INFRASTRUCTURE
MALTA

IM/TD19/18 (Revision A)

Vehicle Road Restraint Systems (VRS) : Criteria for Hazard Risk Analysis and VRS Performance Requirements

July 2018

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1 VEHICLE RESTRAINT SYSTEMS

1.1 Aknowledgement of Sources

This document is based on the German FGSV document “Richtlinien für Passiven Schutz an Straßen durch Fahrzeug-Rückhaltesysteme (RPS - 2007),” amended as required to address specific scenarios encountered in the Malta Road Network.

The document makes use of material from the UK DMRB TD19/06 also amended as required to address specific scenarios encountered in the Malta Road Network.

1.2 Complementary Guidelines

This document is supported by document IM/CG/19.1/18 - Complementary Guidance on the Requirements of Vehicle Road Restraint Systems.

1.3 Scope and Objectives

In CEN[1] terminology the term “vehicle restraint system/s” covers various structures which are defined in accordance with the following parts of European Standard MSA EN 1317:

i.	Safety Barriers	MSA EN 1317, Parts 1, 2 and 5
ii.	Terminals	MSA ENV 1317, Part 4
iii.	Transitions	MSA EN 1317, Part 4
iv.	Crash Cushions	MSA EN 1317, Part 3
v.	Motorcyclist Protection	PD CEN/TS 1317, Part 8
vi.	Pedestrian	CEN/TR 16949 and/or BS 7818

Note: The CEN/TR 16949 and/or BS 7818 are outside the scope of this document.

Vehicle restraint systems are intended to minimise the consequences and severity of accidents following impacts with hazards involving errant vehicles.

Within the context of these Guidelines the following definition of “a hazard” shall apply:

[1] The **European Committee for Standardization** (**CEN**, ***Comité Européen de Normalisation***);

"A feature (e.g. slope) or object (e.g. lighting column) that can cause harm or loss. Harm or loss can be physical, financial or economic, strategic, or be time-based, or any combination of these".

These Guidelines support a concept of risk management that assumes that risks exist and must be controlled to an acceptable level by focusing on measures to be taken to eliminate or lower risk in targeted operations. A "risk" is defined herein as the chance, high or low, that somebody or something will be harmed by the hazard.

1.4 The Infrastructure Malta Risk Management Framework

The risk management framework within these Infrastructure Malta Guidelines comprises the following:

i. Identification of the hazard/s;

ii. Assessment of the level of risk at each;

iii. Deciding on and implementing the appropriate action/s to eliminate; minimise or control the hazards and mitigate the risk and may include the following measures:

   a) "Designing" hazards out of the design output;

   b) Removal of the hazard/s;

   c) Reducing or mitigating the severity of the hazard/s.

Annex 4 of these Guidelines comprises the approved "template" utilised by Infrastructure Malta in addressing the requirements of Items i) to iii) above.

Risk is measured in terms of both the individual risk to a person and the overall concerns of society it gives rise to.

1.5 The "ALARP" Principle (See Annex 3)

The triangular framework figure illustrated in Annex 3 represents an illustration of the "ALARP" principle as included in the UK DMRB TD 19/06 and endorsed in these Guidelines. At the top is the 'unacceptable' region. A risk falling into this region is regarded as unacceptable whatever the level of benefit associated with the activity.

These Guidelines also apply to locations with:

a) reported severe incidents / collisions over any one (1) year period;

b) a known incident reputation;

c) a confirmed or predicted collision / incident per year rate and an associated severity index ranking greater than "Medium Risk" – See Complementary document IM/CS/ 19.1/10, Annex C - Risk Assessment Guide.

These Guidelines are applicable only to permanently installed vehicle restraint systems.

2 REQUIREMENTS OF VEHICLE RESTRAINT SYSTEMS

2.1 General

Vehicle restraint systems are classified in accordance with performance classes indicated in MSA EN 1317 series of standards.

2.2 Safety Barriers

MSA EN 1317-2 classifies the performance of safety barriers according to three fundamental criteria:

d) Containment level;

e) Working width class;

f) Impact severity level.

The required containment level depends on the criteria for selection as established in these guidelines.

The maximum working width class depends on the specific site conditions as illustrated in these guidelines.

The impact severity level (A) represents a lower burden for passengers in an errant vehicle than impact severity level (B) and is preferred in comparable circumstances. In particularly dangerous locations, where containment of an errant vehicle is a matter of priority, a safety barrier of impact severity level (C) representing the highest burden for vehicle passengers, may be selected. The reason for such a selection must be documented in the project file.

2.3 Transitions

Transitions are to be placed where safety barriers of different designs and/or mode/s of operation have to be connected with each other according to their function.

MSA ENV 1317-4 classifies the performance class of transitions according to the following criteria:

a) Containment level,

b) Working width class,

c) Impact severity level.

The containment level of transitions depends on the containment levels of the parent safety barriers to which they are connected. The required containment levels are set out in **Table 1**.

Table 1: Containment Levels of Transitions

	To Containment level			
From Containment level	**N2**	**H1**	**H2**	**H4b**
N2	*N2*	*N2*	*H1*	*H2*
H1	*N2*	*H1*	*H1*	*H2*
H2	*H1*	*H1*	*H2*	*H2*

The choice of the maximum working width class of a transition depends on the specific site conditions and is subject to the relevant provisions in this document.

The impact severity level of a transition should not be higher than the level of the parent safety barriers to which it is connected.

2.4 Junctions with Structures

Junctions with structures (e.g. abutments, walls, portals etc;) shall be regarded as transitions.

2.5 Terminals

Terminals and safety barriers shall be correctly joined with each other so that the functional properties (including any tensioning action, passive safety features of the terminal, load transmission etc.) do not have a mutually negative effect. The manufacturer of the terminals shall demonstrate the functional properties of the systems connected in this way.

In MSA ENV 1317-4, the performance of terminals is classified according to the following criteria:

a) Performance class;

b) Vehicle exit box class;

c) Permanent lateral displacement class;

d) Impact severity level.

The requirements for the performance classes of terminals are shown in **Table 2.**

Table 2: Performance Classes of Terminals

Type of Road	Minimum Performance Class	Exit Box Class (redirection)	PLDZ (deflection)
Single-carriageway (≤ 80km/h)	P2 (A) minimum	Z2 (max.)	x(Da)1 / y(Dd)2
Dual carriageway (≤ 80km/h)	P2 (U) minimum	Z2 (max.)	x(Da)1 / y(Dd)2
(A): Terminal operating in both directions of the traffic ***(U): Terminal operating in the direction of travel only*** ***PLDZ: Permanent lateral displacement***			

The vehicle exit box class and the permanent lateral displacement class may need to be determined according to the specific site conditions. The permanent lateral displacement class shall be selected so that the impacted deformed terminal does not extend further than the inner edge of the carriageway edgeline marking. At specific locations where space constraints (restricted working width) would not permit the installation of a P2 class terminal the use of the next lower level terminal (i.e P1) may be considered. This will require documentation in the project file.

The impact severity level A represents a lower burden for passengers in an errant vehicle than impact severity level B. Its use is desirable in comparable circumstances.

2.6 Crash cushions

All Crash cushions must be of the “re-directive” type.

Crash cushions arrangements and any adjoined safety barrier must be correctly linked so that the functional properties (tensioning action, compression, shearing, deformation and load transmission) do not have a mutually negative effect.

In MSA ENV 1317-3, the performance of crash cushions is classified according to the following criteria:

a) Performance level / velocity class,

b) Permanent lateral displacement class,

c) Redirection zone class,

d) Impact severity level.

The speed class requirements for the performance of crash cushions are shown in **Table 3**.

Table 3: Speed Classes of Crash Cushions

V_{max} (km/h)	Note
50	Re-directive (R)
60	
70	
80	

The permanent lateral displacement class and the redirection zone class shall be stated in the manufacturer's test report, and the requirements must be determined according to the specific site conditions and geometry. The permanent lateral displacement class shall be chosen so that the deformed crash cushion does not extend beyond the inner edge of the carriageway edgeline marking.

The impact severity Level A represents a lower burden for passengers in an errant vehicle than impact severity Level B. Its use is preferred in comparable circumstances.

2.7 Vehicle Restraint Systems – Site Configuration

The operation of the vehicle restraint systems must not be impaired by the particular configuration of the "surroundings". "Surroundings" shall mean the area of the carriageway in front of the restraint system, the area immediately behind as well as the working space of the system.

The area "in front of" and "under" the vehicle restraint system must be capable of withstanding the loads imposed by the traffic permitted onto the same area.

Height differences exceeding 75mm must be avoided in front of the vehicle restraint systems (including terminals and crash cushions).

2.8 System Accessories

Accessories, fixtures and fixings attached to any of the barrier parts must not impair the operation of the vehicle restraint system in any way. Furthermore, accessory parts must not in themselves present a danger for vehicle passengers or third parties. Accessory parts which are intended to operate as part of the vehicle restraint system must always be tested as an integral part of the overall system in accordance with the relevant part of MSA EN 1317.

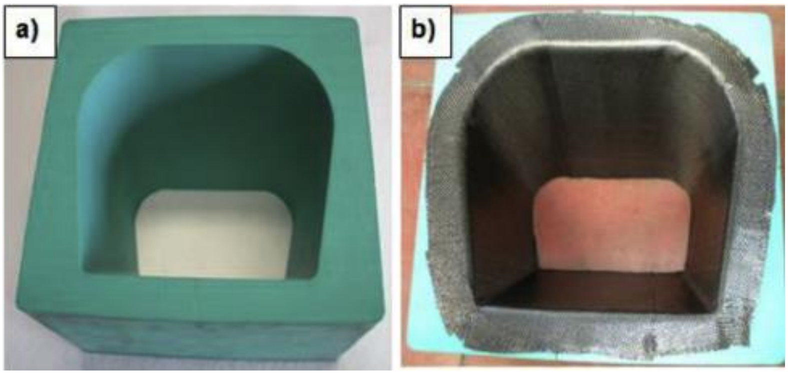
3 PROTECTION FOR MOTORCYCLISTS (PTW - POWERED TWO-WHEELER)

The hazard for motorcyclists in the event of an impact with vehicle restraint systems (especially the barrier vertical posts) may be reduced by the use of systems offering improved protection and impact mitigation.

Such additional attachments to proprietary steel vehicle restraint systems may include the following:

a) A system of soft coatings shielding the guard rail posts (DMPS[2]);

Figure 1: VRS Post-only Impact Attenuator / Protection



b) Suspended longitudinal bottom rail, beams or other proprietary accessory elements (CMPS[3]).

   i. The suspended rail system shall be a low-level type CMPS capable of protecting the motorcyclist from impacting the VRS posts. The system must be covered by Annex A of EN 1317-5 as a modification to an EN 1317-2 certified system and must not invalidate that same certification.

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[2] DMPS - Discontinuous motorcyclist protection system; See CEN/TS/1317-8, clause 3.4

[3] CMPS - Continuous motorcyclist protection system; See CEN/TS/1317-8, clause 3.3

ii. The motorcycle road restraint CMPS (including attachments, fixtures and terminations) shall comply with any one of the following standards:

   a) CEN/TS 1317-8: TM 1.60 and TM 3.60

   b) UNE 135900 (Spain): TM 1.60 and TM 3.60

   c) L.I.E.R (France): Class A (60 km/h, 80.5kg, 30 degrees)

iii. The following limits shall also apply:

   a) Speed Class: 60 km/h

   b) Maximum Working Width: The provisions in CEN/TS 1317-8, clause 8 shall apply.

   c) Maximum HIC_{36}: ≤ 1000 (sliding dummy)

   d) Neck load levels: CEN/TS 1317-8 Table 4 for HIC36 1000 or approved equivalent.

3.1 Evaluation of Risk - Criteria

The criteria for the evaluation of the risk and the need for provision shall be in accordance with **Annex 5** - Evaluation and Provision of VRS Motorcyclist Protection.

4 VEHICLE RESTRAINT SYSTEMS - SPECIFIC CRITERIA FOR USE AND APPLICATION

4.1 General

Before installing the vehicle restraint systems the Designer must consider whether protection can be better provided by the removal and/or re-location of the hazard or the implementation of improvements to the site. Such improvements may include:

a) Re-designing the existing clear zone distance between the road and the hazard;

b) Use of passive items and fixtures to MSA EN 12767.

4.2 "Relaxations" and "Departures"

The Designer shall strive to achieve the best possible level of protection in the prevalent circumstances. The provisions of these Guidelines will normally require a ***"desirable"*** level of intervention by the Designer. A ***"relaxation"*** to the next lower tier of protection below the "desirable" level or a ***"departure"*** from these guidelines may be necessary due to site constraints or a high cost to benefits ratio. **Such "relaxations" or "departures" must be documented in the Project File.**

4.3 Increased likelihood of vehicles leaving the carriageway

The selection process of a safety barrier must consider any increased likelihood of a vehicle leaving the road due to sub-standard geometric design limitations. Such sites include the following geometric characterization:

a) road sections with sub-standard radii outside the range indicated in the ADT Manual of Contract Document for Roadworks, Volume 5;

b) consecutive curves with radii less than 1.5 times the permissible minimum radius under the ADT Manual of Contract Document for Roadworks, Volume 5;

c) sections with substantial or abrupt changes of direction;

d) road sections having sub-standard “clear zone” widths.

