement as, when they collapse during impact, they collapse towards the safety barrier, and this may create a ramp which may allow the vehicle to travel over the safety barrier. The type of passively safe systems that could be used are those where the posts are pivoted, such that if hit at any angle they always collapse parallel to the safety barrier and, therefore, present no risk of a ramp effect.

3.101 Objects should not normally be placed within the Working Width as this will affect the performance of the safety barrier. The objects are likely to be impacted and may also have a detrimental effect on the vehicle hitting it and will increase the risk of injury to its occupants. Passively safe sign posts designed in accordance with **TA 89 [DMRB 8.2.2]** will behave differently to conventional street furniture and it may be beneficial to use them in this situation - refer to that Standard and to Paragraphs 3.126 to 3.128 below for guidance. There has been no testing done with passively safe posts and columns positioned within the Working Width of safety barriers and, therefore, this combination must only be used where there is no other solution to lower the risk as low as reasonably practicable. It is recommended that any passively safe signpost or column is placed a minimum of 600 mm from the back of the safety barrier and be placed centrally between any supports of the VRS to allow the barrier to absorb most of the energy of a vehicular impact.

Location of Safety Barrier in Relation to Structures, such as Abutments and Other 'Smooth' Walls

3.102 A safety barrier is required to prevent an errant vehicle impacting the end of a structure or abutment. In most cases, only a normal containment safety barrier is provided and this safety barrier is not intended to provide protection for the structure. However, it is important to ensure that the structural integrity of a structure that, for instance, fails the assessment requirements of **BD 48 [DMRB 3.4.7]** is maintained following an impact, i.e. that the structure should not collapse, but local damage to a part of the bridge deck, for example, could be accepted. If the structure is designed for impact load to **BD 60 [DMRB 1.3.5]** and has a smooth face (see Paragraph 3.12 (iv)) such that a vehicle hitting it would not be snagged or redirected into the carriageway, it is acceptable to place the safety barrier in line with the face of the structure to prevent impact with the ends or corner of the structure. Abutments are not normally considered for vehicle collision as they are assumed to have sufficient mass to withstand the collision loads for global purposes (see **BD 60**). In the same way as for structures, if the abutment has a smooth face, it is acceptable to place the safety barrier in line with the face of the abutment to prevent impact with the ends or corner of the abutment. This may be the preferable option where there is limited space in front of a structure, see Figure 3-8. Alternatively, a safety barrier could be placed in front of the structure/abutment, e.g. in cases where it is not possible to create a smooth face.

3.103 It is important when connecting safety barrier to an abutment or similar wall to ensure that there is a gradual change in stiffness of the safety barrier as it approaches the structure. If the change in either is too abrupt, there is a possibility that an errant vehicle hitting the safety barrier would cause a 'pocketing' effect. This is where the safety barrier deflects significantly more than the stiffer structure that it is connected to, leading to the vehicle hitting the end of the abutment or wall. See also Paragraph 3.56 and Chapter 6 Paragraph 6.9 et seq. In order to prevent this, a suitable transition should be provided.

Location of Safety Barrier in Relation to Exposed Rock Faced Slopes

3.104 A common means of capturing falling rocks at exposed rock faced slopes is the installation of rock netting. This would be installed vertically or at a slight incline towards the road, and behind any safety barrier that is present. One of the advantages of this arrangement is the ability of the rock netting to absorb, by distortion, some of the energy of the falling rocks. Another advantage is that any arrested debris is relatively easy to monitor. However, on the assumption that a safety barrier is to be installed at the same location as the rock netting, the lateral space for each VRS to perform correctly needs to be taken into account. If fallen rocks encroach into the Working Width of the safety barrier, then there is the prospect of a vehicle not only impacting the safety barrier but also the rock netting and any accumulated debris. This could result in an impact more severe than if only the safety barrier had been involved and there is also the possibility that the vehicle could become unstable and spin out into the live carriageway.

3.105 The safety barrier itself should not be used to contain falling rocks. This could result in:

(i) damage to the rear of the safety barrier which is difficult to assess;

(ii) a serious constraint to the ability for the safety barrier to deflect, invalidating its 'certified' performance.

Any significant modification of the safety barrier (netting between posts, high netting attached to the safety barrier, etc.) would again invalidate the certified performance.

3.106 Inspection and maintenance of both the rock retaining system and the safety barrier are essential to ensure correct performance of both the safety fencing and rock netting fencing.

Closing of Short Gaps Between Safety Barrier Installations

3.107 Short gaps between two separate safety barrier installations should be avoided unless they are required for access, as the terminal section of a safety barrier presents more of a hazard to vehicles than the length of full height safety barrier used to close the gap. The longer the gap, the less the benefit gained in closing it. At present, it is required that gaps of less than 50 m should be closed. It might also be practicable to close gaps up to 100 m; this will depend on the site and the proposed end terminals being considered.

3.108 Where a gap between safety barrier installations cannot physically be closed due to the safety barriers being at different offsets, it may be acceptable to overlap the two installations. It is not acceptable if a vehicle (travelling in either direction on two way roads or contraflow situations) that hits the first safety barrier could be directed into the leading terminal of the second safety barrier or into the hazard that the second is protecting.

Guidance on Factors Regarding Choice of Restraint System

3.109 The choice of Restraint System will normally be made by the Contractor based on the performance criteria specified. Any special requirements should be detailed in the contract documentation to ensure that suitable systems are selected.

3.110 When specifying, designing and installing safety barriers, consideration should be given to the following:

(i) Proximity of other services (e.g. drainage, communications and utilities) (See **TD 27 [DMRB 6.1.2]**) and the need to access these for maintenance.

(ii) Maintenance of the safety barrier system, the verge/central reserve (e.g. grass/surface material) and street furniture and equipment, including provision for mounting temporary signs, especially in the central reserve.

(iii) Drainage of the adjacent carriageway, verge and or central reserve, e.g. it may be necessary to provide drainage 'weep' holes through a solid rigid safety barrier. Advice of the System manufacturer should be sought to ensure that such holes would not invalidate the safety barrier Certification or compromise its durability.

(iv) The need to specify the maximum amount of vehicle intrusion over the safety barrier that can be allowed. N.B. it is necessary to identify locations where vehicle intrusion is critical in determining the Working Width and to ensure that the contractor is aware of the need for manufacturer's stated Working Width to include vehicle intrusion when selecting a VRS, (refer to Guidance on Working Width in Chapter 1 of this Standard). The Working Width quoted in the Highways Agency's list of acceptable VRS includes vehicle intrusion unless stated otherwise.

(v) Sightline requirements, e.g. the effect of the height of the safety barrier on stopping sight distance.

(vi) Environmental considerations: e.g. snow, where a solid safety barrier may give rise to unacceptable levels of drifting; or marine environments where steel or aluminium products may be subject to high levels of corrosion.

(vii) The requirement for the system to be readily removed at emergency or maintenance crossing points, see below for guidance.

(viii) The need to limit the dead loading applied by the system to a supporting structure.

(ix) The need to limit the impact loading applied by the system to a supporting structure.

(x) The effectiveness of safety barrier systems when developing improvement or maintenance schemes. Where pavement overlays are to be undertaken in the future, particular consideration should be given to the height of the safety barrier above the adjacent carriageway surface. Guidance on the range of heights over which safety barrier is effective should be sought from the safety barrier manufacturers and assumptions made stated in contract documents to ensure that provision is adequate. Note that construction tolerances on safety barrier heights would be insufficient to permit pavement overlays without repositioning the safety barrier.

(xi) The implications on future traffic management layouts, e.g. it may be desirable to provide slots in concrete safety barrier for temporary signs.

Guidance on Provision in Verges and Central Reserves

Length of Restraint

3.111 It is very difficult to model accurately in the RRRAP all the factors that might influence the Length of Need for every situation. There have been cases at both cuttings and embankments where an errant vehicle has managed to pass behind a safety barrier and hit a hazard that the safety barrier was there to protect. The site inspections are, therefore, an essential part of ensuring that assumptions made during the design process remain valid, that changes are made where necessary and that adequate length of safety barrier is provided. Site inspections will be needed during the design and construction phases.

Guidance on the Requirements for Gaps in Central Reserve

Emergency and Maintenance Crossing Points

3.112 There are various options available to create an ECP/MCP. They may take the form of a gate or a permanent safety barrier. Each option varies in cost and ease of operation. Systems that are not suitable to be removed should be avoided near ECPs and MCPs.

3.113 For ECPs, the main requirement is the speed with which the ECP can be opened and operational; this will depend on the option chosen. It will also depend on whether specialist equipment or personnel are required to operate or open the ECP. In most cases, a time of less than 30 minutes to open the gate or dismantle a permanent safety barrier would be desirable (See **IAN 68** for details).

3.114 For MCPs, speed may not be an issue as the opening can be planned. Where regular maintenance is required, for example, near tunnels or on long structures, then it may be beneficial to provide permanent MCPs at each end that can be opened and closed quickly. For other situations, there are two options. Provide an MCP from the outset, or create an MCP only when required (i.e. take down or break out the permanent system; this can often be the most cost effective solution).

Gates at MCP/ECP

3.115 A gate is the easiest to open, generally requires no, or minimal, specialist equipment and can be opened in less than 30 minutes. However, personnel do need to be trained to ensure that they know how to operate the gate and close it properly so that it is correctly fixed to the permanent or temporary safety barrier when not in operation. Gates are generally quite expensive. They also have large Working Widths that can make them unsuitable for narrow central reserves (e.g. W5+). If they are used, where there is a mismatch in the working widths between the gate and the permanent system (e.g. Gate is W5 and concrete H2 safety barrier is W2), a transition is required to connect the two systems. Any transitions will increase the length of the MCP. (See Figure 3-16 for typical details).

3.116 Consideration should be given to the length of the openable leaves of the crossing safety barrier (and hence, the overall length of the crossing) such that, when in the open position, the requisite number of lanes are protected by the safety barrier.

