



Safety Barriers - Design and Installation Developments and Pitfalls

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Safety Barriers

NRA APPROVAL LIST **WITHDRAWN**

All Safety Barriers to be **CE Marked**!!!!!!

CE Marking for a barrier kit does NOT mean that the barrier system is a fully compliant installation.

NRA will maintain a list of CE marked barriers for designers to obtain information on available systems

Pre-Construction Checklist

Tender
Document

CONFIDENTIAL

Checklist – Pre-Construction

- Do you need a barrier (could the obstruction be removed or made passively safe)

3.9 Hazard mitigation measures shall be considered by the Designer prior to designing a safety barrier. A safety barrier shall only be introduced if the hazard cannot be mitigated. The mitigation measures for hazards within the Clear Zone are listed below in order of preference:

- a) Remove;
- b) Relocate;
- c) Re-design the hazard to reduce the risk to road users e.g. introducing a passively safe sign post;
- d) Revise the road layout or cross-section to lower the risk, e.g. increase the width of the hard shoulder, improve the road alignment, etc.;
- e) Reduce impact severity (e.g. by using a breakaway feature or by setting a culvert flush with the existing ground);
- f) Provide a suitable safety barrier.



Introduction of Chapter 8

- A new Chapter 8 has been added to NRA TD 19 to include a risk assessment procedure for schemes involving online realignment on National Roads.

NRA DESIGN MANUAL FOR ROADS AND BRIDGES

8. RISK ASSESSMENT PROCEDURE FOR SCHEMES INVOLVING ONLINE REALIGNMENT ON NATIONAL ROADS

General

8.1 To assess the need for a safety barrier on a scheme involving online realignment, a risk assessment procedure shall be undertaken by the Designer as described in sections 8.2 to 8.17 below.

Risk Assessment Procedure

8.2 As part of the risk assessment procedure the Designer shall complete a risk assessment sheet at the preliminary design stage using the layout included in Appendix C and include it in the preliminary design report. This risk assessment procedure shall also be completed at the detailed design stage.

8.3 The Designer shall undertake the following procedure for all hazards and record it in the risk assessment sheet:

- Establish if the hazard is within the clear zone and if it can be mitigated.
- Rank the hazard as per Appendix D.
- Calculate the sinuosity of that section of road.
- Assess the collision rate threshold for that section of road.
- Assess the risk of a vehicle leaving the road based on sinuosity ranking and collision rate ranking.
- Assess the overall risk rating.
- Undertake a site survey to confirm the need for a safety barrier.

8.4 The risk assessment stages described above are explained in more detail in sections 8.5 to 8.17 below.

Hazard Location and Ranking

8.5 The Designer shall establish if the hazard is located within the clear zone in accordance with Chapter 4.

8.6 Where possible hazards shall be mitigated as described in paragraph 3.9.

8.7 If the hazard cannot be mitigated the Designer shall assess if the hazard ranking is high, medium or low using the suggested hazard ranking system included in Appendix D and record it in the risk assessment sheet.

Sinuosity

8.8 The sinuosity of a road is defined as the actual section length between two points on a road divided by the shortest path between them (see figure 8.1). The sinuosity index shall be calculated by the Designer as follows:

$$\text{Sinuosity Index (SI)} = \frac{\text{Actual section length between A and B}}{\text{Shortest path between A and B}}$$


Figure 8.1 Sinuosity Index

8.9 The sinuosity index shall be calculated by the Designer on the approach to a hazard as set out below (in all cases the minimum approach length to the hazard considered shall be 200m).

March 2013 24

Purpose of Safety Barrier Risk Assessment Procedure

To assess the need for a safety barrier on a scheme involving online realignment.



Risk Assessment Procedure Steps

The Designer shall undertake the following risk assessment procedure for all hazards and record it in the risk assessment sheet:

- Establish if hazard **within the clear zone** and can be **mitigated**;
- **Rank** the hazard - new **Appendix D** of NRA TD19;
- Calculate the **sinuosity** of that section of road;



Risk Assessment Procedure Steps

- Assess the **collision rate threshold** for that section of road;
- Assess the **risk of a vehicle leaving the road** based on sinuosity ranking and collision rate ranking;
- Assess the **overall risk rating**;
- Undertake a **site survey** to confirm the need for a safety barrier.