4.4 Lateral Edge of Carriageway and Verges – Hazard levels

The severity potential of hazards at the lateral edge of the carriageway is classified according to four hazard levels:

a) **Hazard Level 1**: areas requiring impact protection with special risks for third parties (e.g. structures / plant that may explode, heavily used stopping areas, areas where people congregate, structures posing a danger of collapse if hit);

b) **Hazard Level 2**: Areas requiring impact protection with risks for third parties (e.g. adjacent heavily used footpaths and cycle paths, adjacent roads with an AADT > 500 vehicles/24 h),

c) **Hazard Level 3**: Obstacles with special risks for vehicle passengers (e.g. non-deformable, extensive obstacles vertical to the direction of traffic, non-deformable, isolated individual obstacles, noise barriers),

d) **Hazard Level 4**: Obstacles with risks for vehicle passengers (e.g. isolated obstacles which are deformable but do not buckle or shear off, intersecting ditches, ascending slopes (incline > 1:3), descending slopes (height > 3m and incline > 1:3), stretches of water with a depth > 1m).

High and wide traffic sign gantries having concrete plinths should not be classified as “structures in danger of collapse if impacted” but as “non-deformable, extensive obstacles” (i.e Hazard Level 3).

Posts for small and medium-sized road signs (tubular posts and forked stanchions made of steel tubes with external diameters > 75mm and wall thickness > 3mm or of aluminium tubes > 75mm and wall thickness > 3.0mm) should be regarded as “deformable but not capable of buckling” (i.e Hazard Level 4).

Other support structures for signs (e.g. rolled beams, tubular fixings) are to be classified as “non-deformable isolated individual obstacles” (i.e Hazard Level 3).

Fixtures which are designed as deformable (including the integral buckle systems or shear-off attachments) should not be regarded as obstacles within the scope of these Guidelines. The same applies to poles of traffic light installations and lighting columns at major road junctions with traffic light systems irrespective of their structural form.

Ascending slopes with an incline > 1:3 should be classified under hazard level 4 if the base of the slope is not adequately rounded off, or if they are rocky slopes, or are characterized by large rocks or stones.

4.5 Safety barriers

The need for safety barriers at the lateral edge of the carriageway should be considered where hazards are located within a critical distance from the road. The hazard potential is classified according to the four hazard levels defined in this document.

The analysis should proceed as follows:

a) Investigation of whether the situation falls within the scope of these Guidelines;

b) Determination of the critical distances and of whether the hazard lies within the critical limits;

c) Investigation as to whether a safety barrier is necessary

d) Establishing the minimum containment level;

e) Selection of a safety barrier according to the maximum permissible working width;

f) Determination of the safety barrier length of need;

g) Determination of the requirements for terminals, transitions and crash cushions;

h) Deployment as shown in the relevant provisions in this document.

4.6 Critical Distances

The overriding principle of these Guidelines is that the protection of uninvolved third parties is of paramount importance and that these generally suffer serious injuries as a result of accidents involving errant vehicles. Thus the "**extended" Distance AE** shall be applied to "areas" requiring protection for third parties (Hazard levels 1 and 2); **Distance A** is applicable to hazards affecting drivers and passengers only (Hazard Levels 3 and 4). In these Guidelines the Distances AE and A are termed the "critical distances".

The width of any hardstrips and the width of the edgeline/s should be included in the determination of the critical distance.

The critical distances A and AE are dependent on V85 and the slope height.

Depending on the speed these critical distances are indicated in these Guidelines as follows:

a) for roads with V_{85} = 80 km/h to 100 km/h, are shown in **Figure 2**;

b) for roads with V_{85} = 60 km/h to 70 km/h, are shown in **Figure 3**.

Only those speeds which are experienced over substantial road sections and which therefore influence driver behaviour on the road are relevant. These Guidelines assume that such a speed benchmark would best be represented by the 85th percentile speed.

These Guidelines exclude the effect of any traffic calming measures ,including speed cameras, along the road sections.

Figure 2: Critical distances for roads with V_{85} = 80 km/h to 100 km/h

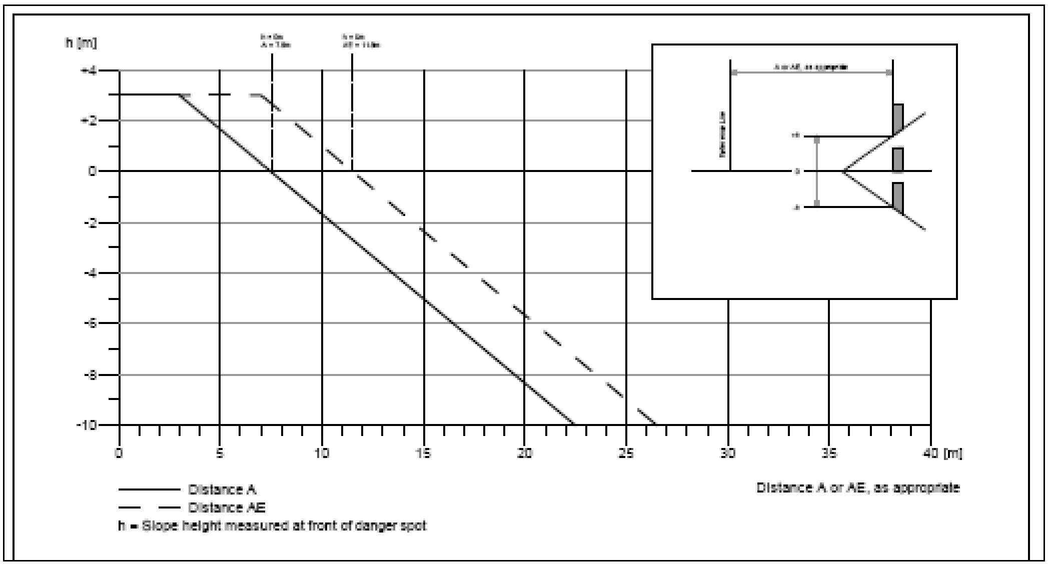
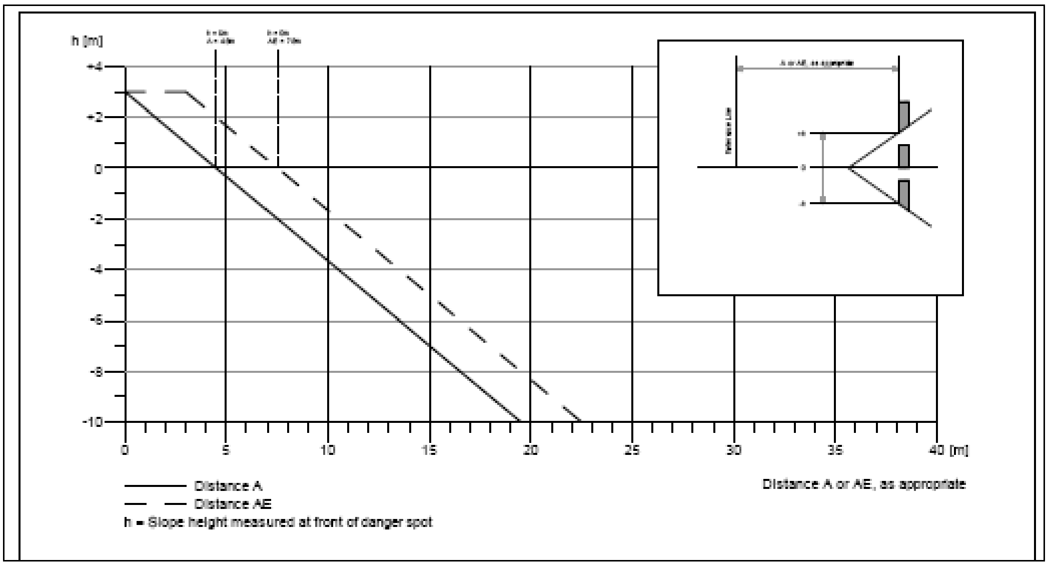


Figure 3: Critical distances for roads with V_{85} = 60 km/h to 70 km



The determining factor for the assessment of whether a hazard lies within the critical zone is the distance between the carriageway edgeline marking and the approach edge of the hazard (this gives the determining distance). The reference line is the side boundary of the traffic space, generally the edge of the paved surface (See Figure 4).

The traffic space includes the traffic lanes, the traffic markings, the hardshoulders and/or hardstrips, drainage channels open for traffic and verges.

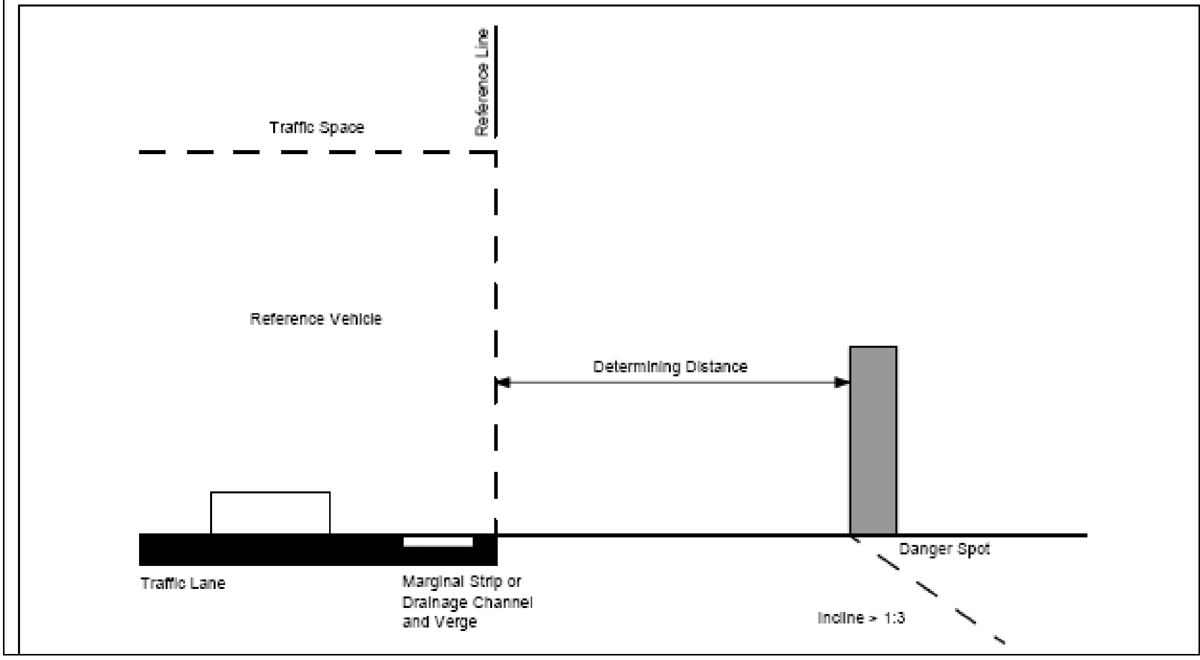
4.7 Width of Roadmarkings

The full width of the edgeline roadmarking (Eg. 150mm, 100mm wide) shall be calculated as forming a part of the determining distance.

In the case of areas requiring protection, the side facing the carriageway is deemed to be the edge of the hazard, and in the case of obstacles, it is the front edge (for slopes and stretches of water, it is the uppermost level of the ground surround).

If the determining distance is less than or equal to the critical distance, the flow diagram in Fig. 6 must be used to ascertain whether a safety barrier is necessary and then to establish the minimum containment level required.

Figure 4: Establishing the Determining Distance



4.8 Containment Levels - Verges

Figure 5 and **Figure 6** describe the analytical process and criteria required to identify the need for a safety barrier and the minimum containment level.

The hazards as listed are not exhaustive. Other potential hazards which are not described must also be evaluated and assigned a hazard level.

The decision boxes in **Figure 6** should be regarded as "leader" questions. If the answer returns a "Yes" then the horizontal flow arrow will show the further path through the diagram; If the answer is a "No" then the process should follow the vertical flow arrows.