3.117 Consideration should also be given to the means by which the openable leaves are opened and the effect that length may have on the practicability of opening and closing, especially when it is likely that the maintenance crossing facility will be used infrequently.

Permanent Safety Barrier at ECP/MCP

3.118 A permanent safety barrier may be used to form an ECP/MCP.

3.119 If this option is chosen for an ECP, specialist personnel and equipment may be required to dismantle or remove the safety barrier and this can take some time and may exceed the normal 30 minute recommendation required for operational reasons. For an MCP it is a viable option.

3.120 Where a concrete H1 or H2 safety barrier is used, an MCP can be created by breaking out the concrete and removing the debris. This operation might take some time depending on length and require specialist equipment. An in-situ concrete section can then be inserted when the MCP is no longer required.

3.121 If the central reserve safety barrier is metal, socketted posts should be used to allow the permanent safety barrier to be dismantled and reinstated quickly (this may not be applicable for all Systems). The time for these operations will vary depending on the System and, if used, can mean a lot of repair work to reinstate the safety barrier. Therefore, this makes this suitable for an MCP, but not an ECP.

3.122 Whenever a section of safety barrier is removed, the ends of the safety barrier must be made safe in accordance with this Standard (e.g. terminals, crash cushion provided, or transition and openable gate/leaf of safety barrier).

Guidance on Other Parameters

Lighting Columns

3.123 As an alternative to ‘conventional’ lighting columns, such as planted concrete columns or planted or flanged tubular steel columns, passively safe road lighting columns meeting the requirements of BS EN 12767 may be considered.

3.124 Consideration should be given to mounting the lighting columns in the verges rather than in the central reserve to keep the central reserve as maintenance free as possible.

3.125 The performance of some types of passively safe lighting columns may make them unsuitable for use in certain situations. For instance, on the elevated approaches to bridges and structures as depending on the form of design, they, or part thereof, could collapse onto a hazard below causing a Secondary Event more serious than the original event. Also they should not be used in central reserves or similar situations.

Signs

3.126 It is not acceptable in terms of safety barrier provision for designers to reduce the size of sign support posts by providing an increased number of posts (unless a passive safety support structure system is used in accordance with BS EN 12767), solely to overcome the requirement to provide a safety barrier. As the spacing of posts supporting a sign decreases, there is an increasing tendency for more than one post to be hit by an errant vehicle and for the sign and posts to act together as a relatively stiff and rigid hazard, thus significantly increasing its aggressiveness and hence, potential to cause damage to an errant vehicle and injury to its occupants.

3.127 There can be significant safety benefits in the use of passively safe signs, however, care must be taken in their placing as they can suffer from metal fatigue caused by vibrations from buffeting by strong winds and turbulence from large vehicles passing close by. The use and siting of such signs should be carefully considered, particularly in areas prone to high winds, to avoid such problems.

3.128 Passively safe signs should not be used where there is a vehicular path that could lead to the sign being knocked towards the road, e.g., unprotected parallel road with a sharp bend and a vehicle goes through the wooden boundary fence into the sign.

3.129 Highway signs on posts of more than 7 m in height, i.e. the vertical distance from top of post to bottom of flange plate or top of foundation whichever is the lesser, require technical approval, see **BD 2 [DMRB 1.1.1]**.

Trees and Other Vegetation

3.130 Trees are a potential hazard and, therefore, need to be considered within the RRRAP. In previous standards, only trees with a girth of 300 mm or more have been classed as a hazard. If the tree girth was measured and it was less than 300 mm this often meant it was excluded and not protected with a safety barrier even though it might grow to >300 mm within its life. To ensure that this does not occur, all trees should be considered a hazard unless it can be shown that they would not reach 250 mm girth (note different dimension) at maturity. If the tree is to remain and is expected to exceed 250 mm girth at maturity, then the maximum size should be used to assess the need for and placement of the VRS to ensure that the Working Width of the safety barrier is not compromised when it grows. The designer should consider the worst case in the RRRAP. In some cases, it may be better to remove young trees that would not pose a current risk and replant them at a safer distance from the running lane. However, a check should be made on why they were planted, for example, are they part of a visual screen or planted where they are due to land constraints?

3.131 Trees are an important biodiversity asset and amenity and should not be removed without prior agreement by the Overseeing Organisation; they may also be subject to a Tree Preservation Order. They might also provide a visual screen, earth work stabilisation, wind protection or mask another hazard e.g. railings. Consideration should be given to all these factors. Where it is agreed a tree may be removed, it should be cut flush with ground level. Removal of stumps to ground level will require chemical treatment to ensure there is no re-growth; the same applies for removal of young trees.

3.132 Vegetation within the Working Width of the safety barrier will affect its performance. It will also hinder maintenance and create problems for the drivers of broken down vehicles who may seek temporary refuge behind the safety barrier. Where space exists, trees and other vegetation should be placed as far from the kerb face or back of hardstrip or hardshoulder as practicable (see **HA 56 [DMRB 10.1.2]**). However, where practicable, the following is recommended, for climax trees (e.g. Oak) 9 m, medium trees (e.g. Birch) 7.5 m, small trees (e.g. Malus) 5 m, and shrubs 4.5 m from the edge of the carriageway.

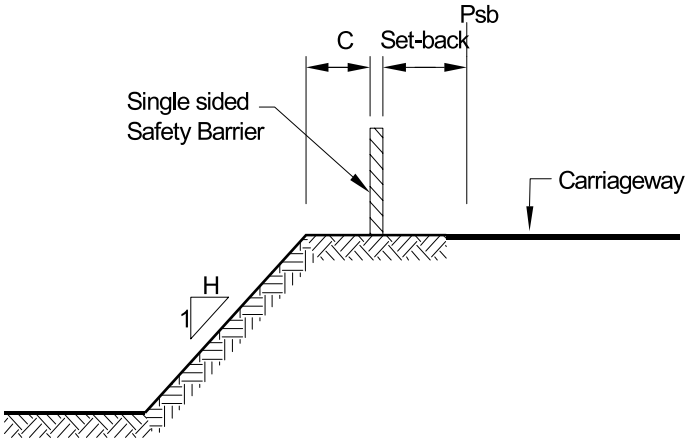


Figure 3-1 (a). At Embankments and Sidelong Ground Where Ground Slopes Down Behind Barrier.

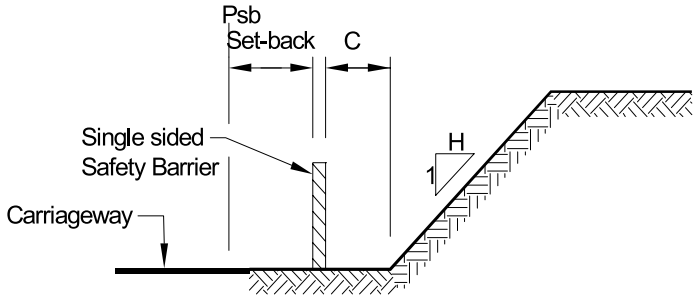


Figure 3-1 (b). At Cuttings

Notes

1. Psb = point from which set-back is measured (see **TD 27**).
2. The following conditions apply

a) Where the slope (1 in H) is shallower than or equal to 1 in 3, the dimension C may be less than the Working Width Class of the safety barrier, but not less than 600 mm.

b) Where the slope (1 in H) is steeper than 1 in 3 but shallower than or equal to 1 in 2, the dimension C must not be less than the greater of 0.75 times the Working Width Class of the safety barrier and 600 mm.

c) Where the slope (1 in H) is steeper than 1 in 2, the dimension C must not be less than the greater of the Working Width Class of the safety barrier and 600 mm.

d) On embankments and sidelong ground where the proximity of the safety barrier to the top of the slope and / or the ground conditions are likely to affect the integrity of the barrier, the advice of a Geotechnical Engineer must be sought and in-situ tests undertaken to verify the integrity of the barrier and its foundation. The advice and results of tests must be recorded.

3. General

a) The restrictions on dimension C are to ensure that (i) in cuttings, the barrier will perform satisfactorily and will not be affected by the slope behind it, and (ii) on embankments and sidelong ground, the ground is sufficiently strong to resist the forces that an errant vehicle and safety barrier may give rise to and also, when deflecting during a collision, that an errant vehicle is not adversely affected by the slope.

b) Refer to Figure 3-4 and Paragraphs 3.21 to 3.25 for details of Set-back requirements

Figure 3-1 Minimum Distances of Safety Barrier from the Top and Toe of Slopes at Verges where Safety Barrier is Required for Other Reasons

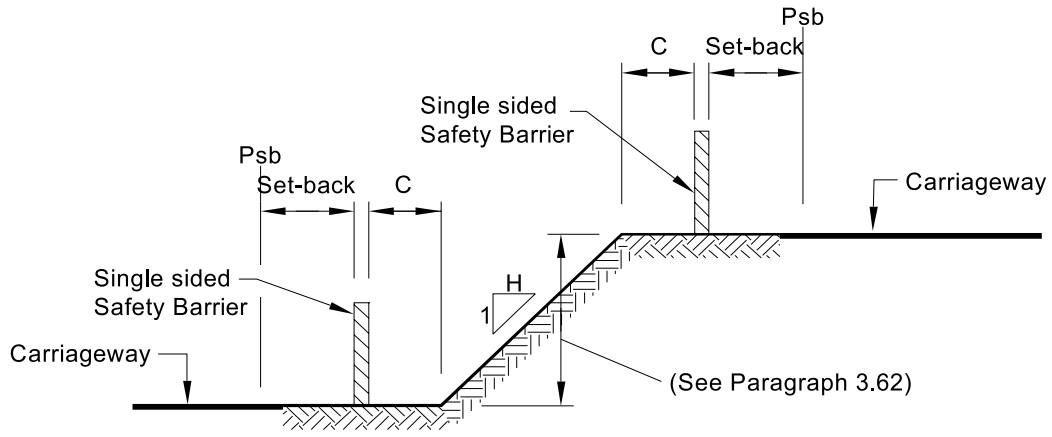


Figure 3-2(a). Height difference in carriageway greater than 200mm and slopes greater than 1 in 20