Risk Assessment Sheet

The Designer shall complete a risk assessment sheet using the new layout included in Appendix C of NRA TD 19.

 Risk Assessment Sheet for Safety Barriers							Date: X/X/XX			Completed By: X		
							Location ID/Description:					
							Site Survey Conducted (Y/N): Y					
Hazard Type, Start and End Co-ordinates	Is Hazard within Clear Zone (Y/N)	Can the Hazard be Mitigated?	(1) Hazard Ranking	Sinuosity Index (SI)	(2) Sinuosity Ranking	(3a) Collision Rate Threshold	(3b) Collision Rate Ranking	(4) Risk of a Vehicle Leaving the Road	(5) Overall Risk Rating	Distance to Hazard (m)	Barrier to be Installed (Y/N), Start and End Co- ordinates	Reasons for Installing / Not Installing Barrier

Hazard Definition

A hazard is any physical obstruction which may, in the event of an errant vehicle leaving the carriageway, result in significant injury to the occupants of the vehicle.



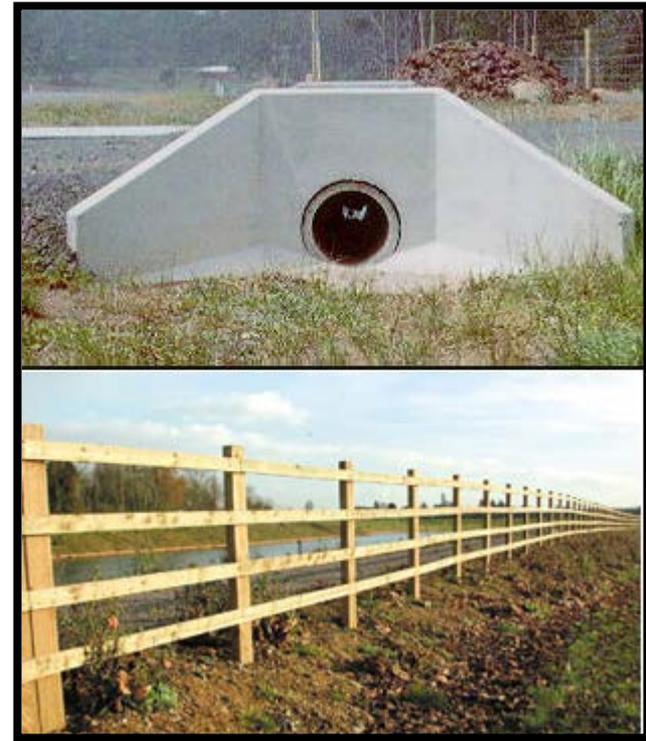
Hazard Categories

- Chapter 3 of NRA TD 19 gives the types of hazard which present a significant risk to an errant vehicle.
- Categories of hazards include side slopes, fixed objects, water and linear hazards e.g. roads, railways.



Hazard Categories

- New/Updated fixed objects within the Clear Zone considered as hazards requiring mitigation (par 3.17):
 - Wooden poles/ posts with **cross-sectional area > 25,000mm²** that do not have breakaway features
 - Timber posts and rail fences if not being used as a road boundary
 - Drainage items, such as culvert headwalls and transverse ditches that are not detailed to be traversed safely



Hazard Mitigation

Hazard mitigation measures shall be considered by the Designer **prior** to designing a safety barrier.

A safety barrier shall **only** be introduced if the hazard **cannot** be mitigated.



Hazard Mitigation

Where possible hazards shall be mitigated as follows in accordance with Par 3.9:

- Remove;
- Relocate;
- Re-design the hazard to reduce the risk to road users e.g. introducing a passively safe sign post;



Hazard Mitigation

- Revise the road layout or cross-section to lower the risk, e.g. increase the width of the hard shoulder, improve the road alignment, etc;
- Reduce impact severity e.g. by setting a culvert flush with the existing ground;
- Provide a suitable safety barrier.



