

Guidance for Designers when Specifying Safety Barrier End Terminals

June 2020

Introduction

This technical bulletin has been prepared to provide guidance for Designers when specifying safety barrier end terminals on National Road projects in accordance with DN-REQ-03034 The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges and CC-SPW-00400 Specification for Road Restraints Systems (Vehicle and Pedestrian). The guidance is provided in two distinct parts:

- Guidance for Specifying Exit Box Class Requirements for Safety Barrier End Terminals.
- Guidance for Specifying T80 Safety Barrier End Terminals.

Guidance for Specifying Exit Box Class Requirements for Safety Barrier End Terminals

This section of GE-TBU-01041 provides guidance for Designers when specifying the Exit Box Class requirements for safety barrier end terminals on National Road projects. It specifically addresses the fact that all terminals included on the TII [Compliant Terminal Systems List](#) are appropriate in the majority of scenarios on National Roads and as such, Designers should not specify Exit Box Class Z1 as a default value, thereby unnecessarily excluding products which are not Z1 classification. It also explains the updated details to be specified by Designers in relation to the Exit Box Class of terminals within Appendix 4/3 of Contract specific Works Requirements as per the June 2020 publication of CC-GSW-00400 Notes for Guidance to the Specification for Road Restraint Systems (Vehicle and Pedestrian) sample Appendix 4/3.

Safety barrier end terminals are an important and integral safety component of Vehicle Restraint Systems (VRS). When specifying terminals, Designers are required to include the required Exit Box Class value of a terminal referred to as the ‘Z-Class’ in accordance with Section 5.7 of DN-REQ-03034 and include this requirement within Appendix 4/3. In simple terms, the Exit Box Class is a measure of the post impact trajectory of the test vehicle either **in front** of or **behind** the terminal. It is determined during the initial type testing of the terminal, relative to a theoretical exit box measured around the terminal. Six separate impact or crash tests are required to certify a terminal under prEN 1317-7:2014, each with a different impact point and/ or approach angle. The declared Z-Class of a terminal is the worst-case exit box measurement across the 6 tests. There are two separate components of the Z-Class as defined below:

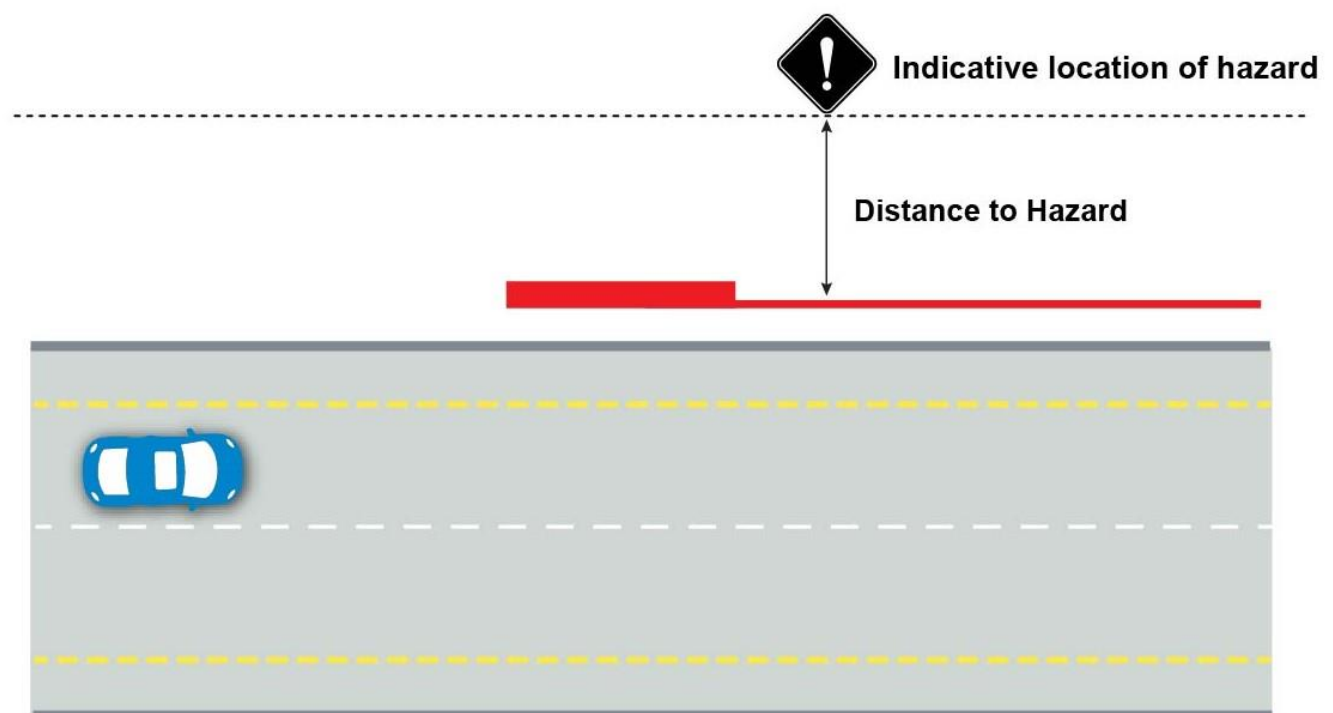
- **Za** (as defined within DN-REQ-03034, Figures 5.5 and 5.6 and Table 5.5) is the maximum vehicle redirection **in front** of the original front face line of the connecting safety barrier.
- **Zd** (as defined within DN-REQ-03034, Figure 5.6 and Table 5.5) is the maximum vehicle redirection **behind** the original front face line of the connecting safety barrier.