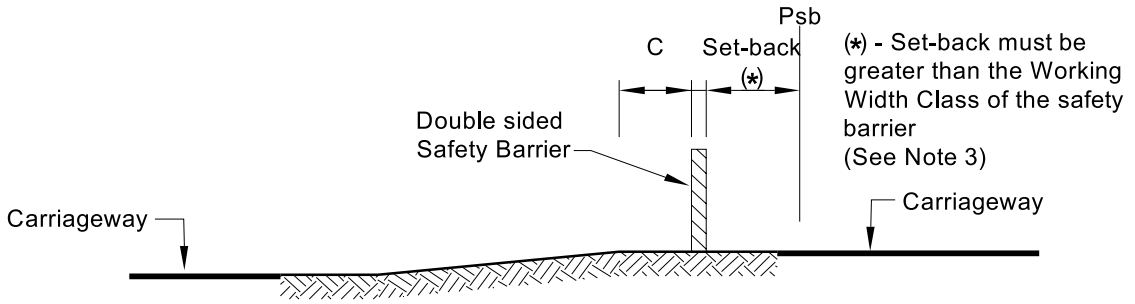


Figure 3-2(b). For slopes not greater than 1 in 20

Notes:

1. Psb = point from which set-back is measured (see **TD 27**).
2. The following conditions apply
a) Where the level difference across the central reserve is less than 200mm and the slope (1 in H) is shallower than 1 in 20, the dimension C may be less than the Working Width of the safety barrier.
b) Where the slope (1 in H) is shallower than or equal to 1 in 3, the dimension C may be less than the Working Width Class of the safety barrier, but not less than 600 mm.
c) Where the slope (1 in H) is steeper than 1 in 3 but shallower than or equal to 1 in 2, the dimension C must not be less than the greater of 0.75 times the Working Width Class of the safety barrier and 600 mm.
d) Where the slope (1 in H) is steeper than 1 in 2, the dimension C must not be less than the greater of the Working Width Class of the safety barrier and 600 mm.
e) On embankments and sidelong ground where the proximity of the safety barrier to the top of the slope and / or the ground conditions are likely to affect the integrity of the barrier, the advice of a Geotechnical Engineer must be sought and in-situ tests undertaken to verify the integrity of the barrier and its foundation. The advice and results of tests must be recorded.
3. General
a) The restrictions on dimension C are to ensure that (i) in cuttings, the barrier will perform satisfactorily and will not be affected by the slope behind it, and (ii) on embankments and sidelong ground, the ground is sufficiently strong to resist the forces that an errant vehicle and safety barrier may give rise to and also, when deflecting during a collision, that an errant vehicle is not adversely affected by the slope.
b) Refer to Figure 3-4 and Paragraphs 3.21 to 3.25 for details of Set-back requirements

Figure 3-2 Minimum Distances of Safety Barrier from the Top and Toe of Slopes in Central Reserves where Safety Barrier is Required for Other Reasons

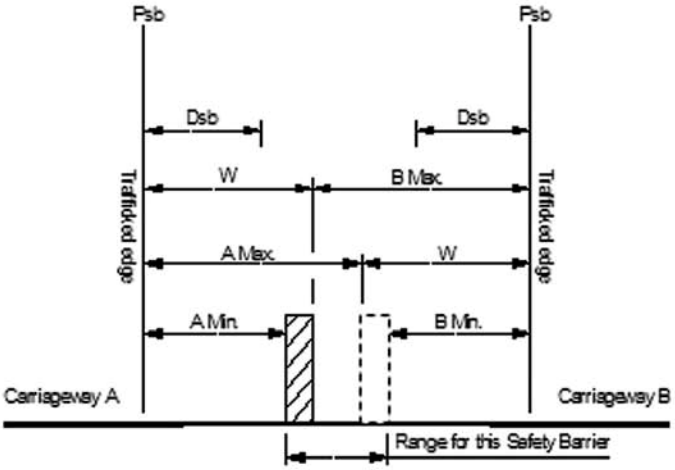


Figure 3-3(a). Range of Positions with High Value of Working Width Class (e.g. W6).

Key:

Dsb	=	Desirable min set-back from TD 27
W	=	Working Width Class
W max	=	Max barrier Working Width Class that can be provided
A	=	Set-back to Carriageway A
B	=	Set-back to Carriageway B

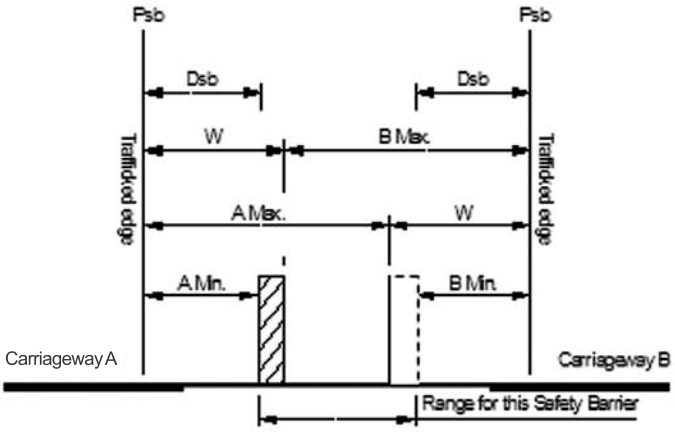


Figure 3-3(b). Range of Positions with Low Value of Working Width Class (e.g. W4).

Key: (continued)

A (B) max	=	Max possible set-back to Carriageway A (B) with the proposed Working Width Class of Barrier
A (B) min	=	Min possible set-back to Carriageway A (B) with the proposed Working Width Class of Barrier

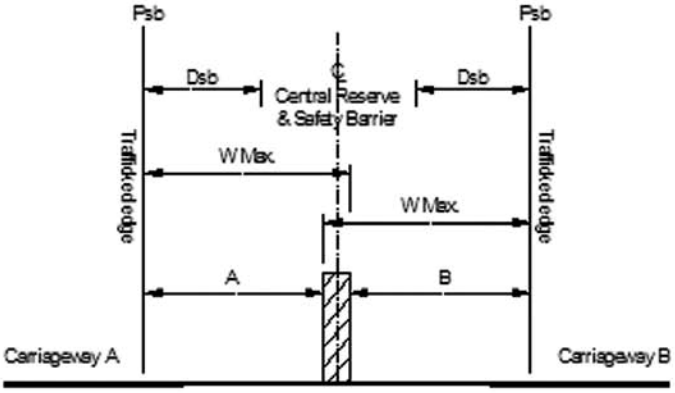


Figure 3-3(c). Maximum Working Width Class Achievable with Safety Barrier Located Centrally in Central Reserve.

Figure 3-3 Central Reserve: Ranges of Positions for Double Sided Safety Barrier

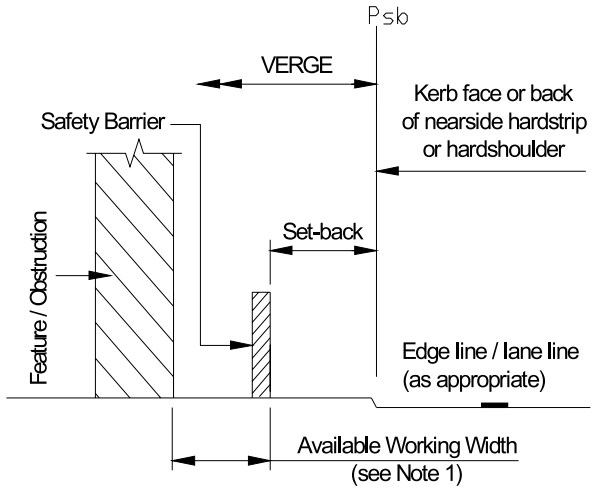


Figure 3-4 (a). Safety Barrier at Verge

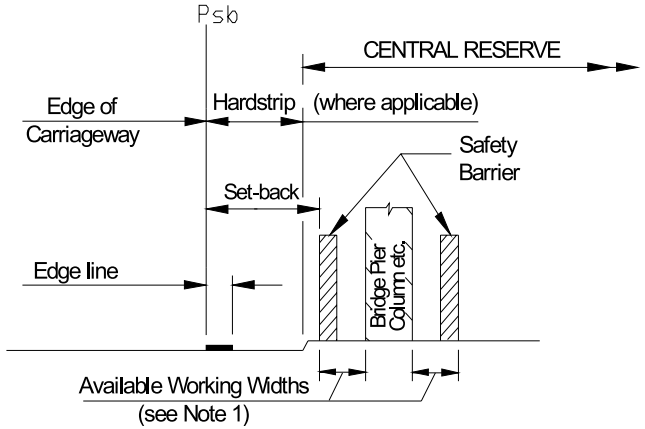


Figure 3-4 (b). Safety Barrier at Central Reserve (with Offside Edge Line)