Hazard Ranking

If the hazard cannot be mitigated the Designer shall assess if the hazard ranking is:

- High
- Medium
- Low

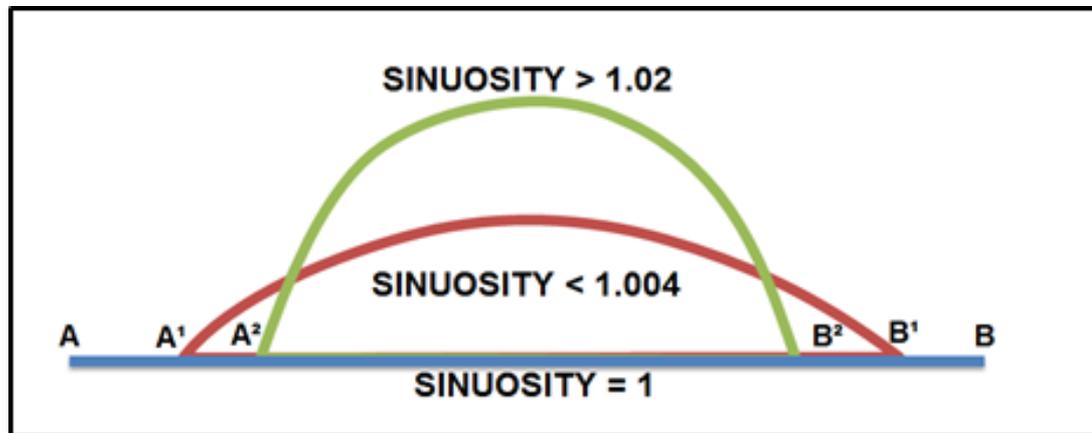
using the new suggested **hazard ranking system** included in the new **Appendix D** and record it in the risk assessment sheet.

APPENDIX D: HAZARD RANKING

Hazard Ranking	Hazard Description
High	<ul style="list-style-type: none">• Lighting Columns that are not passively safe.• Tubular Steel Signposts >89mm diameter by 3.2mm thick, or equivalent strength.• Wooden Poles or Posts with Cross Sectional Area > 25,000mm² that do not have breakaway features.• Trees having a girth 175mm or more measured at 1m above the ground.• Concrete posts with Cross Sectional Area > 15,000mm².• Playgrounds/Monuments and other locations of high socio-economic value.• Water of likely depth > 0.6m.• Bridge Parapets, Bridge Piers, Abutments, Railing Ends, Gantry Legs• Location where errant vehicle may encroach onto road/railway which crosses or runs parallel to road.• Substantial fixed objects e.g. walls extending above the ground by more than 150mm with projections or recesses > 100mm and running parallel to the road.• Underbridges or retaining walls >0.5m high supporting the road, where a vehicle parapet or vehicle/pedestrian parapet of the required performance class is not provided.• Buildings in danger of collapse.• Industrial sites with potential for explosion or chemical spill.• Rock cutting with rough face.
Medium	<ul style="list-style-type: none">• Steep Embankment Slopes, steeper than 1:2 and ≥0.5m height.• Embankment Slopes between 1:2 and 1:3 (inclusive) and ≥2m height.• Slopes to ditches.• Drainage Items such as culvert headwalls and transverse ditches that are not detailed to be traversed safely.• Hazardous topographical features beyond the road boundary, but within the width defined in Table 4/1.• Single cross culvert opening exceeding 1000mm measured parallel to the direction of travel.• Culvert approximately parallel to the roadway that has an opening exceeding 600mm measured perpendicular to the direction of travel.• Steep sided cuttings or earth bunds (steeper than 1:2) within the clear zone.• Multiple cross culvert openings exceeding 750mm each, measured parallel to direction of travel.• Linear V-ditches alongside the scheme.• Timber post and rail fences when not being used as a road boundary.• Environmental Barriers.
Low	<ul style="list-style-type: none">• Shallow Slopes, between 1:3 and 1:5 gradient and ≥6m in height.• Substantial fixed objects e.g. walls extending above the ground by more than 150mm with projections or recesses ≤ 100mm and running parallel to the road.