Figure 5: Criteria for the use of Safety Barriers at the Lateral Edge of the Carriageway

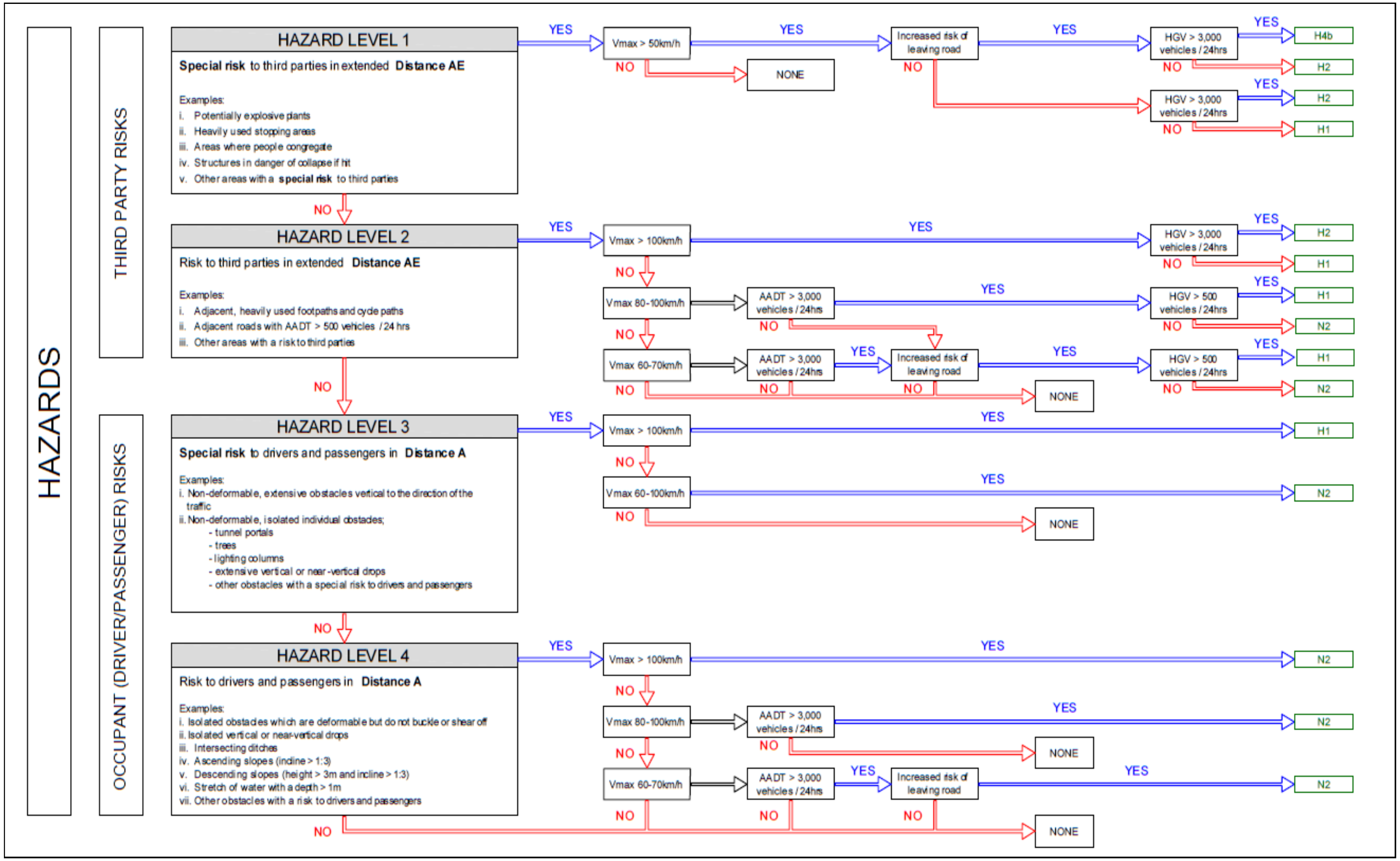
		Hazard Level 1
HAZARDS	**Special Third Party Risk Areas**	**Special (High) risk to third parties in extended distance AE** *Examples* i. Potentially explosive plants ii. Heavily used stopping areas iii. Very crowded areas (Frequent) iv. Public / Commercial / Services buildings with frequent crowding v. Structures in danger of collapse if hit vi. Other areas with an identified special risk to third parties **No** ↓

HAZARDS		**Hazard Level 2**
		Risk to third parties in extended distance AE *Examples* i. Opposite flow traffic ii. Adjacent, heavily used footpaths and cycle paths iii. Adjacent roads with ADT > 500 vehicles/24 h vii. Private residences iv. Other areas with a risk to third parties **No**
		Hazard Level 3 →

HAZARDS		→ **Hazard Level 3**	
	Driver and Passengers Obstacles	**Special risk to drivers and passengers in distance A** *Examples* i. non-deformable, extensive obstacles vertical to the direction of the traffic ii. non-deformable, isolated individual obstacles iii. tunnel portals iv. trees v. non-passive lighting columns vi. extensive vertical or near-vertical drops vii. noise barriers viii. other obstacles with a special risk to drivers and passengers. **No** ↓	

		Hazard Level 4	
		Risk to drivers and passengers in distance A *Examples* i. isolated obstacles which are deformable but do not buckle or shear off ii. isolated vertical or near-vertical drops iii. intersecting ditches iv. ascending slopes (incline > 1:3) v. descending slopes (height > 3 m and incline > 1:3) vi. stretch of water with a depth > 1 m vii. other obstacles with a risk to drivers and passengers	
		No (Stop / End)	

Figure 6: Criteria for the Use of Safety Barriers - Lateral Edge of Carriageways



4.9 Working Widths and Set-back (Shy Line)

In principle, the safety barrier selected shall be such that the working width is less than or equal to the distance between the front face of the safety barrier and the front edge of the hazard (Figure 7).

Figure 7: **Position of Safety Barriers in relation to the Working Width and the Traffic Space**

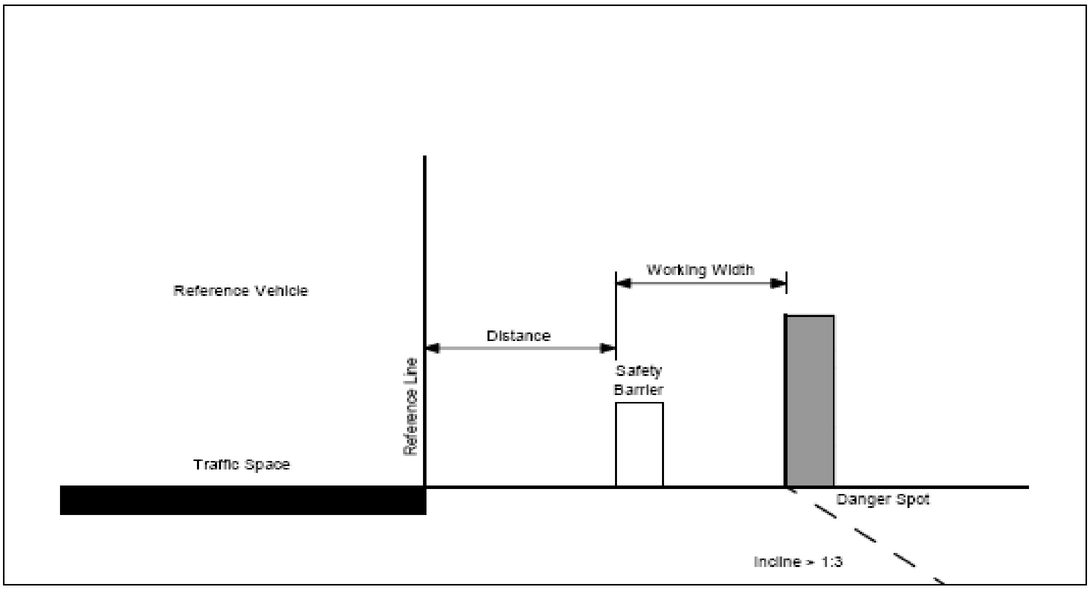
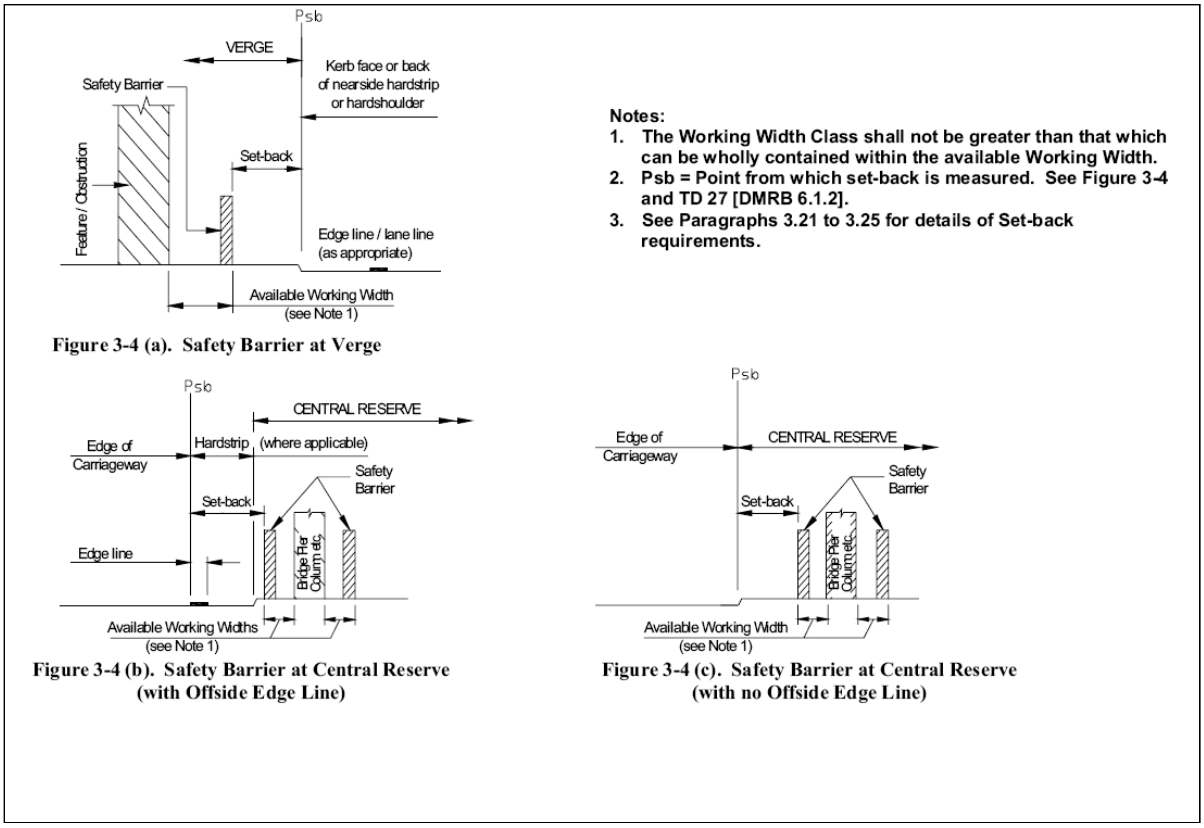


Figure 8: Set-back (Extracted from DMRB TD 19/06, Figure 3-4)



Set-back at permanent systems must be in accordance with the ADT DMRB TD 27/00**.** The relationship between set-back and Working Width at hazards in verge and central reserve is given in the ADT DMRB TD 19/06, Figure 3-4 as denoted in **Figure 8**.

Any proposal to reduce set-back from the values required in TD 27 must be accompanied by an assessment of risks identifying the factors considered, their likely combined effects and justification for the proposal and be included in an application for a “Departure” from these Guidelines.

The width of any hardstrips and the width of the edgeline/s should be included in the determination of the set-back distance.

4.10 Forward Visibility

The minimum forward visibility distances should be verified and maintained throughout the length of need.

The requirements stipulated in the ADT DMRB TD 9/00 in respect of visibility, sightlines over and in front of safety barriers and Stopping Sight Distances must be complied with.

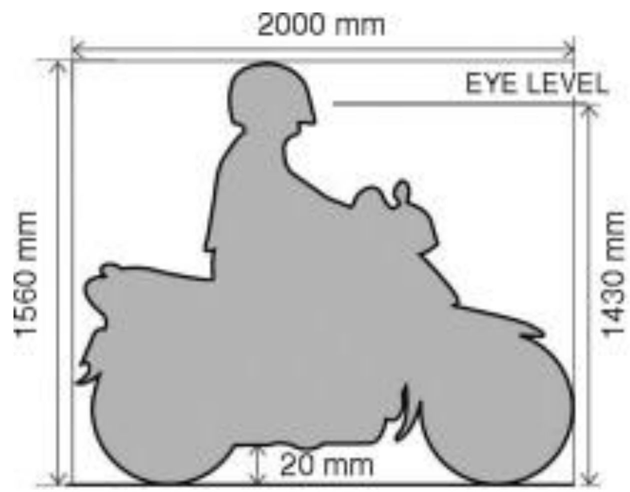
In difficult situations where the horizontal and/or the vertical alignments or other physical features prevent the establishment of the appropriate Stopping Sight Distance requirements stated in the ADT DMRB TD 9/00, the Designer must apply a “Departure” from these Guidelines. This shall be documented in the Project File.

If space allows or if required by traffic conditions (Eg. on roads without separate footpaths and cycle paths), the safety barrier should be placed a distance of 1.0m to 1.5m from the reference line. The operation of the safety barrier must not be adversely affected.

Safety barriers with a working width class greater than the distance available on site between the front face of the safety barrier and the front edge of the hazard may be used where location constraints cannot be reasonably upgraded and where the installation of such working width arrangements may still render a tangible protection benefit. A “Departure” from these Guidelines must be applied and documented in the Project File.

Note for PTW (Motorcycles): Eye-Level Height

The eye-level height of PTW riders shall be taken as 1.43m.



4.11 Minimum Length of Need

For safety barriers to be effective, they must extend a certain minimum length forward and backward beyond the hazard (leading and trailing lengths). This minimum length **“L1”** is either to be as indicated in the manufacturer’s test report (in accordance with MSA EN 1317-2)

In the case of dual-carriageway roads, it is possible to provide for a reduction of one level in the containment level at a distance of 15m after the hazard.

4.12 Prevention of Vaulting and Driving Behind the VRS

The lengths of need of safety barriers must address the potential of vaulting over the VRS and/or driving behind the VRS.

Safety barriers must have a minimum length of "L2" in front of the hazard in order to prevent vaulting and driving behind (See Table 4, Figure 9 and Figure 10).

On single-carriageway roads with oncoming traffic, the length **"L2"** must be to both sides of the hazard **(**Figure 9). A reduction in the containment level by one level within the range of length **"L2"** from the hazard is possible after a distance of 0.5 x **L2**.

If the possibility of errant vehicles driving behind the safety barrier can be precluded (Eg high and steep embankment or slope) and the criterion for vaulting under **Table 4** is not present, the lengths "**L2"** may be reduced to 40m in accordance with **Table 4**. However the containment level within the 40m may not be reduced.

If the safety barrier pivots outwards away from the carriageway with a diagonal offset of 1:20 (and up to 1:12 in exceptional circumstances only) the length **"L2"** can be reduced (see **Table 4**). In such cases, the safety barrier shall be extended parallel to the carriageway in front of the start of the hazard for a distance of at least 15m in the case of dual-carriageway roads

(See **Figure 11**) , and for at least 10m in the case of single-carriageway roads (See **Figure 12**). This length must be considered as integral to the lengths of the barrier indicated in **Table 4.**

If the start of safety barriers is terminated into embankments and/or slopes, it is then not necessary to observe the length **L2**. In this case, the safety barrier shall pivot outwards away from the carriageway with a diagonal offset of 1:20 (and up to 1:12 in exceptional circumstances only). The termination shall then reflect the recommendations of the barrier manufacturer.