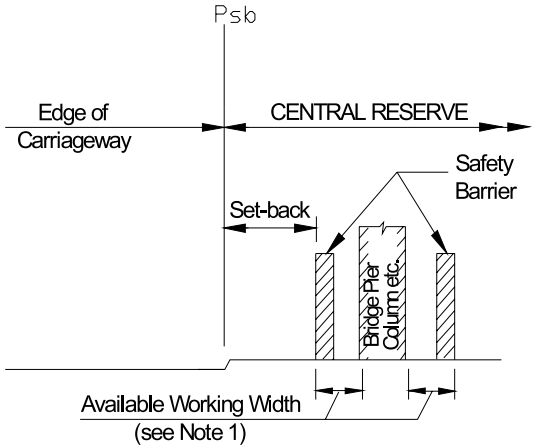
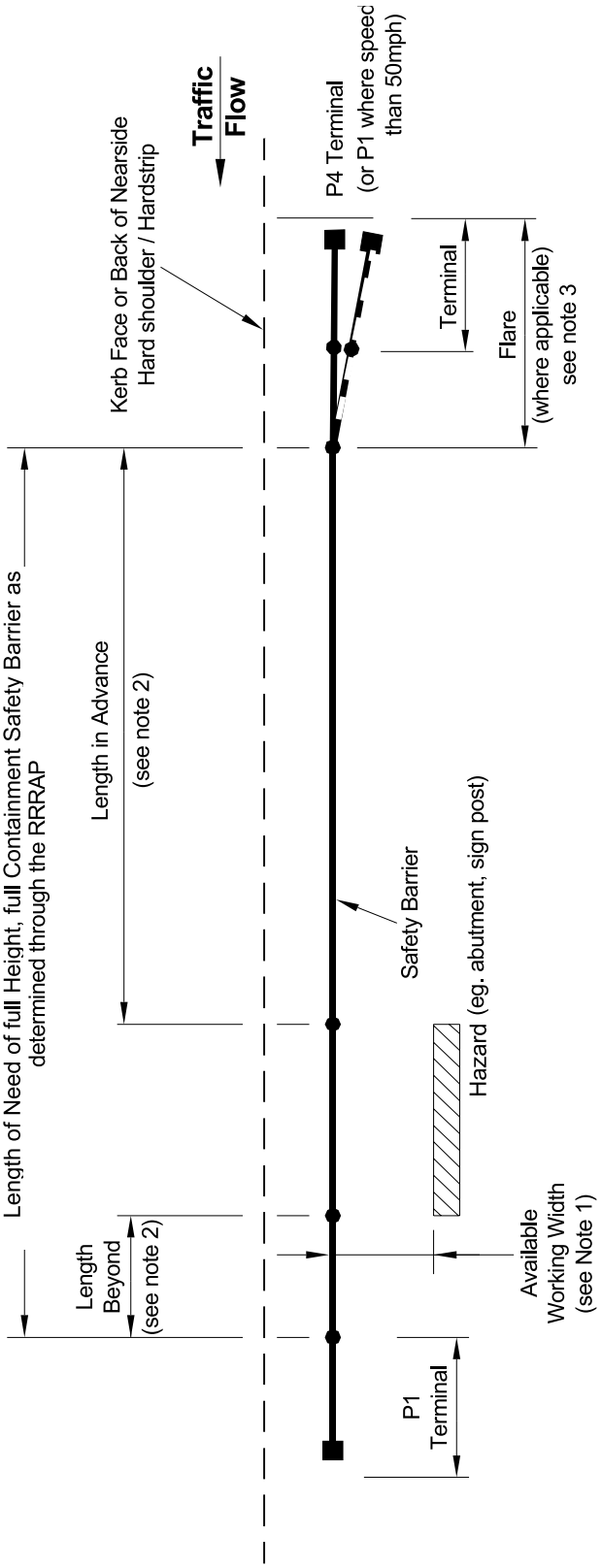


Figure 3-4 (c). Safety Barrier at Central Reserve (with no Offside Edge Line)

Notes:

1. **The Working Width Class shall not be greater than that which can be wholly contained within the available Working Width.**
2. **Psb = Point from which set-back is measured. See Figure 3-4 and TD 27 [DMRB 6.1.2].**
3. **See Paragraphs 3.21 to 3.25 for details of Set-back requirements.**

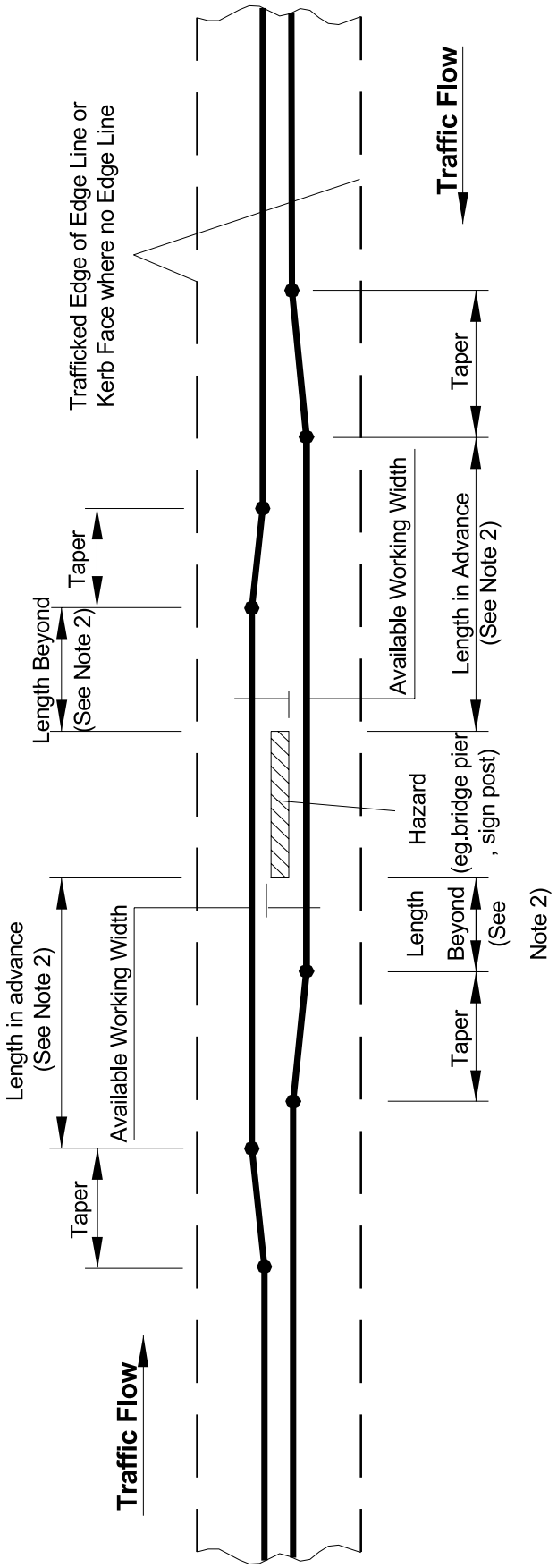
Figure 3-4 Set-back and Working Widths Adjacent to Hazards



Notes:

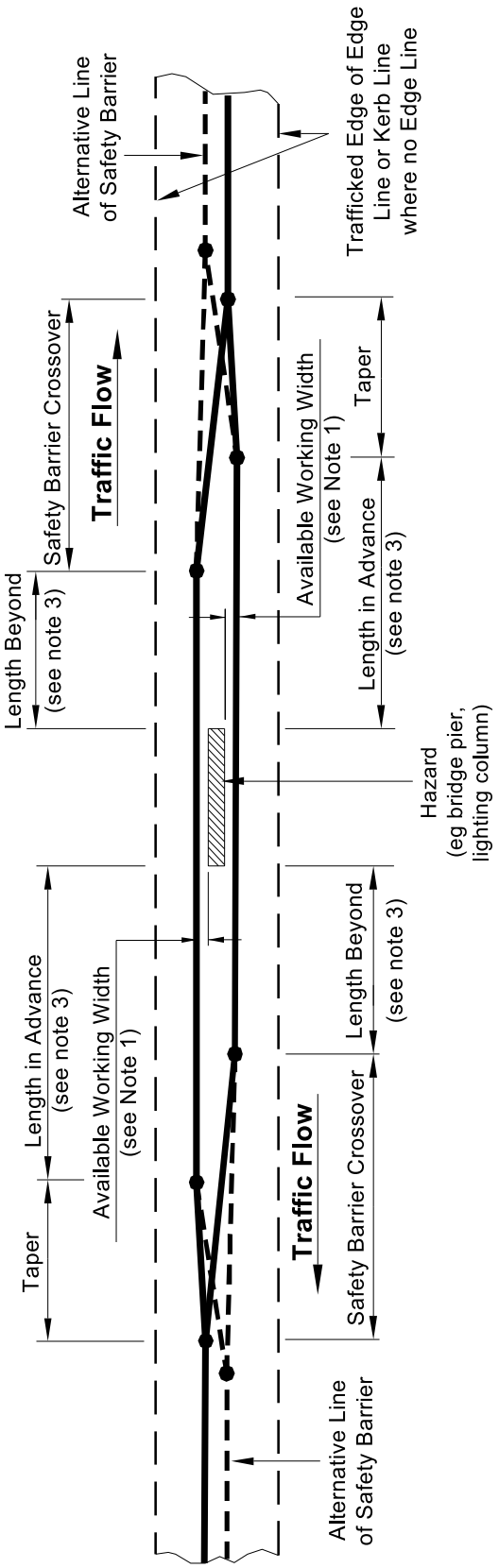
1. At hazards (e.g. structures, sign post, etc) the Working Width Class shall not be greater than that which can be wholly contained within the available Working Width.
2. Refer to Paragraphs 3.26 to 3.29 and Table 3-1.
3. Flare only provided where required by Manufacturer's system, e.g. to maintain set-back to terminal.
4. See Figure 3-4 and Paragraphs 3.21 to 3.23 for details of Set-back requirements.

Figure 3-5 Verge Safety Barrier Layout Adjacent to Hazards



Notes:
1. At hazards (e.g. structures, etc) the Working Width Class shall not be greater than that which can be wholly contained within the available Working Width.
2. Refer to Paragraphs 3.26 to 3.29 and Table 3-1.
3. See Figure 3-4 and Paragraphs 3.21 to 3.25 for details of Set-back requirements.
4. See Figure 3-12 for taper length requirements.