Sinuosity

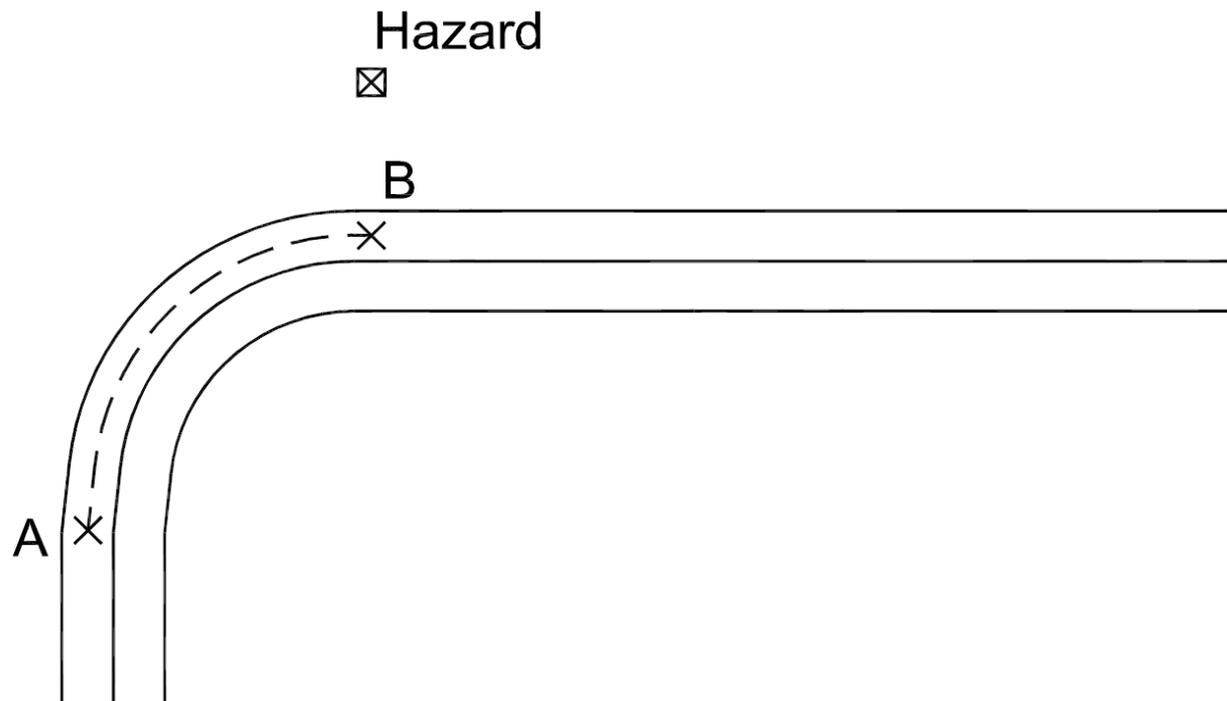
$$\text{Sinuosity Index (SI)} = \frac{\text{Actual section length between A and B}}{\text{Shortest Path between A and B}}$$