Figure 9: Minimum lengths of need of Safety Barriers on Single-carriageway roads

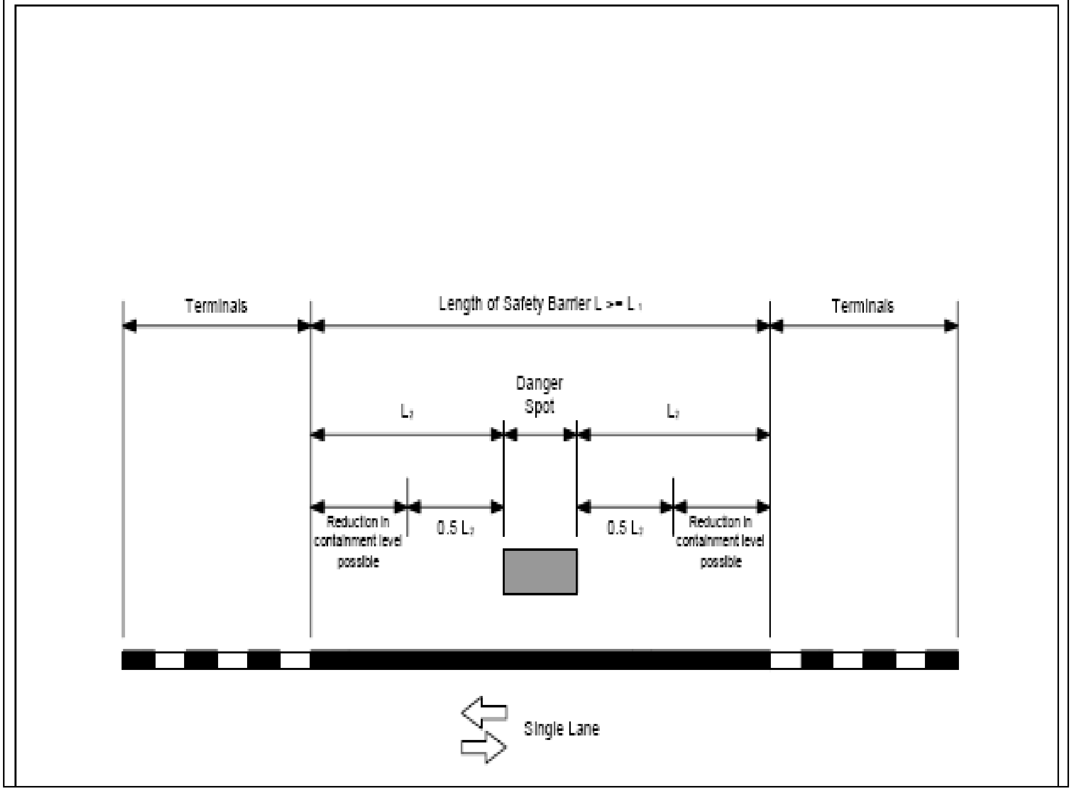


Figure 10: Minimum lengths of Safety Barriers on Dual-carriageway roads

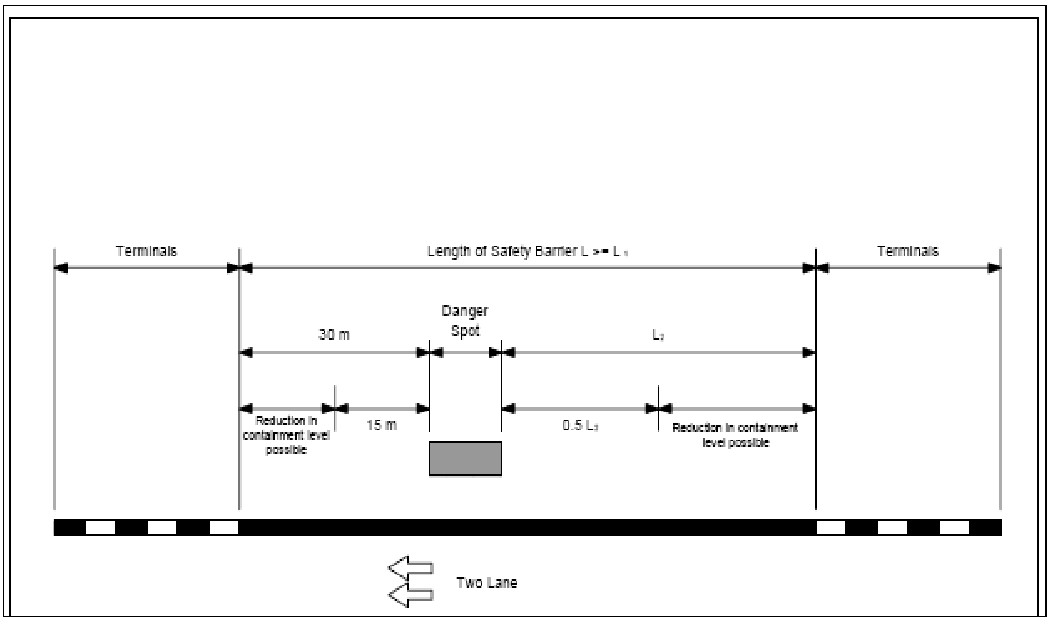


Figure 11: Minimum lengths of safety barriers with diagonal offset in front of a hazard (single-carriageway road)

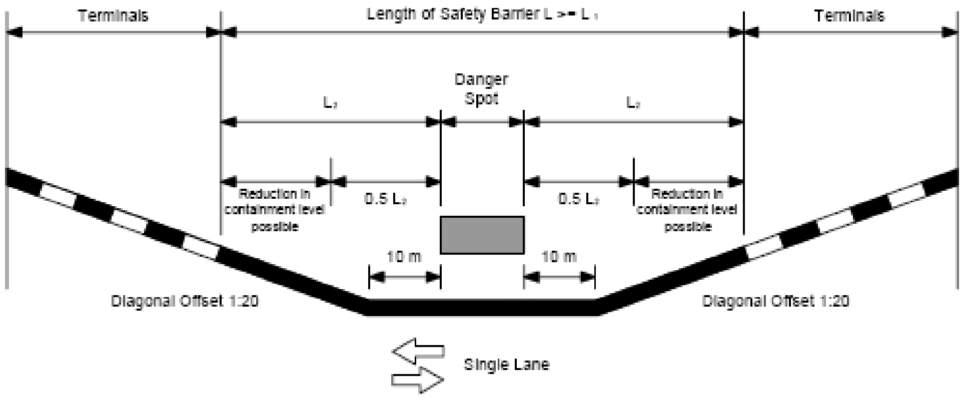


Figure 9a: Minimum lengths of safety barriers with diagonal offset in front of a danger spot (single-lane road)

Figure 12: Minimum lengths of safety barriers with diagonal offset in front of a hazard (dual-carriageway road)

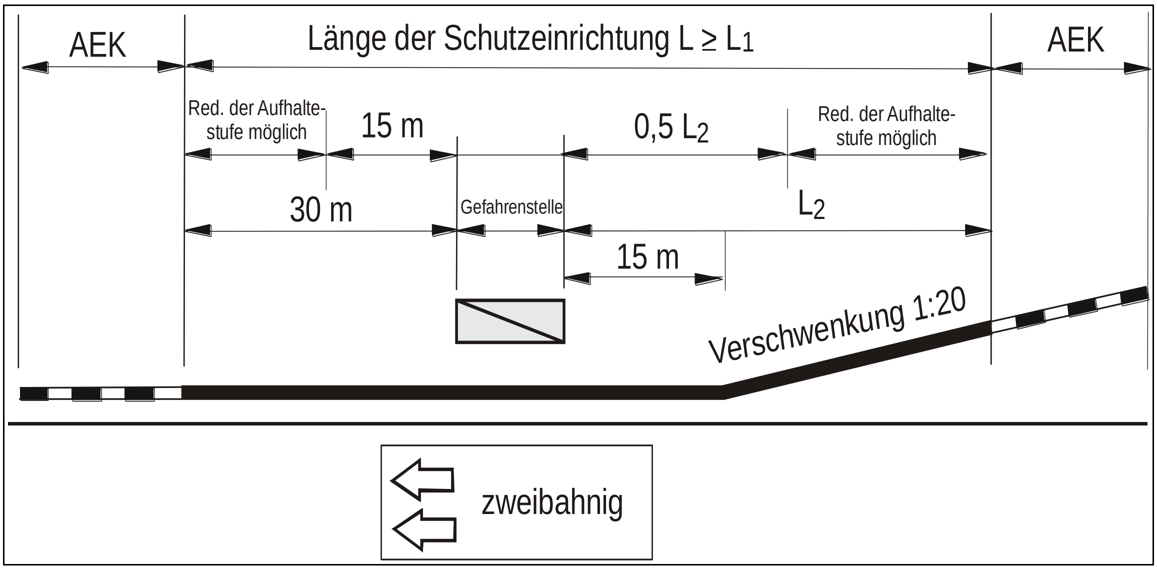


Table 4: Required length of need "L2" to prevent vaulting and/or driving behind

Criterion	Type of road	Position of VRS		
		Parallel to road	Pivots to the side	Driving behind precluded
Vaulting, if hazard is ≤1.5m behind the front face of the VRS	Single-carriageway	100 m	-	-
	Dual-carriageway	140 m	-	-
Driving behind the VRS	Single-carriageway	80 m	60 m	40 m
	Dual-carriageway	100 m	60 m	40 m

If the length **"L2"** required to prevent vaulting and driving behind the VRS cannot be observed, it will be necessary to investigate whether the required safety can be achieved by the use of a crash cushion.

Terminals are not included in the aforementioned length **"L"** of the safety barrier.

4.13 Breaks in Safety Barriers

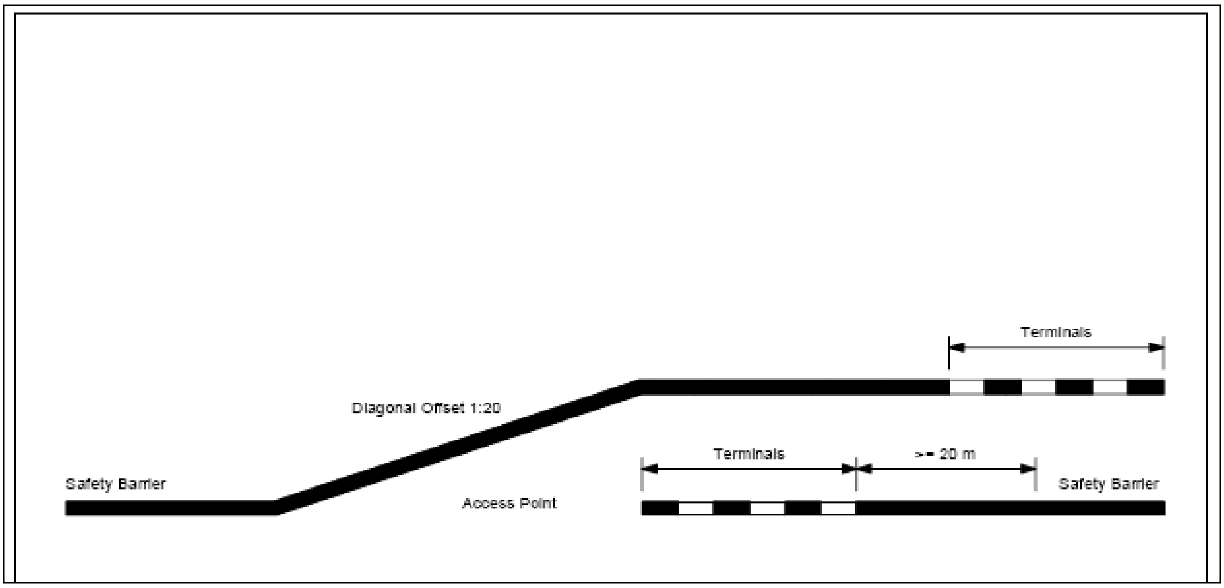
Breaks in safety barriers should only be permitted where justified by non-remediable constraints and must be of very limited length.

In cases where safety barriers are not required between hazards for relatively short distances the designer must consider installing a continuous barrier system without any breaks.

Breaks in safety barriers should be avoided particularly at roadway locations characterised by small radii of curvature.

In general, access points etc. should not lead to a break in safety barriers. It is necessary therefore to investigate whether access points can be re-located so that they lead into the road where safety barriers are not necessary. If breaks cannot be avoided in such cases, the safety barriers must overlap in accordance with **Figure 13**.

Figure 13: Breaks in safety barriers at access points



Unavoidable breaks along single and dual carriageway roads should be designed in accordance with Figure 14 to Figure 17.

If there is no risk of a crash in the area of the break, the safety barrier should be converted to a terminal by means of a diagonal offset (**Figs. 11a and 11b**). In addition, the offset of the safety barriers and the terminals shall be 1:12 where possible.

A curved offset barrier arrangement can prevent errant vehicles from penetrating and hitting the hazards and should be constructed with the biggest possible radii **(Figure 16** and **Figure 17).** Where possible, the safety barriers shall pivot 1:12 away from the carriageway. In each case, a curved safety barrier must merge into a transition or into another safety barrier.