Figure 3-6 Central Reserve Safety Barriers (Single Sided) Layout Adjacent to Hazards



Notes:

1. **At hazards (e.g. structures, etc) the Working Width Class shall not be greater than that which can be wholly contained within the available Working Width.**
2. **Where there is a single Double Sided Safety Barrier, the Set-back to either carriageway must not be less than the Working Width Class minus the actual width of the safety barrier, see Figure 3-3.**
3. **Refer to Paragraphs 3.26 to 3.29 and Table 3-1.**
4. **See Figure 3-4 and Paragraphs 3.21 to 3.23 for details of Set-back requirements.**
5. **See Figure 3-12 for taper length requirements.**

Figure 3-7 Central Reserve Safety Barrier (Double Sided) Layout Adjacent to Hazards

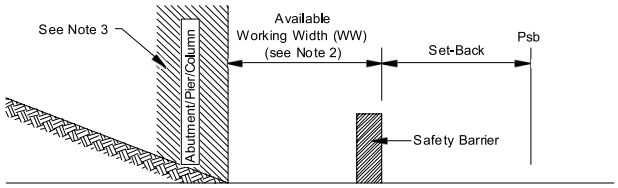


Figure 3-8 (a)

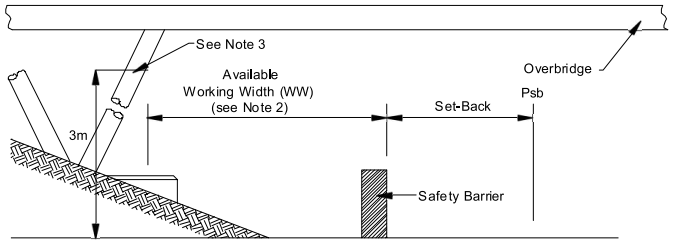


Figure 3-8 (b)

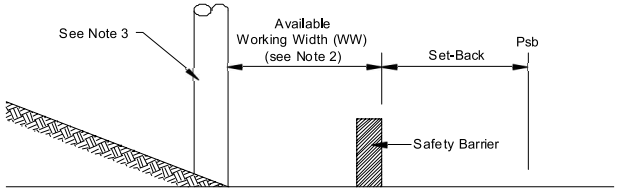


Figure 3-8 (c)

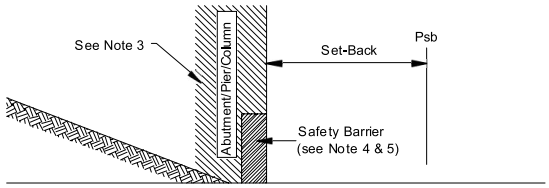


Figure 3-8 (d)

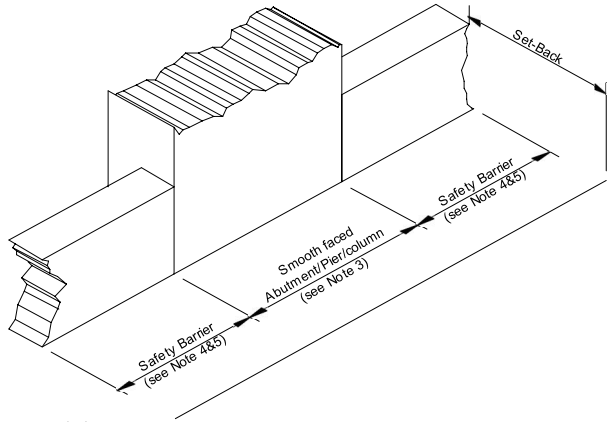
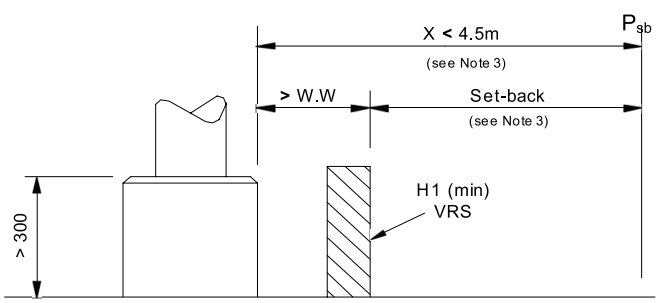


Figure 3-8 (e)

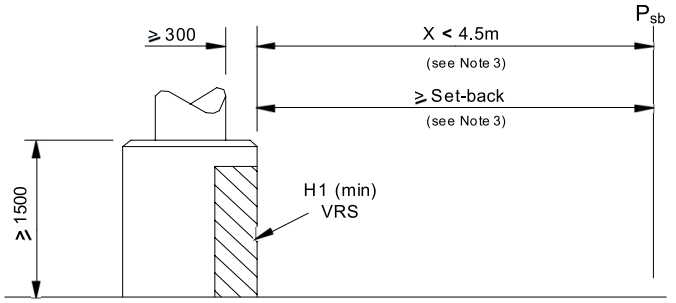
Notes:

1. **Psb = Point from which set-back is measured. See Figure 3-4 and TD 27 [DMRB 6.1.2].**
2. **At obstructions (e.g. structures, gantries, columns, etc) the Working Width Class shall not be greater than that which can be wholly contained within the available Working Width.**
3. **For collision loading requirements see BD 60 [DMRB 1.3.5].**
4. **Deformable safety barriers must be connected to an abutment / pier by a suitable transition.**
5. **This method of interface between supports and safety barrier is not to be used without prior agreement with the Overseeing Organisation.**
6. **Refer to Paragraphs 1.49 to 1.52 and 3.10 for guidance on Working Width and vehicle overhang and to Paragraphs 3.102 and 3.103 for guidance on location of safety barrier in relation to structures such as abutments.**

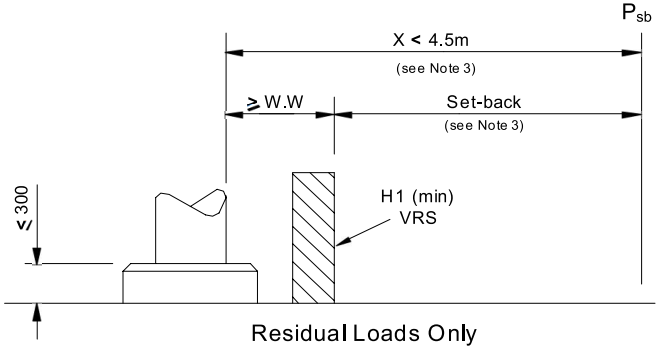
Figure 3-8 Provision of Safety Barriers at Structural Support in Verges



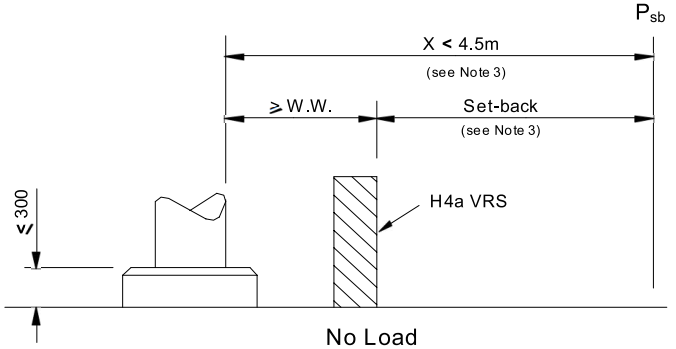
Residual Loads Only



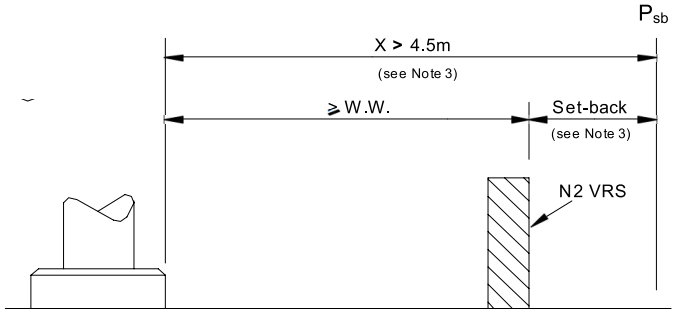
Main + Residual Loads



Residual Loads Only



No Load

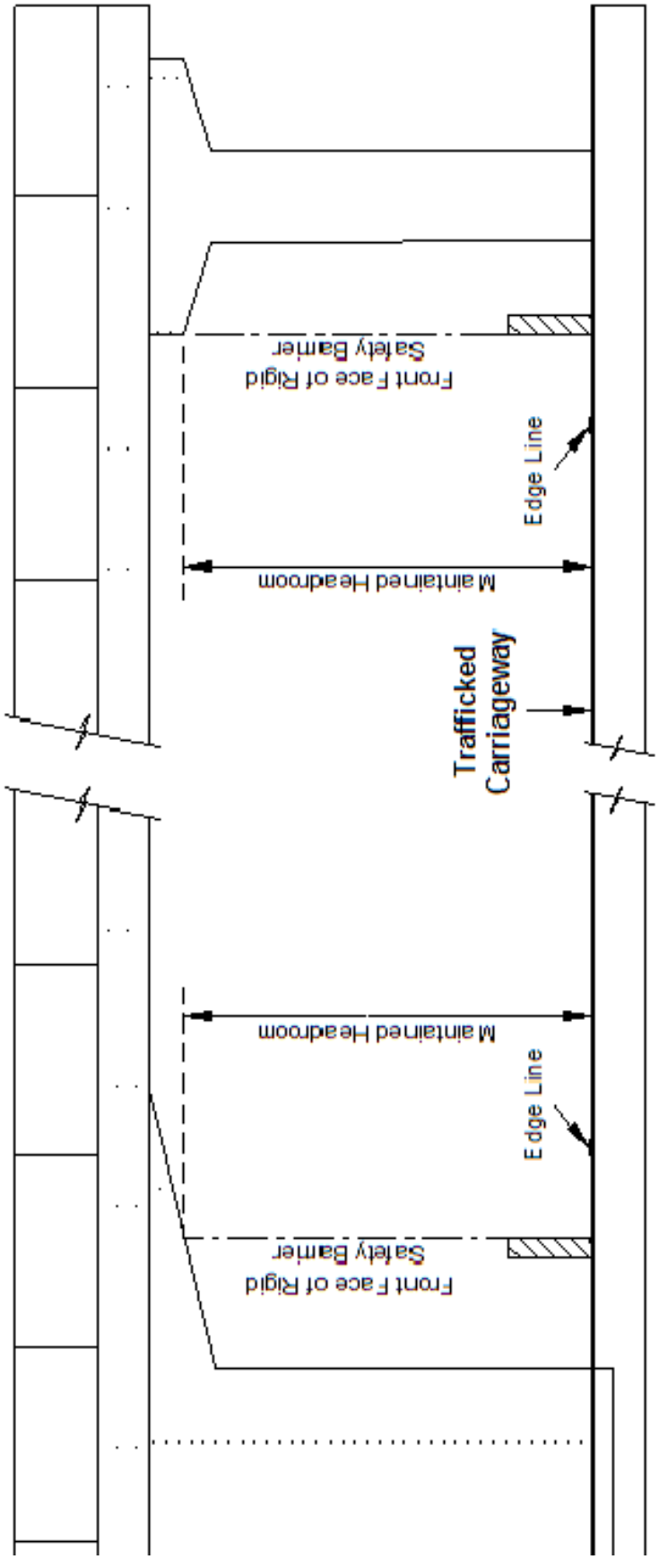


No Load

Notes:

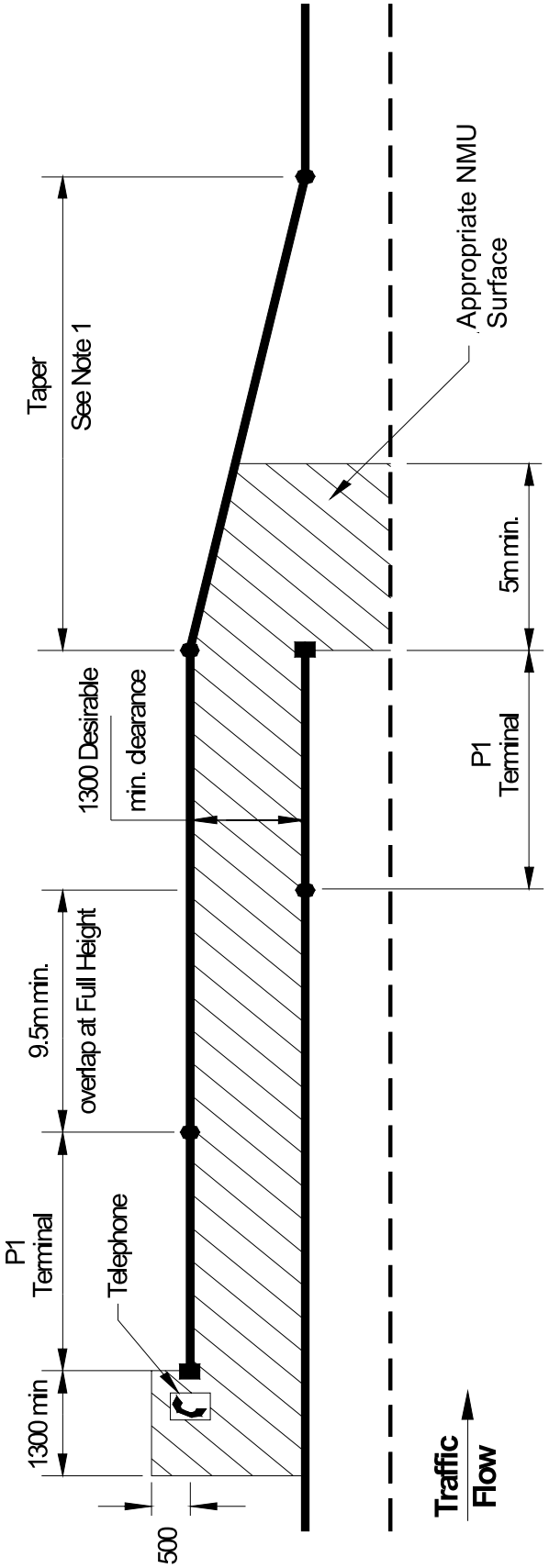
1. **Details are for roads with a speed limit of 50 mph or over. (Below 50 mph, a VRS is not required, but may be necessary in certain situations).**
2. **VRS = Vehicle Restraint System (safety barrier)**
   WW = Working Width
   N2, H1, H4a are Containment Levels defined in BS EN 1317-2
3. **PSb = Point from which set-back is measured. See Figure 3-4 and TD 27 [DMRB 6.1.2].**
   For Near side: Kerb face or back of hardstrip or hardshoulder.
   For offside: Trafficked edge of edge line or the kerb face where there is no kerb line.
4. **Measurements 'X' and 'W.W.' are taken to plinth where plinth height is >= 0.3 m, and to face of sign / gantry support where plinth height is < 0.3 m.**
5. **For collision loading requirements see BD 51 [DMRB 2.2.4].**
6. **For No Load situations, containment level requirement is determined through the RRRAP.**
7. **See Figure 3-4 and Paragraphs 3.21 to 3.25 for details of set-back requirements.**
8. **Verge situation shown; for central reserves, safety barrier will be required on both sides of the sign / signal gantry.**

Figure 3-9 Requirements for Protection of Sign/Signal Gantries from Collision Loads



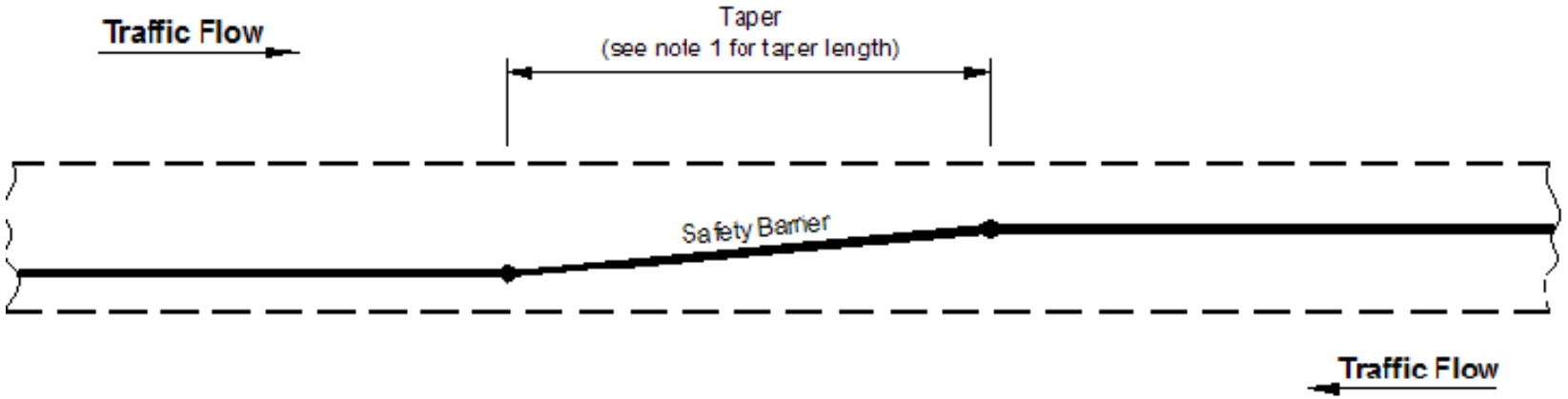
Notes:
1. See Paragraphs 1.49 to 1.52 and 3.10 regarding overhang of vehicle over rigid safety barrier.
2. See also Figures 3-8 and 3-9.

Figure 3-10 Provision of Rigid Safety Barriers at Restricted Headroom



Notes:
1. Refer to Figure 3-12 for Taper requirements.
2. Emergency telephones do not require VRS protection. This drawing illustrates the situation where a VRS is required for other reasons.

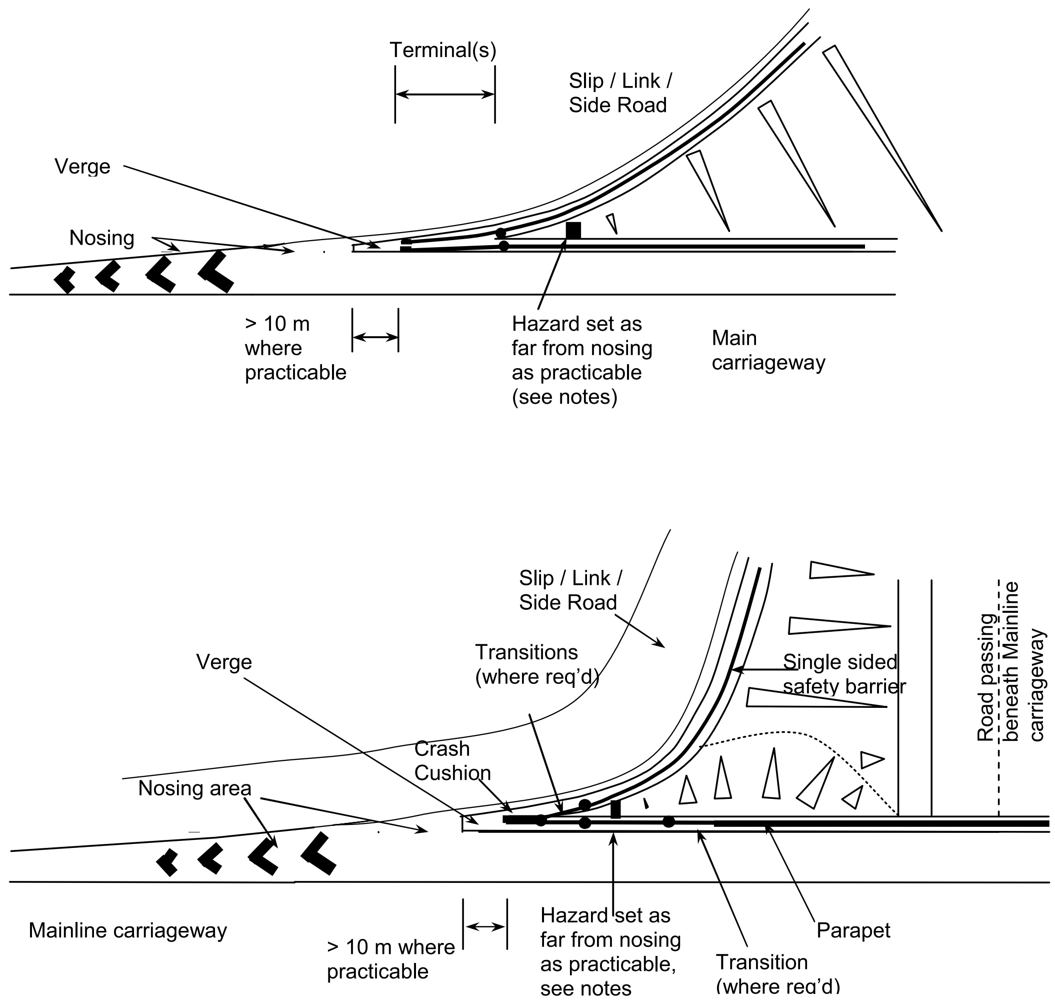
Figure 3-11 Accommodating Emergency Telephone at Verge Safety Barrier