Sinuosity

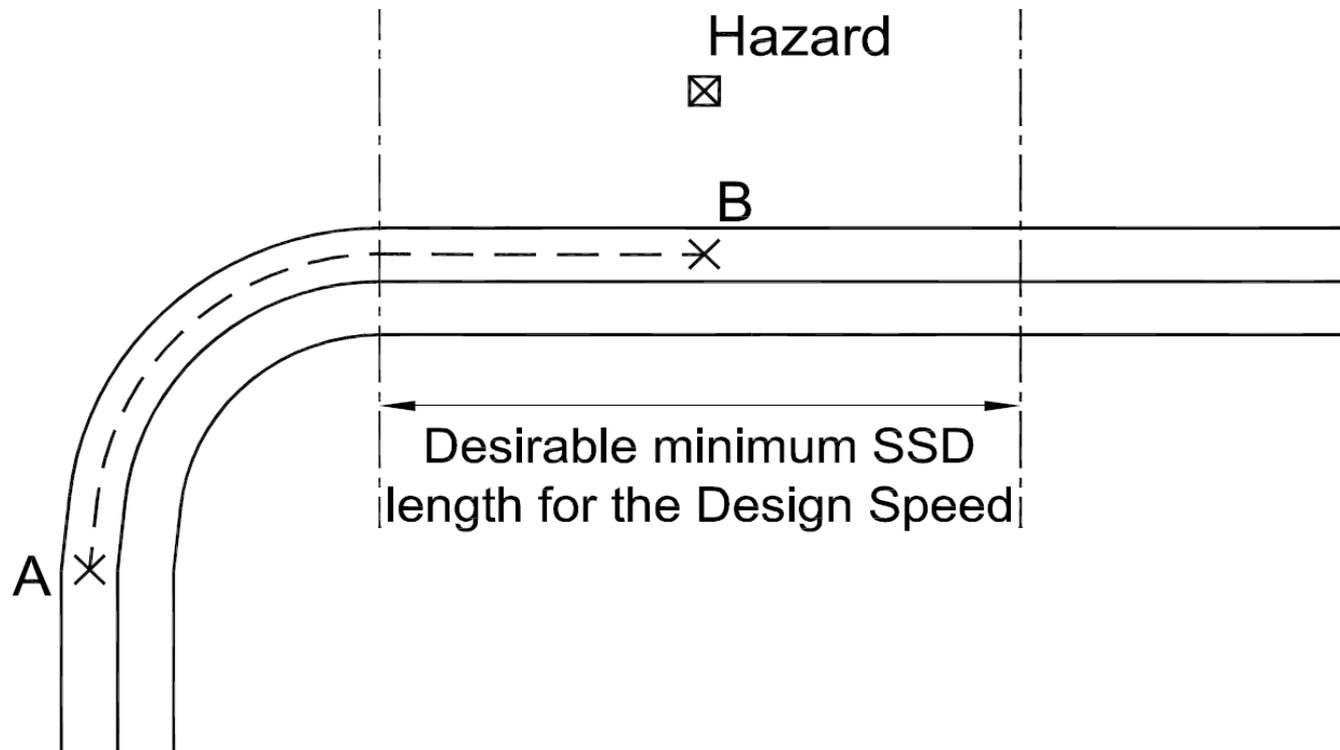
- The sinuosity index shall be calculated by the Designer **on the approach** to a hazard
- Minimum length over which the sinuosity shall be assessed = **200m**

Sinuosity



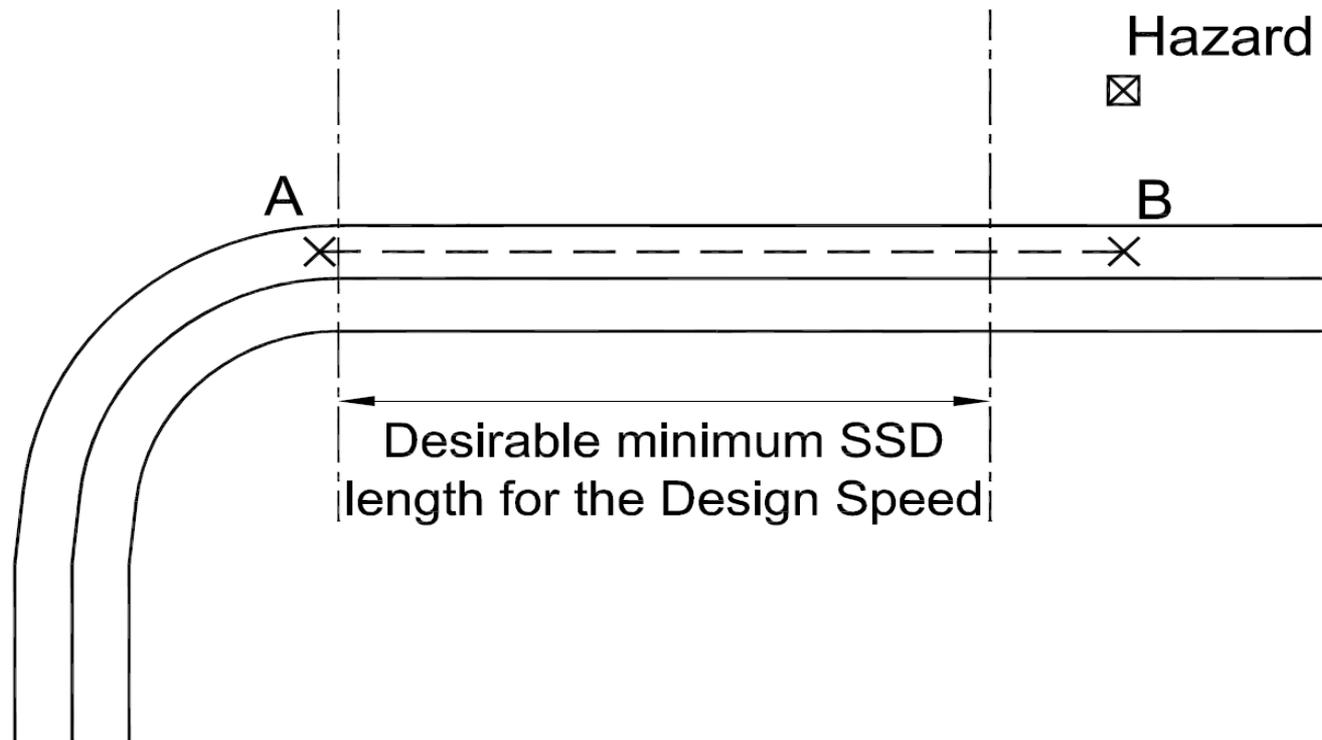
Hazard Located within or at the end of a Horizontal Curve