Figure 14 Break in safety barriers with terminal and with diagonal offset

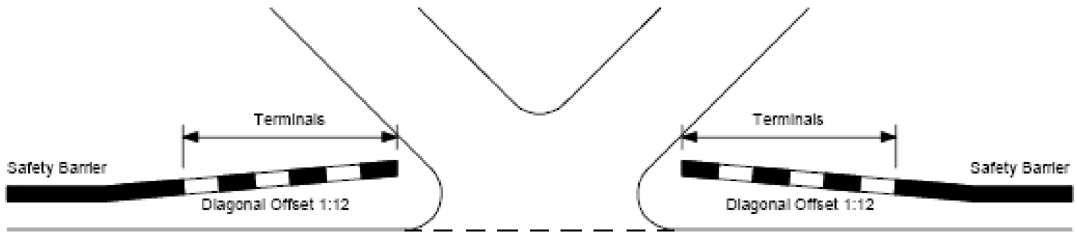


Figure 11a: Break in safety barriers with terminal and with diagonal offset

Figure 15 Break in safety barriers with terminal in alignment with the safety barrier

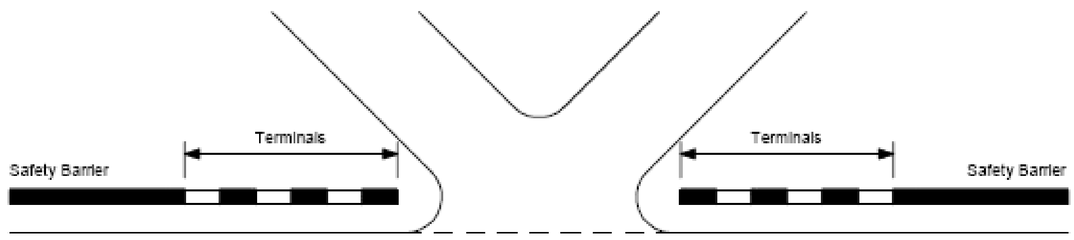


Figure 11b: Break in safety barriers with terminal in alignment with the safety barrier

Figure 16 Break in safety barriers with curve and diagonal offset

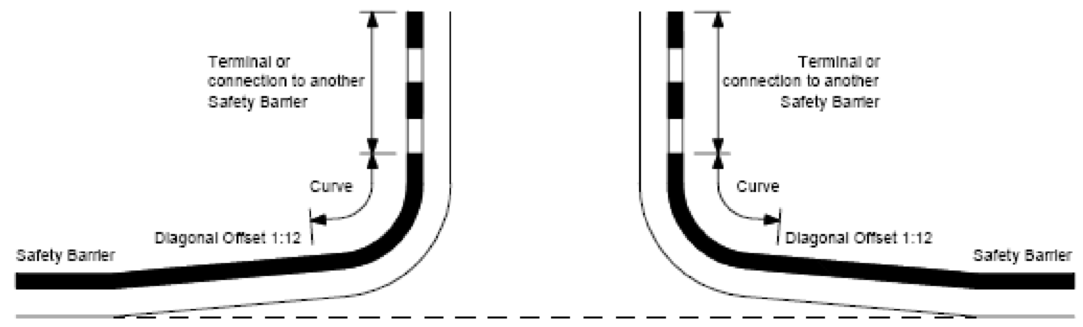


Figure 11c: Break in the safety barrier with curve and diagonal offset

Figure 17 Break in the safety barrier with curve but without a diagonal offset

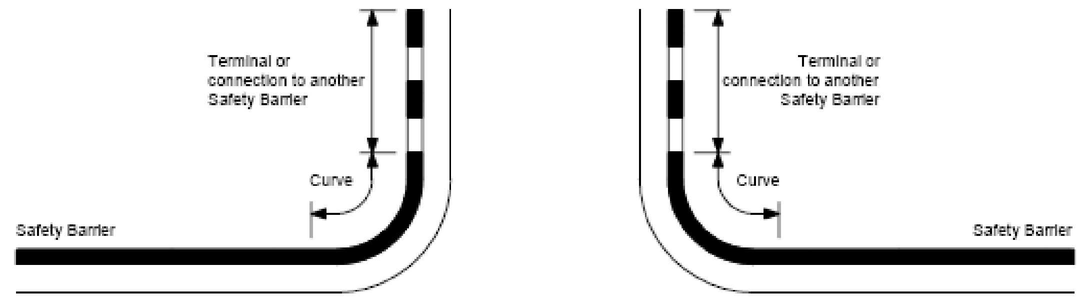


Figure 11d: Break in the safety barrier with curve but without diagonal offset

4.14 Breaks in Safety Barriers – Access to agricultural land

Breaks in safety barriers along single and dual carriageway roads providing access to adjacent fields for husbandry shall be discouraged.

In such situations the Designer must seek to:

a) re-locate access points to secondary roads and pathways in the vicinity. This may entail land expropriation oe easement provisions.

b) Reduce multiple access from any one land envelope.

c) Group access points and construct adequate service pathways away from the main carriageway and onto secondary roads

4.15 Transitions

Transitions between safety barriers having different design, arrangement, performance and/or mode of operation must be correctly joined with each other according to their function.

4.16 Terminals

Safety barriers shall always be fitted with a terminal (**Figure 18)**.

Figure 18: Traffic island nosing with a safety barrier (along one side only) and terminal

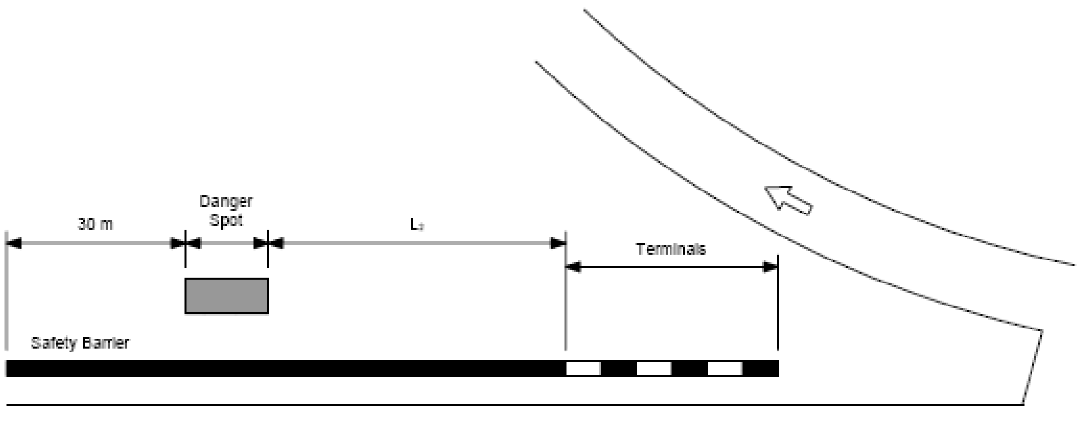


Figure 12: Nose of traffic island with a safety barrier and terminal

If safety barriers are required at both edges of the carriageway on traffic island nosings, the distance between the terminals must be at least 3m (**Figure 18**).

Figure 19: Traffic island nosing with safety barriers (along two sides) and terminal/s

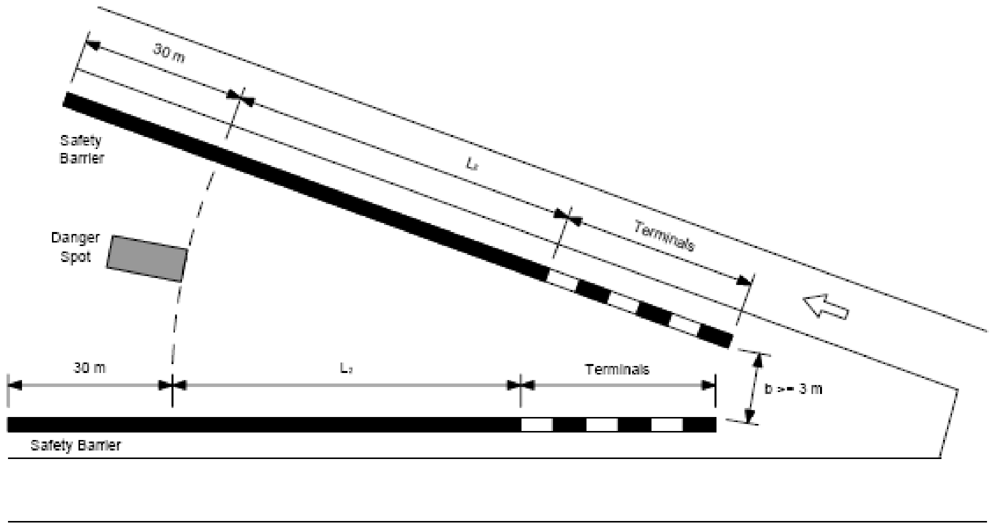


Figure 13: Nose of traffic island with safety barriers and terminals

4.17 <u>Crash Cushions</u>

The installation of crash cushions must be evaluated where hazards are located within the critical zone <u>and</u> the required lengths **"L2"** cannot be observed.

Figure 20: Traffic island nosing with crash cushion in front of a hazard

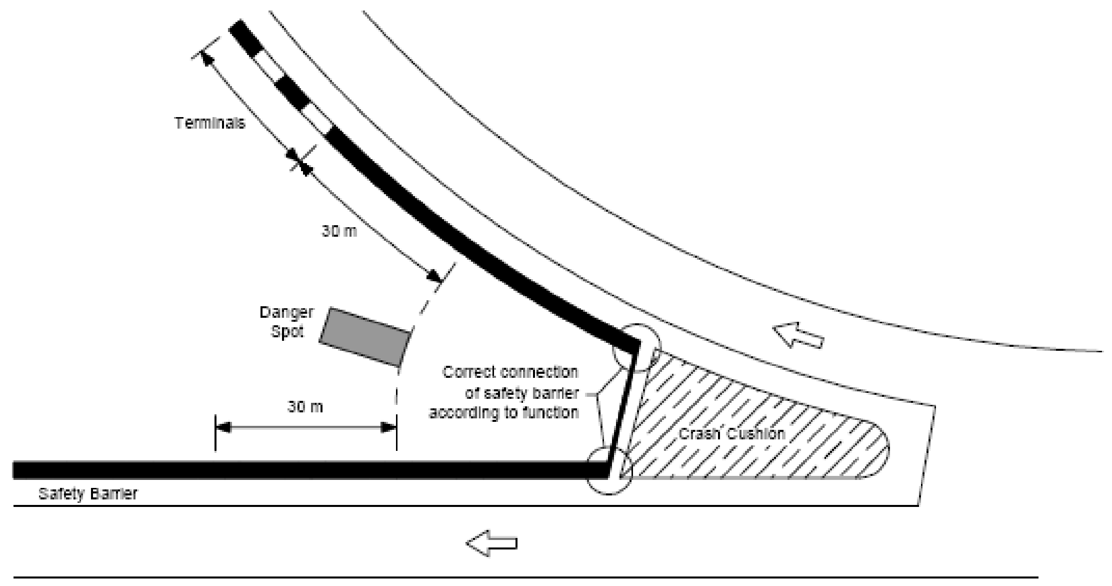


Figure 14: Nose of traffic island with crash cushion in front of a danger spot

4.18 Central Reserves / Strips and other Dividers: Safety Barriers

The provision

of safety barriers in central reserves, centre strips and merger dividing strips of dual carriageway roads must be evaluated where the median clear width is < 10.0m **(See Annex B: Document IM/CS/ 19.1/10)**. Barriers may not be provided where the median width > 10.0m unless special hazards are identified.

Median barriers shall be provided:

a) in the presence of hazardous objects in the median area;

b) where the median area has a critical slope > 1:3 due to carriageway level differencies.

There are various possibilities for the arrangement of safety barriers in central reserves and dividing strips:

a) double-sided safety barrier, erected centrally;

b) double-sided safety barrier, erected off-centre;

c) one-sided safety barriers with split operation, erected at both edges,

d) one-sided safety barriers with joint operation, erected at both edges.

Double-sided safety barriers should be erected centrally. If this is not possible due to the presence of peripheral road features (e.g. drainage, services, drawpits, forward visibility, etc) the double-sided safety barriers may be erected off-centre (if space permits).

Where hazards are located in the central reserve or merger strips/verges, one-sided safety barriers with split operation shall be placed.

Double-sided safety barriers must be converted to one-sided barriers in front of hazards located centrally. The leading and trailing section shall have a taper of ≤ 1:20.

Figure 21: Safety barriers in front of hazards in the central reserve

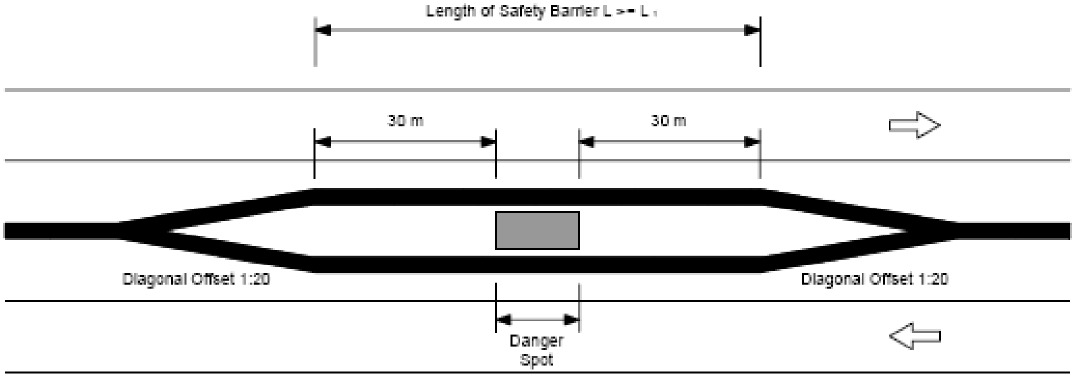


Figure 15: Safety barriers in front of danger spots in the central reserve

The width of any hardstrips and the width of the edgeline/s should be included as part of the central reserve width for the determination of set-back distance.