Notes:

1. **Changes of horizontal alignment to take place over taper length. Length of taper to suit rate of change in set-back.**
   Rate of change of set-back not to exceed 1 in 16 for deformable safety barriers or 1 in 20 for rigid safety barriers.
   For changes in set-back less than 300 mm, length of taper to be 32 times the difference in the set-back with start and end transition curves.
   The requirements of the particular manufacturer must be verified and, where necessary, the taper length increased.
2. **On central reserves, where there is a single Double Sided safety barrier, the set-backs must not be less than the Working Width Class of the safety barrier minus the actual width of the safety barrier. See Figure 3-3.**
3. **See Figures 3-1, 3-2 and 3-4 and Paragraphs 3.21 to 3.25.**

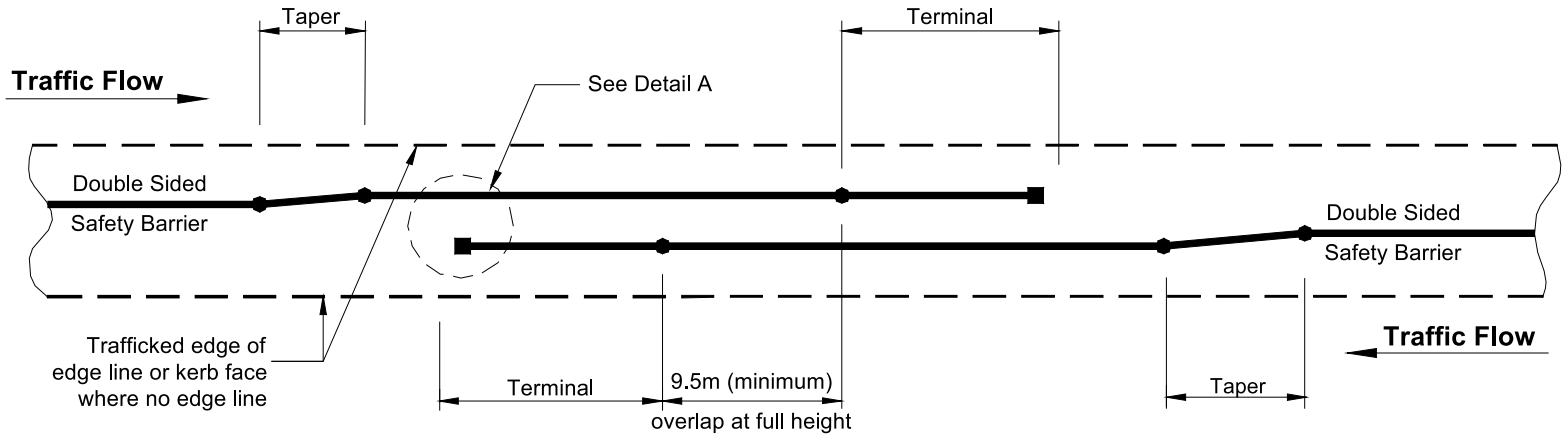
Figure 3-12 Taper Lengths at Changes in Horizontal Alignment of Verge and Central Reserve Safety Barrier

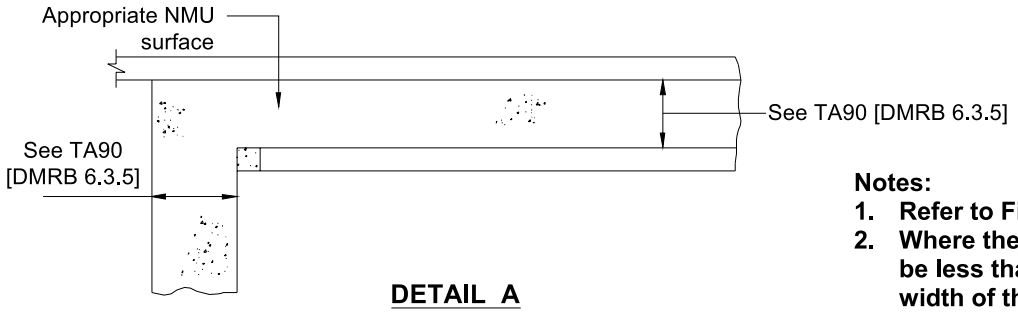


Notes:

1) If feature has to be placed in Nosing area, consideration should be given to:
   a) Can feature be made passively safe?
   b) Can feature be moved/relocated further from Nosing, thereby decreasing risk of it being hit, whilst still fulfilling its function?
   c) Is safety barrier required to nearside of Mainline and to offside of Slip/Link/Side road to protect the Feature and or to protect other hazards, e.g. tight bend, slope, lighting columns, etc. The RRRAP should be used to aid determination of requirements.
   d) Can Feature be placed sufficiently far from the terminal(s) and are they of a type whereby an errant vehicle hitting them would not be guided into the Feature that the safety barrier is intended to protect?
   e) Provision of a crash cushion, especially where space is limited and feature cannot be located to satisfy (a) to (d) above, see Chapter 7.

Figure 3-13 Safety Barrier Layout and Factors to Consider at Nosings

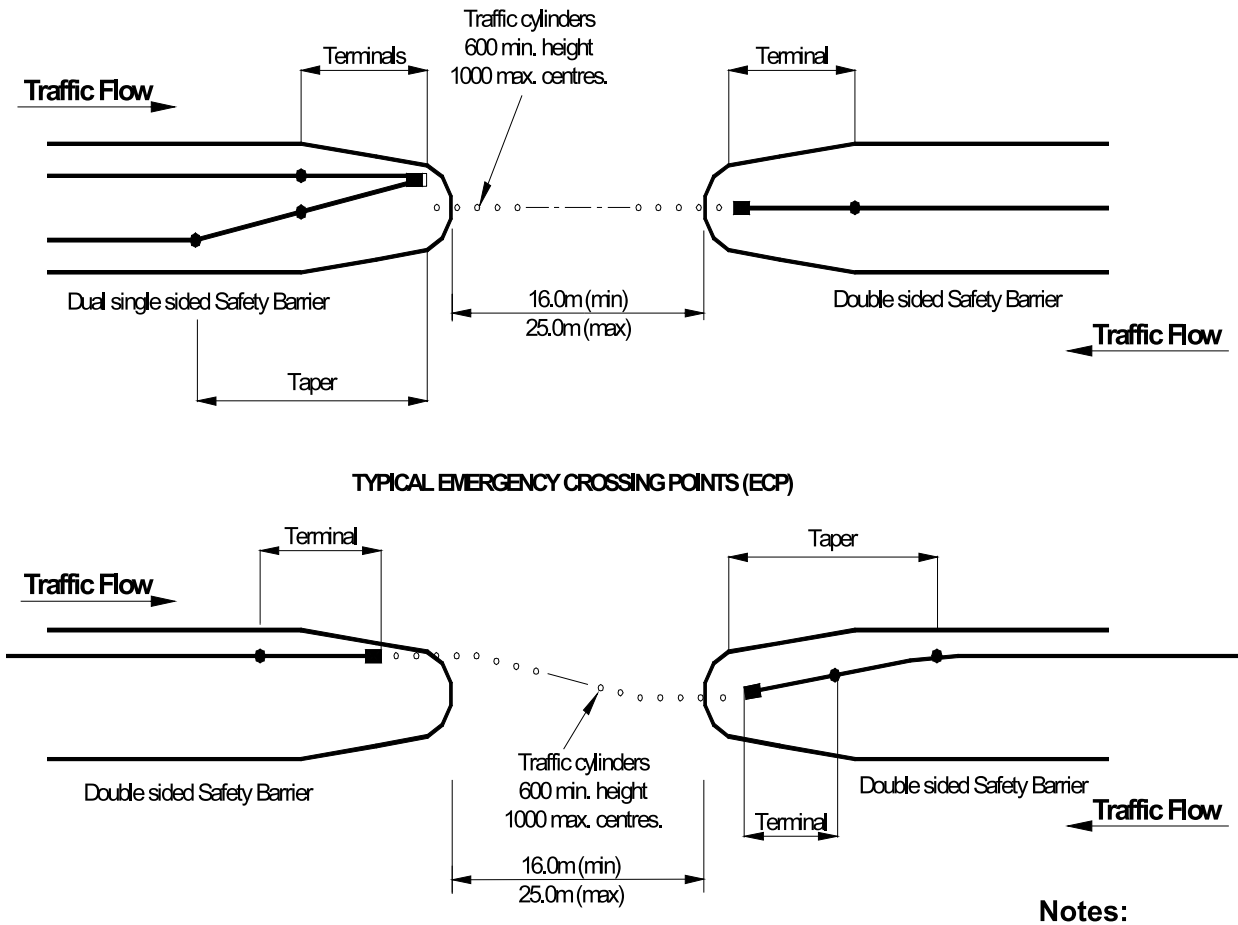




Notes:

1. **Refer to Figure 3-12 for taper requirements.**
2. **Where there is a single Double Sided safety barrier, the set-backs must not be less than the Working Width Class of the safety barrier minus the actual width of the safety barrier. See Figure 3-3.**
3. **See Figure 3-4 and Paragraphs 3.21 to 3.25 for details of set-back requirements.**

Figure 3-14 Central Reserve Pedestrian Crossing Point



Notes:

1. **Refer to Figure 3-12 for Taper requirements.**
2. **Refer to Paragraphs 3.64 and 3.65**
3. **It may not be possible to use P4 terminals in these situations. The manufacturer should be consulted.**

Figure 3-15 Safety Barrier at "Open" Emergency Crossing Points

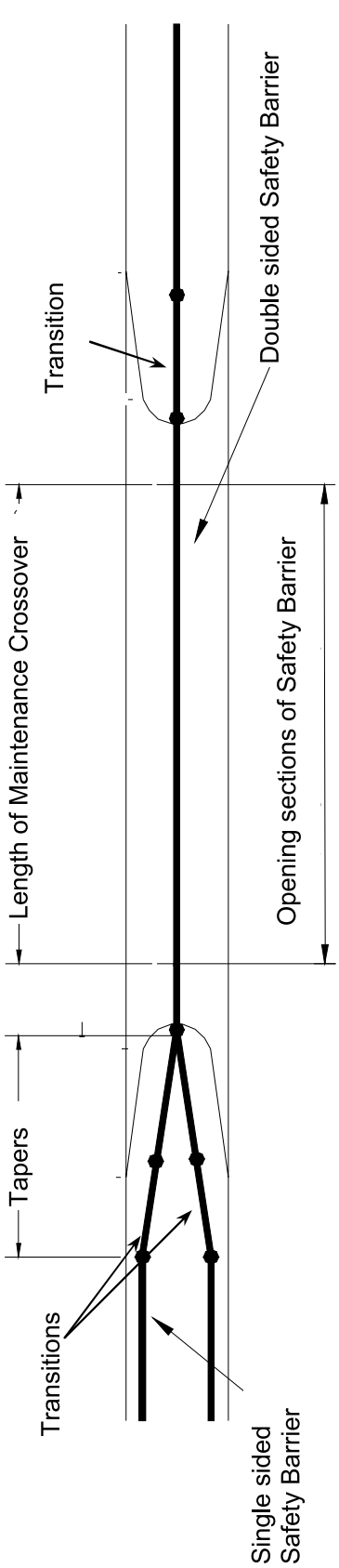


Figure 3-16 (a). Maintenance Crossover in Normal "Closed" Position.

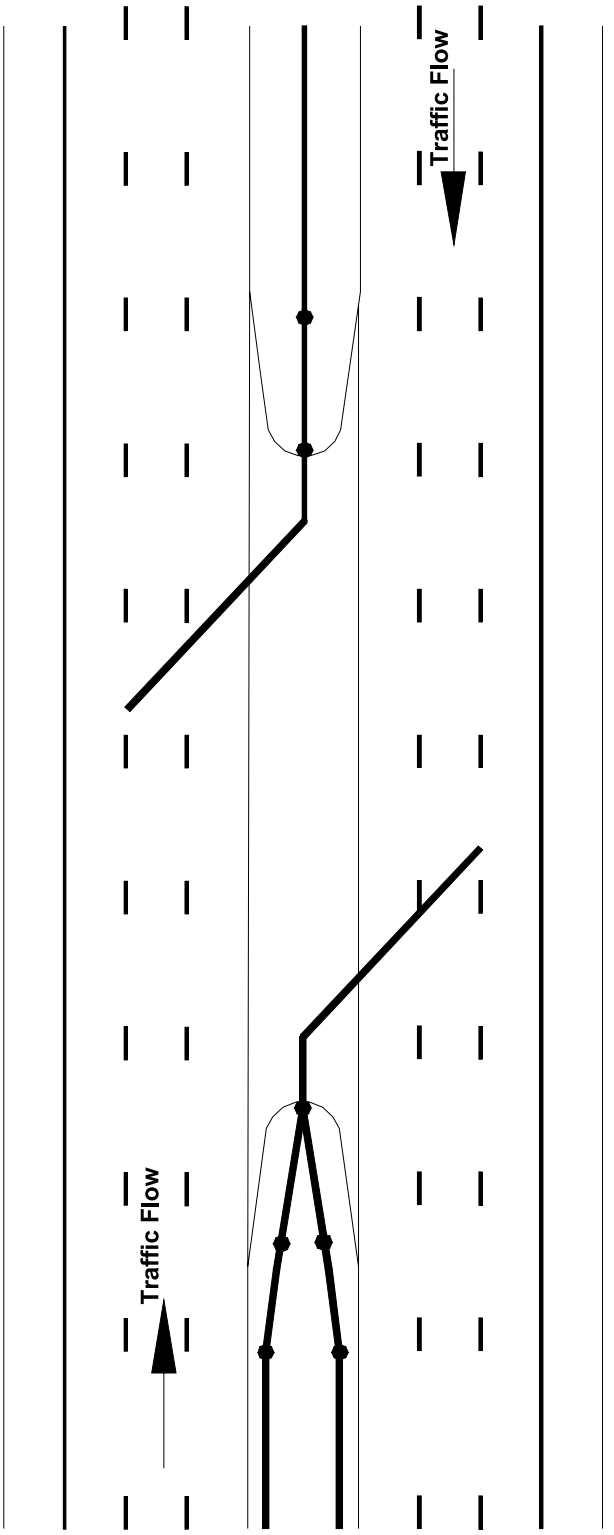


Figure 3-16 (b). Maintenance Crossover in Temporary "Open" Position During Maintenance Contraflow Periods.

Notes

1. Refer to paragraphs 3-78 & 3-79 and 3-112, 3-118 to 3.122.

Figure 3-16 Central Reserve Maintenance Crossover at Tunnels

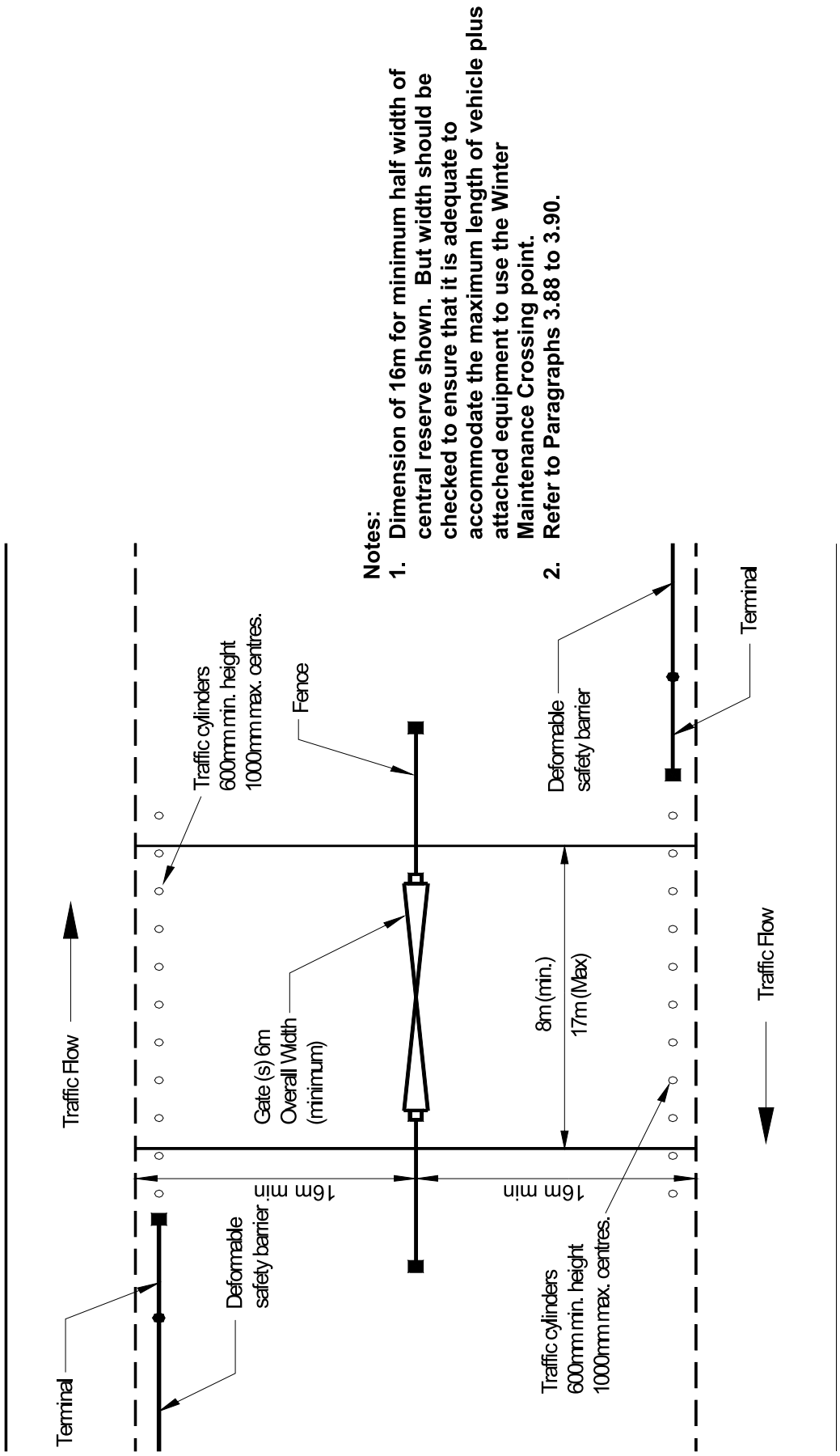


Figure 3-17 Example of Winter Maintenance Crossing