Sinuosity



Hazard located on a straight or nearly straight section beyond a horizontal curve

Sinuosity



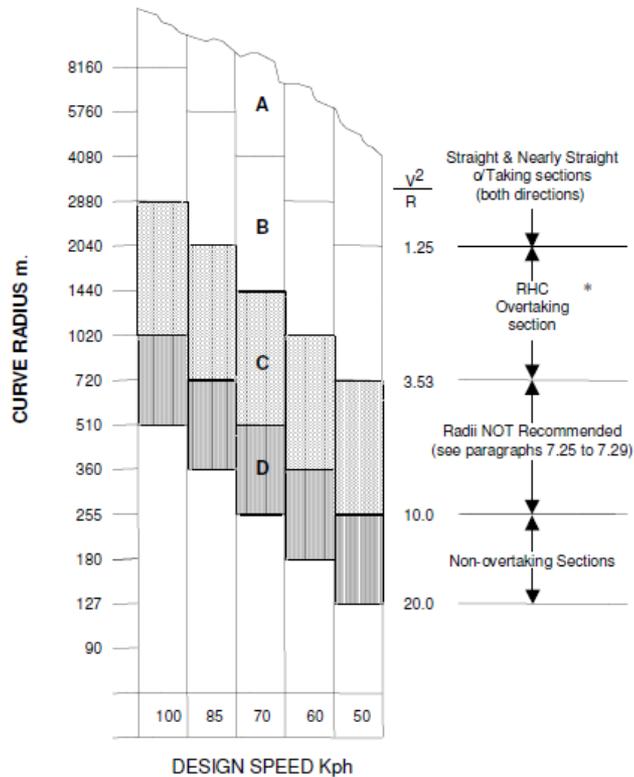
Hazard located on a straight or nearly straight section of road beyond the horizontal curve and the Desirable Minimum SSD length

Sinuosity

DESIGN SPEED (km/h)	120	100	85	70	60	50	V ² /R
STOPPING SIGHT DISTANCE m							
Desirable Minimum Stopping Sight Distance	295	215	160	120	90	70	
One Step below Desirable Minimum	215	160	120	90	70	50	
Two Steps below Desirable Minimum	160	120	90	70	50	50	
HORIZONTAL CURVATURE m							
Minimum R* without elimination of Adverse Camber and Transitions	2880	2040	1440	1020	720	510	5
Minimum R* with Superelevation of 2.5%	2040	1440	1020	720	510	360	7.07
Minimum R with Superelevation of 3.5%	1440	1020	720	510	360	255*	10
Desirable Minimum R with Superelevation of 5%	1020	720	510	360**	255**	180*	14.14
One Step below Desirable Min R with Superelevation of 7%	720	510	360	255**	180**	127*	20
Two Steps below Desirable Min R with Superelevation of 7%	510	360	255	180**	127**	90*	28.28
Three Steps below Desirable Min R with Superelevation of 7%			180	127**	90**	65*	40
Four Steps below Desirable Min R with Superelevation of 7%			127	90**	65**	44*	56.56
VERTICAL CURVATURE – CREST							
Desirable Minimum Crest K Value	182	100	55	30	17	10	
One Step below Desirable Min Crest K Value	100	55	30	17	10	6.5	
Two Steps below Desirable Min Crest K Value	55	30	17	10	6.5	6.5	
VERTICAL CURVATURE – SAG							
Desirable Minimum Sag K Value	53	37	26	20	13	9	
One Step below Desirable Min Sag K Value	37	26	20	13	9	6.5	
Two Steps below Desirable Min Sag K Value	26	20	13	9	6.5	6.5	
*** Absolute Minimum Vertical Curve Length to be used on Dual Carriageways	240	200	-	-	-	-	
OVERTAKING SIGHT DISTANCES							
Full Overtaking Sight Distance FOSD m.	N/A	580	490	410	345	290	
FOSD Overtaking Crest K Value	N/A	400	285	200	142	100	