Double-sided safety barriers should be converted to one-sided safety barriers with diagonal offsets ≤ 1:20 in front of the hazard.

Frequent changes in barrier configuration (eg. double-sided to two one-sided safety barriers placed at the edges and vice-versa) should be avoided.

In central reserve crossings, the safety barriers should be configured to an arrangement similar to that of the adjoining sections.

It is preferable to use two one-sided safety barriers if the crossfall of the central reserve or verge is ≥ 1:10.

The requirements regarding the barrier terminations, transitions and crash cushions must be also be observed when these are located in centre reserves.

4.19 Central reserves / Strips and other Dividers: Narrow centre strips

4.19.1.1 The provision of safety barriers along very narrow centre strips (≤ 3.0m) requires additional considerations. In such cases (i.e where the available barrier working width is restricted) the Designer shall provide for either the removal of hazards from the centre strip or adopt mitigation measures. Irrespective of all other considerations (eg. hazards cannot be removed, inadequate working width) the design must still provide for the correct level of containment.

4.20 Central Reserves / Strips and other Dividers: Provision and Containment

The containment of barriers located at central reserves and/or merge dividers ≤ 10.0m shall be established using the criteria in **Figure 6** but qualified as follows:

i. Where the centre reserve acts as a separator between **opposing** streams of traffic:

   a. The opposite flow traffic shall constitute the third party risk distance AE due to the crossover potential and the associated risk shall be **Level 2**.

   b. A safety barrier must also be provided to protect against the risk posed to occupants from hazards within the centre reserve (Eg. non-passive lighting columns, traffic signal posts, gantry posts, mature trees). The associated risk shall be **Level 3 or Level 4** risk for critical distance A.

   c. The minimum critical distance AE shall be increased to greater than 10.0m.

ii. Where the centre reserve acts as a separator between streams of traffic in the same direction (merging):

   a. the parallel flow traffic shall constitute the third party risk AE due to the crossover potential and the associated risk shall be **Level 2** (≥ 500 vehicles/day) or **Level 3** (≤ 500 vehicles/day).

b. the minimum critical distance AE shall be increased to greater than 10.0m.

Where the central reserve is wider than 10.0m the Designer must still assess the risks pertaining to such locations and document in the project file (with explanations) the decision for not providing the barriers.

4.21 Central Reserves / Strips and other Dividers: Working Widths

In central reserves or lateral dividers without any hazards the maximum working width "**W"** is determined from the width of the central reserve (including the width of the safety barrier). Furthermore, the type of safety barriers (double-sided or two one-sided safety barriers having split or joint operation) and their position (centrally or off-centre placement) is also considered **(Figure 22** to **Figure 25)**. With double-sided safety barriers and one-sided safety barriers having joint operation the working width may extend, at most, to the inner edge of the edgeline marking.

In the central reserve and other dividers with hazards the necessary working width shall be determined in a manner similar to that for barriers located laterally.

As a general rule the distance of the front face of the safety barriers from the reference line should be 0.6m. Any reduction of this dimension will require justification and documentation in the project file . Larger distances may be required in order to maintain the necessary forward visibility.

Where two one-sided safety barriers with split operation are used the second safety barrier may not lie within the working width of the first safety barrier (if the working widths are different, the larger width is determining). This restriction shall not apply to:

i. one-sided safety barriers which have been shown, in an impact test performed by the manufacturer in accordance with MSA EN 1317-2, to operate jointly (i.e. in conjunction with each other);

ii. In narrow reserves where the available barrier working width is restricted and where irrespective of all other considerations (eg. hazards cannot be removed) the designer must provide barriers having the correct level of containment.

Figure 22 Double-sided safety barrier erected centrally

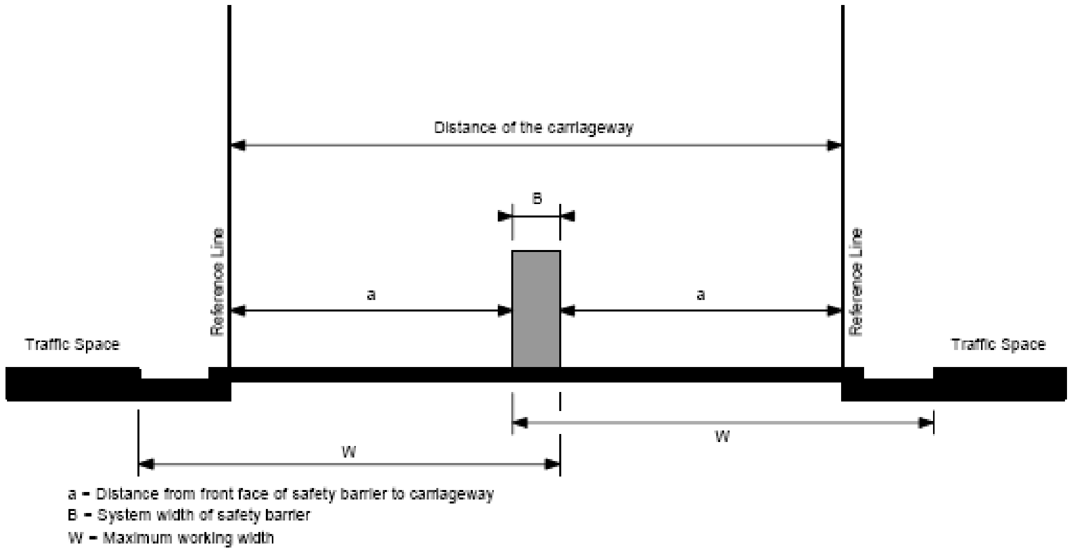


Figure 16a: Double-sided safety barrier erected centrally

Figure 23 Double-sided safety barrier erected off-centre

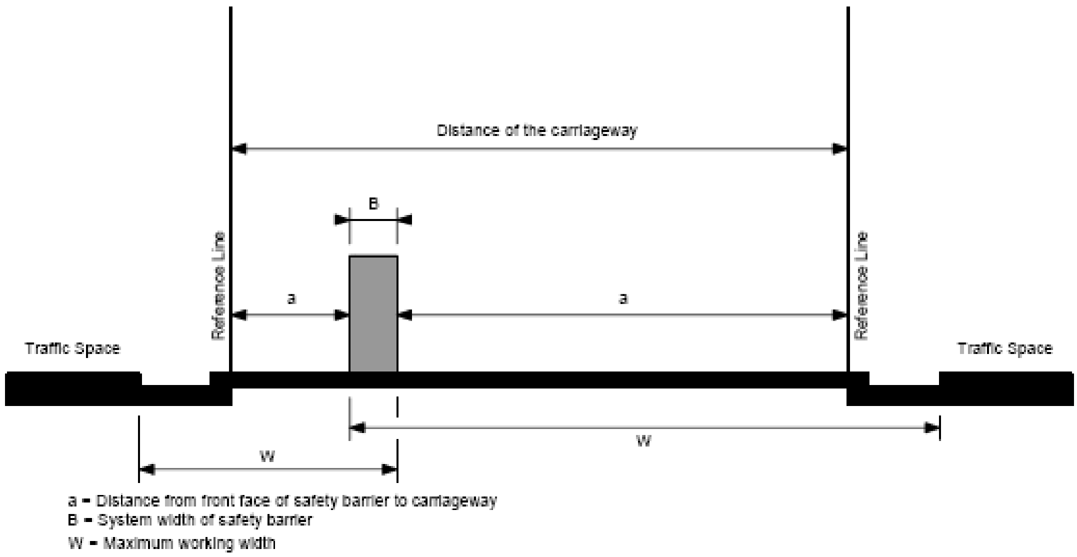


Figure 16b: Double-sided safety barrier erected off-centre

Figure 24 One-sided safety barrier with split operation, erected at both edges

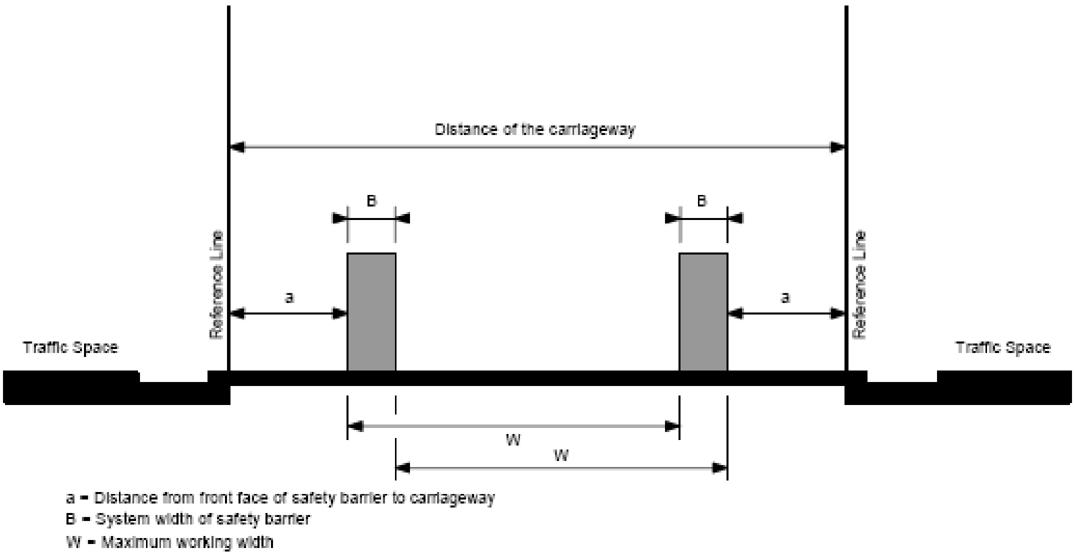


Figure 16c: One-sided safety barrier with split operation, erected at both edges

Figure 25 One-sided safety barrier with joint operation, erected at both edges

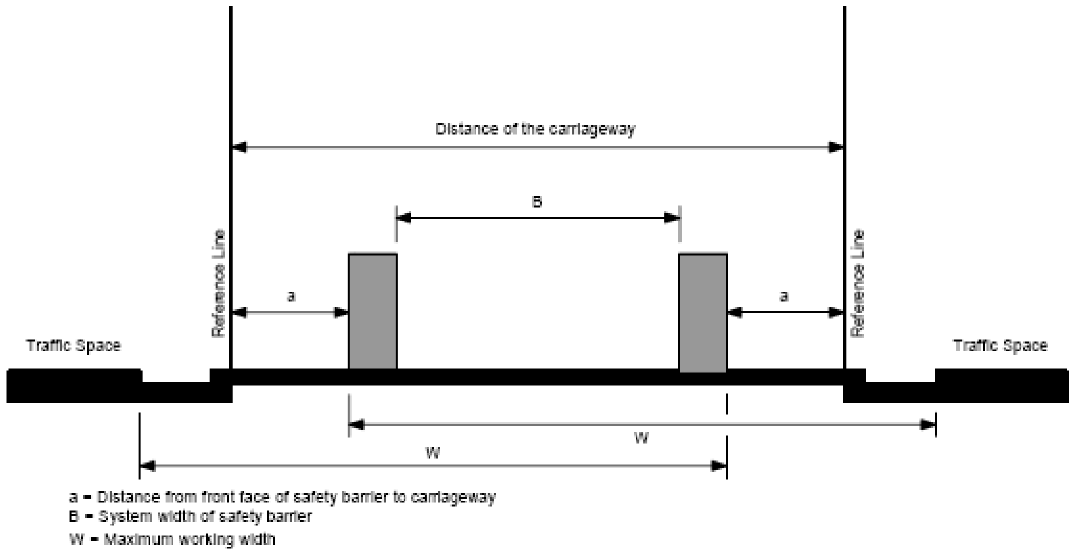


Figure 16d: One-sided safety barrier with joint operation, erected at both edges

Figure 26: Pictorial representation of one-sided safety barrier with joint operation, erected at both edges as described in Figure 25

4.22 Central Reserves / Strips and other Dividers: Transitions

Transitions shall be placed where safety barriers of different design and/or mode of operation have to be connected with each other according to their function.

The provisions relevant to barriers located laterally are to be similarly applied for transitions in centre reserves.

4.23 Central reserves / Strips and other Dividers: Terminals

Terminals shall be provided at the approach and departure ends of central reserves or divider strip barriers.

The provisions (including performance classes) relevant to barriers located laterally are to be similarly applied for terminals in centre reserves.

In the presence of hazards the lengths "**L2"** as indicated for barriers located laterally must also be observed (Figure 27) at central reserves.

In the case of central reserve temporary crossings or openings terminals shall be provided for the period in which they are in use.