The Desirable Minimum SSD length shall be as per Table 1/3 of NRA TD 9 for the particular Design Speed.

Sinuosity



Nearly Straight sections shall be as per Figure 7/6 of NRA TD 9.

Sinuosity

Sinuosity is divided into three sinuosity rankings as follows:

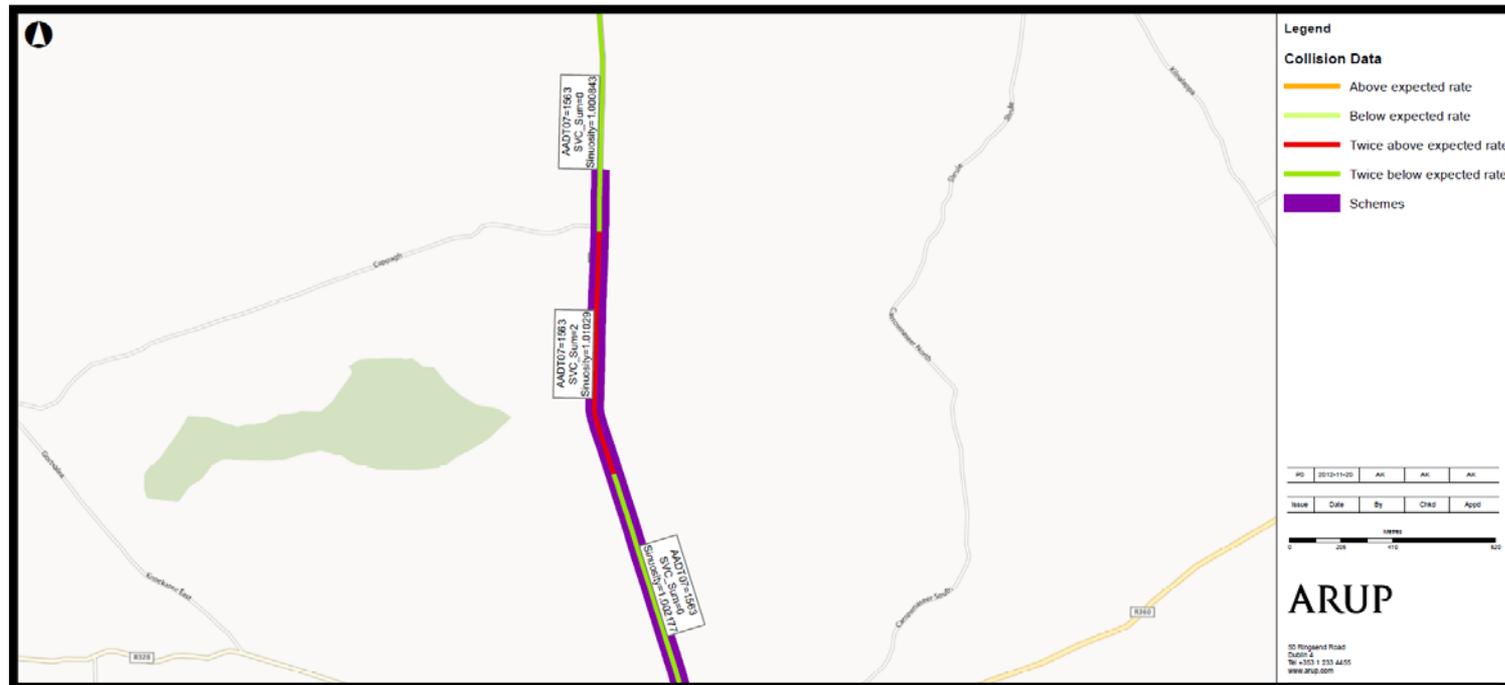
- High (H) - Sinuosity Index > 1.02 ;
- Medium (M) - $1.004 \leq$ Sinuosity Index ≤ 1.02 ;
- Low (L) - Sinuosity Index < 1.004

The Designer shall **record** the calculated Sinuosity Index and the Sinuosity Ranking in the **risk assessment sheet**.



Collision Rate Thresholds as per NRA HD 15

Collision Rate Threshold Data can be requested from the NRA by the Designer at infosafety@NRA.ie



Collision Rate Ranking

The Designer shall assign a Collision Rate Ranking to the Collision Rate Threshold for the section of road and **record** it in the risk assessment sheet:

- High (H) - Twice Above Expected Collision Rate;
- Medium (M) - Above Expected Collision Rate;
- Low (L) - Below Expected Collision Rate and Twice Below Expected Collision Rate.

Risk of a Vehicle Leaving the Road

Risk of a Vehicle Leaving the Road	Collision Rate Ranking		
Sinuosity Ranking	H	M	L
H	H	H	M
M	H	M	L
L	M	L	L

** Where H=High, M=Medium, L=Low*

Overall Risk Rating

Overall Risk Rating	Hazard Ranking		
Risk of a vehicle leaving the road	H	M	L
H	H	H	M
M	H	M	L
L	M	L	L

** Where H=High, M=Medium, L=Low*

Overall Risk Rating

For each hazard location a determination shall be made as follows:

Overall risk rating - High

- Safety barrier shall be installed or the hazard shall be mitigated.

Overall Risk Rating

Overall risk rating - Medium

- Safety barrier shall be installed or the hazard shall be mitigated if within 2m of carriageway edge.
- If the hazard is $\geq 2\text{m}$ from the carriageway edge the Designer shall assess the hazard level and the risk of a vehicle leaving the road **on site** and determine if a safety barrier is required.

Overall Risk Rating

Overall risk rating - Low

- A safety barrier is not required.

Each determination shall be **recorded** in the risk assessment sheet along with the **reason for providing or not providing the safety barrier.**

Site Survey

A site survey shall be carried out by the Designer as part of the risk assessment procedure to confirm the need or otherwise for a safety barrier at all locations.



TA85 Update - Safety Barriers

- The Design Organisation shall follow the risk assessment procedure outlined in Chap 8 of NRA TD 19 and include the risk assessment sheet in the Preliminary Design Report.
- The Design Organisation shall review the operational characteristics of any existing safety barriers for compliance with NRA TD 19 and replace those which do not satisfy the requirements of the standard.



Checklist - Preconstruction

- Specify barrier in accordance with NRA TD 19?
 - This includes Containment (N2, H2 or H4a for rail)
 - Impact Severity (A or B, now also C)
 - Working Width (Is there anything within the working width, including passively safe products)
 - Set-back (How far the barrier should be from the road)

Construction Checklist



Construction Checklist

Clause 401.2: The person responsible for the design shall ensure:

- (i) comply with this Series, Appendices 4/1, 4/3 and 4/7 and the requirements of standards NRA TD19 and NRA BD52 (as appropriate);
- (ii) are certified in accordance with IS EN 1317-5 to conform to the parameters of containment level, impact severity level and working width identified in Appendices 4/1 and 4/7; and
- (iii) are installed in accordance with the manufacturers' installation manual, attached to the relevant CE Certificate.



Construction Checklist

- Is the barrier CE marked to EN 1317
- Has it been installed in accordance with the **test report (Installation Manual)**?

Ask for it!!!

Construction Checklist

- Has the barrier been modified?
- Have the Ground Conditions been certified by an **independent Chartered Engineer**?

Terminals

➤ Compatibility

- Can the terminal function adequately in combination with the type of safety barrier it is attached to.
- Contractor must check with the Safety Barrier manufacturer(s) and ensure that the proposed Safety Barrier and Terminal will act together and meet the Performance criteria.

Finally: Please check that it has been installed properly!!!







Safety Barrier Site Info

THANK YOU

ANY QUESTIONS??

*National Roads Authority - Standards Section
Training for New Developments
April 2013*

ARUP