Figure 27: Safety barriers with single-sided operation, with terminal at the start of central reserves or verges

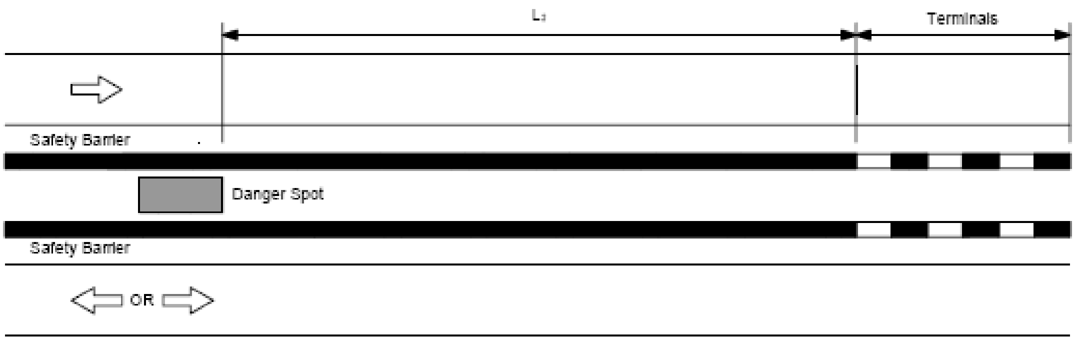


Figure 17: Safety barriers with single-sided operation, with terminal at the start of central reserves or verges

4.24 Central Reserves / Strips and other Dividers: Crash Cushions

Crash cushions shall be installed if the lengths “**L2” -** as required for situations where barriers are located laterally - cannot be observed at the approach end of central reserves or dividers **(Figure 28**).

The provisions (including performance classes) relevant to barriers located laterally are to be similarly applied for crash cushions in centre reserves.

Crash cushions shall also be provided if it is not possible to:

a) observe a distance of 50m from the hazard;

Figure 28 Crash cushions at the start of central reserves and verges

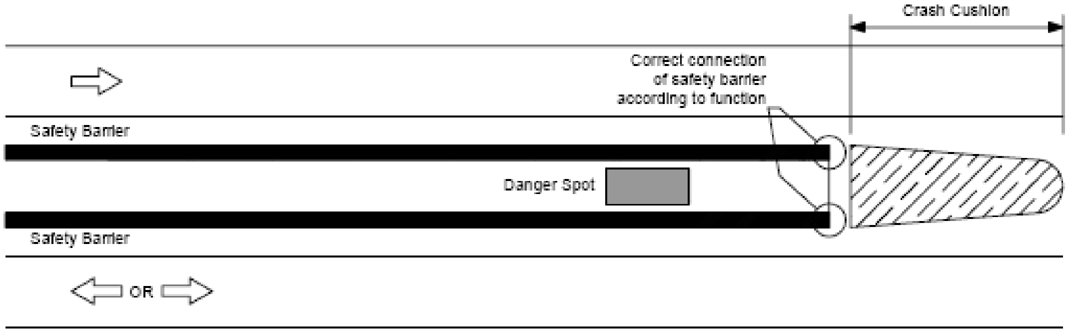


Figure 18: Crash cushions at the start of central reserves and verges

4.25 Bridges and Parapets – Safety Barriers

The provision of safety barriers protecting the edge/s of the carriageway at bridges and parapets shall be in accordance with the requirements of **Figure 6** but qualified as follows:

The designer shall evaluate the risks and hazards not only to drivers and passengers but also to **third parties** using the facilities below the bridge or parapet.

Wherever the evaluation returns a “**None”** result this shall be substituted by a minimum containment level Class N2.

<u>IMPORTANT</u>: For safety barriers on bridges and parapets the designer shall also take into consideration the local and global structural effects (transfer of loading) of any impact on the structure (See UK DMRB BD 37/01). This consideration is however outside the scope of this document

4.26 <u>Bridges and Parapets – Safety Barrier Working Widths</u>

The edge of the bridge and/or parapet wall is regarded as the front of the hazard when determining the maximum working width class, unless there is an existing noise barrier or other hazards. Safety barriers with a higher working width class may be permitted if tests by the manufacturer in accordance with MSA EN 1317-2 show that vehicles are nevertheless contained.

4.27 <u>Bridges and Parapets – Safety barrier lengths of need</u>

The provisions for "at grade" situations shall also be applicable with regard to the lengths of need of safety barriers at bridges and parapets.

In particular the lengths "**L2"** must be observed.

<u>In addition</u>, the point at which the safety barrier becomes fully effective shall be of an adequate length in front of the hazard (**Figure 29**, **Case A**).

The safety barrier installed on the bridge must be continued beyond the end of the bridge and with the same containment level. If this is not possible, the safety barrier may end with the bridge and/or parapet wall, provided that a safety barrier with the same containment level is connected (**Figure 29**, **Case B**).

Figure 29 Safety barriers at bridges

- *Bridge Case A: Safety barrier on Bridge*
- *Bridge Case B: Safety barrier with connector on Bridge*

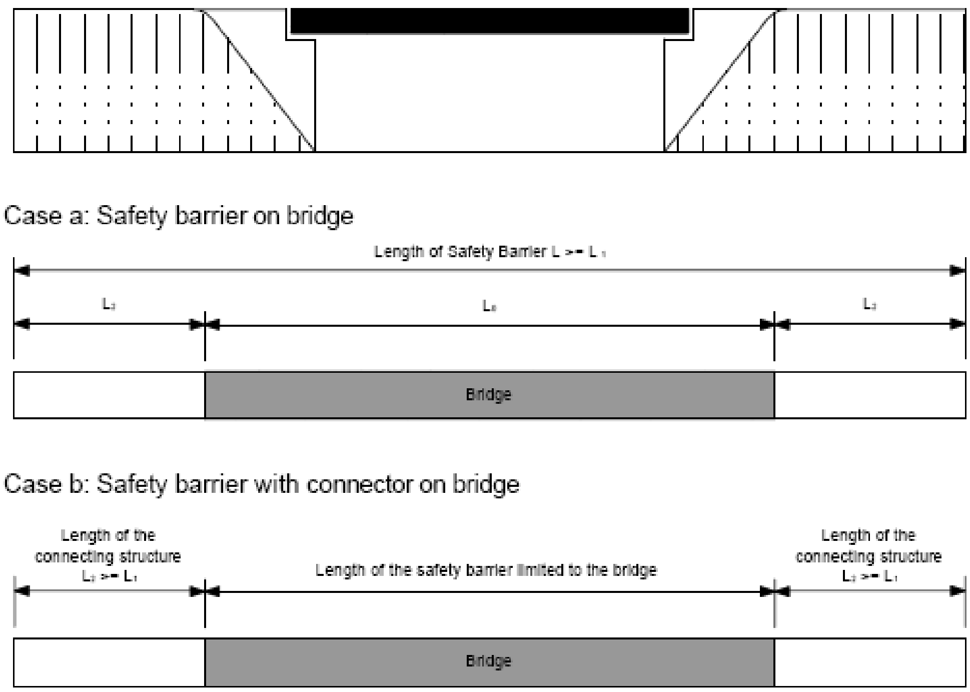


Figure 19: One-sided safety barrier with joint operation, erected at both edges

4.28 Bridges - Carriageways with structural movement joints

Where movement joints are incorporated in the deckslab carriageways the safety barriers shall be placed in such a way that their correct working is not appreciably impaired by the joints.

The safety barrier manufacturer shall indicate whether any special attachments are required at movement joint locations.

4.29 Bridges and Parapets - Transitions

The provisions regarding transitions are similar to those indicated where safety barrier transitions are installed in "at grade" carriageways.

4.30 Bridges and Parapets - Terminals

The provisions regarding terminals are similar to those indicated where safety barrier terminals are installed in "at grade" carriageways.

4.31 Bridges and Parapets - Crash cushions

The provisions regarding crash cushions at bridge traffic island nosings shall be similar to those indicated where safety barrier crash cushions are installed in "at grade" carriageways unless additional requirements must be met (Eg. special measures to prevent HGV falls; Special risks for third parties).

Crash cushion installation is qualified by limits to the transverse slope of the carriageway. The limits imposed by the producers shall be respected.

Figure 30 Example - The use of crash cushions at traffic island nosings on bridges

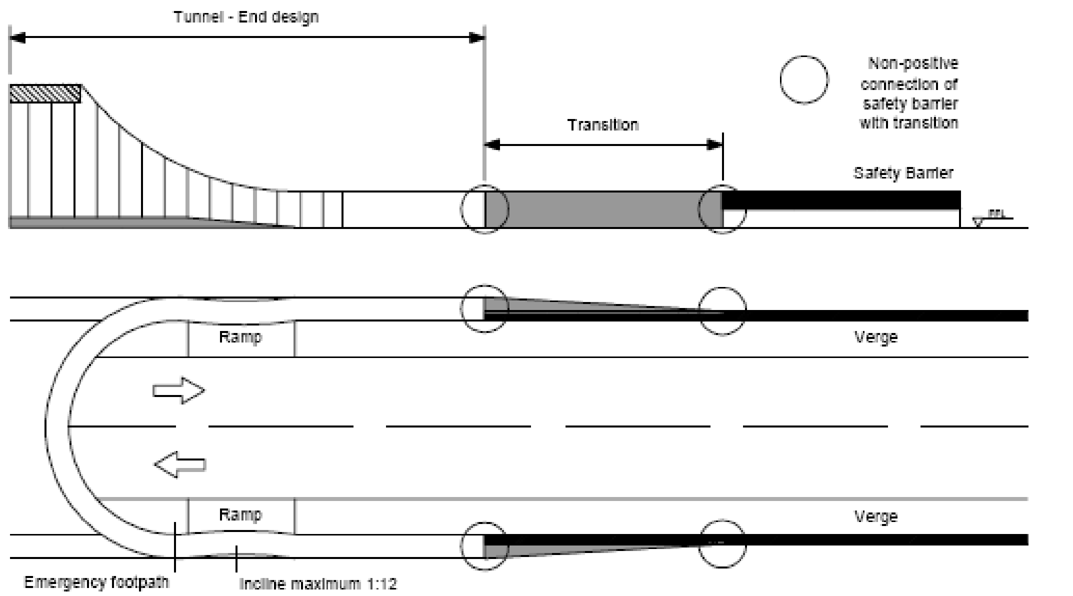


Figure 21: Diagram showing an example of a transition and safety barrier in front of tunnel portals

4.32 Bridges - Central reserves and Dividing strips: Safety barrier selection criteria

In central reserves and dividing strips on bridges, the selection of the safety barrier will be dependent on whether there exists a substantial difference in the levels of the transverse section of the deck superstructure.

Additionally, the Designer must address the transfer of the impact loads onto the bridge structure (global and local effects – See UK DMRB BD 37/01, BD 60/04 and the relevant Eurocode) through the barrier attachments and anchorages.

The Designer shall ensure that the barrier attachments (usually restraining the post baseplates) are the elements designed to break-off first under all possible impact scenarios.

Under no circumstance shall impacts with the barrier result in the break-off of the barrier anchorages connected to the structure.

4.33 Bridges - Central reserves and Dividing strips: Safety barrier Containment levels

Where safety barriers are installed in central reserves or dividing strips on bridges with separate superstructures having a difference in level not greater than 1.5m or a carriageway gap greater than 1.5m the criteria for containment are similar to those indicated where safety barriers are installed in central reserves along "at grade" carriageways.

The same principle for containment level applies to bridges with an undivided deck superstructure.

In the case of bridges with separate superstructures and which have a level difference greater than 1.5m and/or a carriageway gap greater than 1.5m the two structures shall be regarded as being independent of each other.

4.34 Bridges - Central reserves and Dividing strips: Safety barrier Working widths

Where safety barriers are installed in central reserves or dividing strips on bridges with separate superstructures having a difference in level not greater than 0.1m or a carriageway gap greater than 0.1m the criteria for working width are similar to those indicated where safety barriers are installed in central reserves along "at grade" carriageways.

The same principle for working width applies to bridges with an undivided deck superstructure.

In the case of bridges with separate superstructures having a level difference greater than 0.1m and/or a carriageway gap greater than 0.1m, the two structures shall be regarded as independent of each other. It should be noted that a bridge superstructure which is higher than the adjacent structure by more than 0.1m represents a hazard in itself. It should also be noted that the higher superstructure may in itself pose a restriction to the working width zone of the safety barrier.

4.35 Bridges - Central Reserves and Dividing Strips: Movement joints

The relevant provisions in this document shall apply.

4.36 Bridges - Central reserves and Dividing strips: Safety barrier Transitions

Transitions shall be placed where safety barriers of different design and/or mode of operation have to be connected with each other according to their function. The provisions regarding the required containment levels are equivalent to those applicable to safety barriers installed along "at grade" locations.

4.37 Wall Ends and Tunnel portals - Safety barriers

Continuous solid walls shall not be classified as hazards provided that:

i. they can contain the vehicle whilst retaining their structural integrity under impact;

ii. they do not have projections or recesses of more than 0.1m.

Recesses in tunnels of less than 4.0m in length (normally required for safety reasons) may be disregarded (i.e considered as not constituting a hazard) during the assessment for the provision of safety barriers.

The approach ends of continuous walls and portals, projections of more than 0.1m and the ends of recesses more than 4.0m in length shall be classified as non-deformable extensive obstacles vertical to the direction of the traffic (i.e hazard Level 3 in accordance with **Figure 6**) unless they are so designed that they are potentially impacted at an offset (or otherwise protected).

4.38 Masonry and Brickwork Walls: Stone, HCB and Dry Rubble Walls

Walls constructed of standard globigerina limestone ("franka") dimension masonry stone, hollow concrete blocks (HCB) and dry rubble walls may not normally be considered as capable of "retaining their structural integrity under impact" unless reinforced by special or proprietary joint detailing and are to be considered as hazards even when infilled or capped with concrete.

4.39 Wall Ends and Tunnel Portals - Transitions

The relevant guidelines regarding the required performance classes of transitions shall be applicable for establishing the working width.

4.40 Wall Ends and Tunnel portals - Terminals

Terminals shall be placed at the start and end of the safety barriers.

4.41 Wall Ends and Tunnel portals - Crash cushions

Crash cushions may also be used to provide protection at the start of walls, portals and the end of significant recesses.

5 ANNEX 1 - LIST OF STANDARDS AND TECHNICAL REGULATIONS

i. MSA EN 1317-1 Road restraint systems - Part 1: Terminology and general criteria for test methods

ii. MSA EN 1317-2 Road restraint systems - Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers

iii. MSA EN 1317-3 Road restraint systems - Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions

iv. MSA ENV 1317-4 Road restraint systems - Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers

v. MSA prEN 1317-5 Road restraint systems - Part 5: Durability and evaluation of conformity

vi. MSA EN 12767 Passive safety of support structures for road equipment – Terminology, performance classes, impact test acceptance criteria and test methods

vii. Infrastucture Malta, IM/CS/19.1/10 - Complementary Standard: Guidelines on the Requirement for Road Restraint Systems.

6 ANNEX 2 - DEFINITIONS

i. Exit box - Movement zone of the vehicle after the impact with a terminal in the impact tests in accordance with MSA ENV 1317-4

ii. Distance, critical - Distance within which it is necessary to investigate whether a safety barrier is required, if it includes hazards (area requiring protection, obstacle)

iii. Distance, determining - Distance between the edge of the carriageway and the edge of the hazard (obstacle, area requiring protection)

iv. Terminal - End anchorage / formation of a safety barrier

v. Crash cushion - Structure fitted in front of obstacles on roads, in order to reduce the severity of a vehicle impact and thereby to convert the kinetic energy into strain energy

vi. Impact severity level - Theoretical parameter for assessing the physical demands, severity of injuries or risk of death for car passengers

vii. Connector - Connected transition or safety barrier with the same cross-section connected without a transition, near to bridges

viii. Containment level - The containment level indicates the containment capacity of a safety barrier as a function of vehicle mass, impact angle and impact speed in impact tests in accordance with MSA EN 1317.

ix. Permanent lateral displacement - Lasting lateral deformation of crash cushions and of terminals in impact tests in accordance with MSA EN 1317-3 or MSA ENV 1317-4.

x. Dynamic deflection - The dynamic deflection of vehicle restraint systems is determined in the impact test in accordance with MSA EN 1317-2. It corresponds to the maximum lateral dynamic (possibly only short-term) displacement of the side of the system facing the traffic.

xi. Vehicle restraint system - System installed on roads, which is intended to contain or redirect or turn back a vehicle which has left the carriageway.

xii. Hazard - A place or a roadway area next to the carriageway where there are dangers for uninvolved third parties, areas requiring protection or vehicle passengers if vehicles leave the carriageway.

xiii. MSA EN 1317-2 performance class - The performance class of a safety barrier and transition is determined by means of the containment level, the working width and the impact severity level.

xiv. MSA ENV 1317-4 performance class - The performance class of a terminal is determined by means of the performance class (demonstrated by impact tests), the lateral displacement, the exit box and the impact severity level.

xv. MSA EN 1317-3 performance class - The performance class of a crash cushion is determined by means of the velocity class, the lateral displacement, the redirection zone and the impact severity level.

xvi. Safety barrier - Vehicle restraint system which is erected alongside the outer edge of the carriageway or in the central reserve and verges

xvii. Transition - Mechanical connection between restraint systems or safety barriers of different design and/or different mode of operation in the event of a collision by vehicles

xviii. Deformation class - The deformation class indicates different deformations and displacements of crash cushions in impact tests in accordance with MSA EN 1317-3.

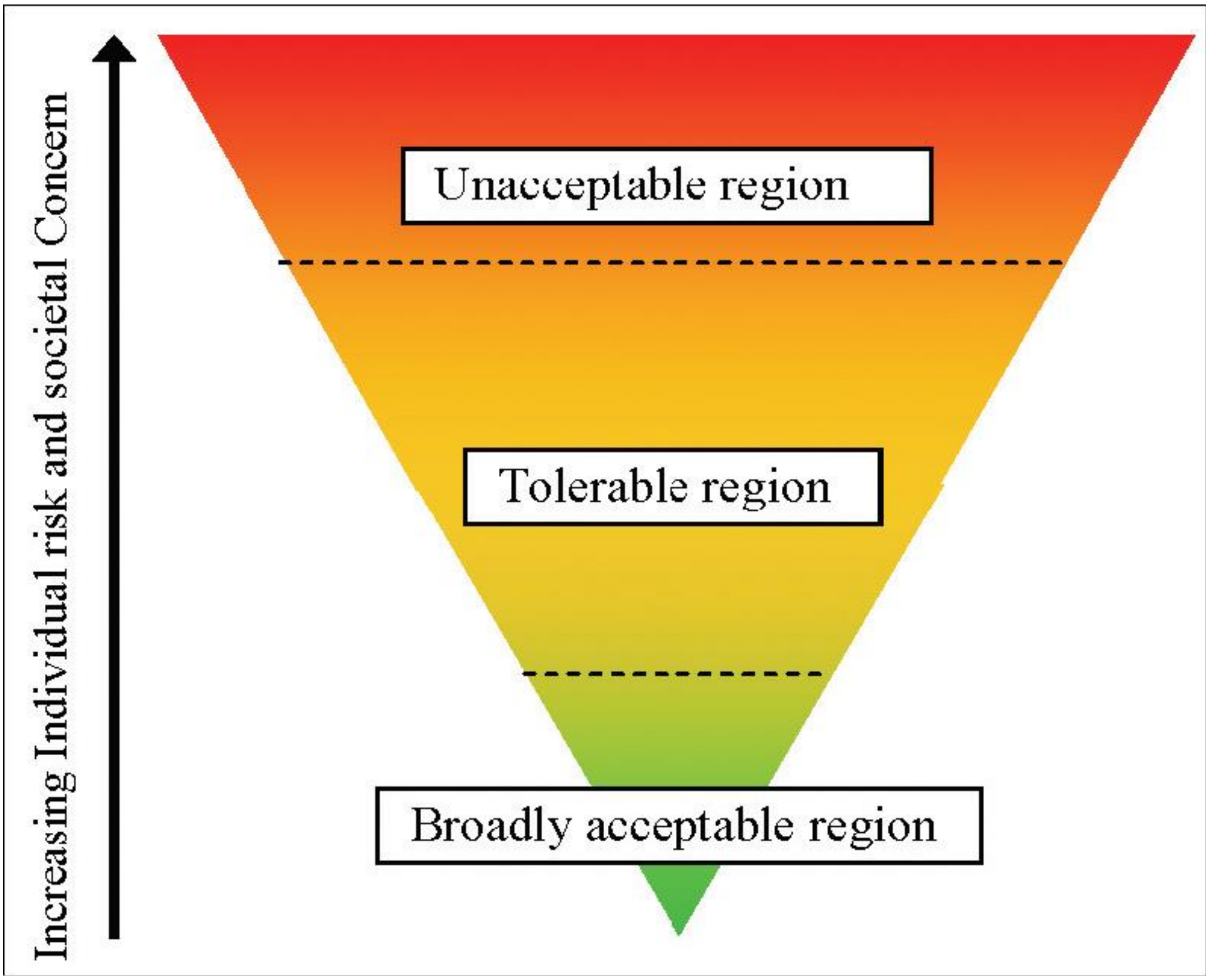
xix. Working width - Distance between the side of a safety barrier facing the traffic and the maximum dynamic lateral position of each essential part of the system in impact tests in accordance with MSA EN 1317-2.

xx. Redirection zone - The redirection zone is determined in impact tests in accordance with MSA EN 1317-3. It describes the area which the test vehicle may not leave after the collision.

7 ANNEX 3 – ALARP (FROM THE UK DMRB, TD 19/06)

a. Risk is measured in terms of both the individual risk to a person and the overall concerns of society it gives rise to. The triangular framework illustrated in the UK DMRB, TD 19/06, Figure 2-1 represents decreasing levels of risk as a result of a particular hazard as one moves from the top to the bottom of the triangle. At the top is the 'unacceptable' region. A risk falling into this region is regarded as unacceptable whatever the level of benefit associated with the activity.

Figure 31: ALARP extracted from the UK DMRB, TD 19/06, Figure 2-1



b. The region at the bottom of the diagram represents the 'broadly acceptable' risk. Risks falling into this region are regarded as minor or insignificant and adequately controlled. Further action will not usually be required. In simpler terms money spent in further reducing the level of risk would be better spent elsewhere where a greater cost benefit could be realised. The levels of risk here are comparable to those that people regard as acceptable in every day life. An example of risk in this region might be the use of passively safe lighting columns placed at an optimum distance back from the edge of the road.

c. The zone between the ‘unacceptable’ and ‘broadly acceptable’ regions is the ‘tolerable’ region. Risks in this region are typical of risks people are prepared to tolerate in order to secure benefits, in expectation that:

    i. the risks are kept As Low As Reasonably Practicable (ALARP);

    ii. the risks are reviewed to ensure they continue to be ALARP.

d. What does ‘reasonably practicable’ mean? In essence, the risk has to be weighed against the trouble, time and money (i.e. the overall cost) needed to control or remove it. Making sure a risk has been reduced ALARP is about weighing the risk against the overall cost needed to further reduce it. The balance to be achieved is weighed in favour of health and safety because *<u>the courts have ruled</u>* that to avoid putting a measure in place, it must be shown that the cost of the measure is grossly disproportionate to the benefit it would achieve.

<u>Unacceptable risks</u>

e. These risks cannot be justified save in extraordinary circumstances. For risk in the ‘unacceptable’ region, every effort must be made to introduce control measures to drive residual risk towards ‘broadly acceptable’. The residual risk is tolerable only if further risk reduction is impracticable or requires action that is grossly disproportionate in time, trouble and resources to the reduction in risk achieved.

<u>Tolerable risks</u>

f. The level of risk is regarded as acceptable and further effort to reduce risk is not likely to be required as resources to reduce risk would be grossly disproportionate to the risk reduction achieved.

8 ANNEX 4 – INFRASTRUCTURE MALTA HAZARD ANALYSIS: TYPICAL SCHEDULE

Annex 4 of these Guidelines comprises of the approved template (Schedule) utilised by Infrastructure Malta in the classification of hazards.

Mellieha ByPass: VRS Schedule - Lateral								
Procedure	TMTD19/10							
							Date	16-06-10
Speed km/h (RPS Figure 4)	70		Critical distance A (m)		A	4.5	RPS figure 4	
			Critical distance AE (m)		AE	7.5	RPS figure 4	
AADT	26000		No value		no	nil		
HGV %	8%							
HGV AADT	2080							
Severity Index (RTA, 1996)	2.0							
Identified Hazard list	**Hazard Type**	**escription/Locatio**	**I Distance**	**Critical Distance (m)**	**Hazard level Fig.6**	**Notes**	**Provision (RPS Figure 6)**	**Comments**
HA1	barrier kerb	none	no	nil				
HA2.1	mountable kerb	All carriageway southbound nearside	A	4.5	3	Severity index 0.5	none	
HA2.2	mountable kerb	All carriageway northbound nearside	A	4.5	3	Severity index 0.5	none	
HA3	bridge abutment	none	no	nil				
HA4	tunnel portal	none	no	nil				
HA5	bridge pier	none	no	nil				
HA6	building	none	no	nil				
HA7.1	culvert (open)	carriageway northbound nearside CH0+800 to 1+667	A	4.5	4		H1	descending long. gradient (downhill) - Increased risk +Consider motorcyclist protection; See Drg. Mell/PS/002, Section C
HA8	culvert end	none	no	nil				
HA9	culvert headwall	none	no	nil				
HA10.1	cutting	carriageway southbound nearside CH 0+900 to 1+500					cut rockface protected by dry rubble walls	ascending long. gradient (uphill)
HA10.2	cutting	carriageway northbound nearside CH0+800 to 1+667	A	4.5	4	downhill speed increase assumed + open culvert (no boundary wall protection)	H1	descending long. gradient (downhill) - Increased risk +Consider motorcyclist protection
HA11	cutting end	none	no	nil				
HA12	ditch	none	no	nil				
HA13	drains U	none	no	nil				
HA14	drains V	none	no	nil				
HA15	fence	none	no	nil				
HA16	gantry post > 0.1m	none	no	nil				
HA17	near vertical drops	none	no	nil				
HA18.1	vertical drops	southbound nearside CH 0+200 to 0+600	A	4.5	4	uphill speed decrease assumed	N2	ascending long. gradient (uphill)
HA18.2	vertical drops	southbound nearside CH 1+500 to 1+670	A	4.5	4		N2	
HA18.3	vertical drops	northbound nearside CH 0+000 to 0+800	A	4.5	4	downhill speed increase assumed + open culvert (no boundary wall protection)	H1	descending long. gradient (downhill) - Increased risk
HA19	oncoming vehicle	none	no	nil				
HA20	open channels	none	no	nil				
HA21	open drains	none	no	nil				
HA22	parapets at separate grade (Eg. Bridge, Slip lanes)	none	no	nil				
HA23	pedestrian footpath	extensive southbound	AE	7.5	0	not heavily used	none	See ADT TD 27/00, Table 1A
HA24	poles > 0.1m	none	no	nil				
HA25	sign posts > 0.1m	none	no	nil				

Figure 32 Hazard Schedule

9 ANNEX 5 – CRITERIA FOR THE EVALUATION OF RISK AND PROVISION OF MOTORCYCLE (PTW) VRS PROTECTION

Additional protection for PTW shall be provided on metal vehicle restraint systems in the following circumstances:

a) at curves having a radius (r) < 100m;

b) at curves having a radius (r) 100m < r < 250m and a hardstrip width < 1.75m;

c) at all curves having an adverse camber.

10 ENQUIRIES

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