The importance of the maximum vehicle redirection in front of the barrier (Za) or behind the barrier (Zd) for each of the six impact tests on the terminal during the Initial Type Testing will vary for different situations on National Roads. As such, **TII now requires Designers to specify both Za and Zd requirements for terminals within Appendix 4/3.**

The values for Z_a and Z_d for all terminals assessed as compliant under DN-REQ-03080 TII Terminal Assessment Procedure are available on the products Assessment Summary Sheet as linked from the TII [Compliant Terminal Systems List](#) and Designers should be cognisant of these when specifying both Z_a and Z_d .

Requirements for Z_d

As per DN-REQ-03034, Section 3.16, the length of the terminal is not to be included in the Length of Need of the safety barrier. The sole purpose of the end terminal is therefore to protect a vehicle from penetrating the end of the safety barrier. As such, the Z_d value, or the maximum vehicle redirection behind the line of the connecting safety barrier, is not relevant and the most appropriate Z_d value to specify for terminals is “ Z_{d3} ” with Z_{d3} being “no limit” as defined in Table 5.5 of DN-REQ-03034. The Z_d value specified by the designer is the minimum value acceptable at the location i.e. products with a declared Z_d value of Z_{d1} , Z_{d2} or Z_{d3} are permitted where Z_{d3} is specified. In scenarios where the full Length of Need of a safety barrier cannot be achieved due to site specific constraints (e.g. a field access on an online improvement project), and the terminal itself is providing protection to the hazard, a Departure from Standards is required, see **Figure 1**. In these scenarios, the Z_d value of the terminal product chosen shall be less than the distance to the Hazard. Terminals with a Z_{d3} classification are not permitted in such scenarios as the maximum vehicle redirection behind the line of the connecting safety barrier for such terminals has “no limit” as defined in Table 5.5 of DN-REQ-03034.



Z_d value of the terminal to be less than the Distance to the Hazard in constrained locations where the terminal forms part of the length of need and is protecting the hazard.

Figure 1 - Z_d Value of Terminal where Terminal forms part of the Length of Need

Requirements for Za

The Za value specified by the Designer, or the maximum vehicle redirection in front of the line of the connecting safety barrier, shall look to minimise the risk of an errant vehicle encroaching beyond the first traffic lane adjacent to the safety barrier for single carriageway roads. For dual carriageway roads with a central median, the Za value specified by the Designer shall look to minimise the risk of an errant vehicle encroaching beyond the hard strip of the opposite carriageway.

Single Carriageway Roads

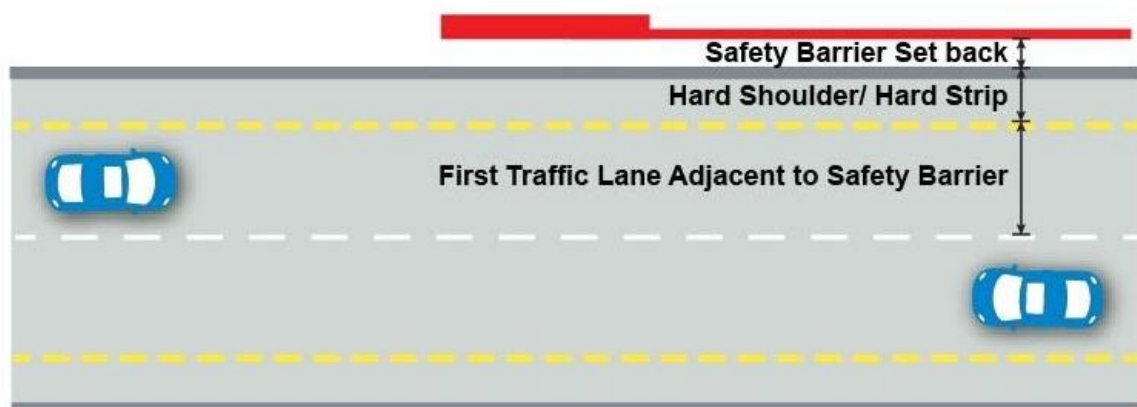
The Za value to be specified by the Designer shall consider the specific conditions where the terminal is to be installed i.e. the available space in front of the line of the safety barrier before an errant vehicle rebounding off the terminal, in the event of a collision, will encroach beyond the first traffic lane adjacent to the terminal for a single carriageway road. This available space will be made up of the following elements:

- Set back to the safety barrier i.e. the distance from the front face of the safety barrier to the edge of the pavement and
- Hard shoulder/ hard strip width and
- Width of the adjacent running lane for single carriageways.

The available Za classifications for terminals included within DN-REQ-03034 are listed below.

- $Za_1 = 4\text{m}$.
- $Za_2 = 6\text{m}$.

The Za classification chosen shall be less than the total combined value of the setback, hard strip/ hard shoulder and adjacent running lane as per **Figure 2**.



Za value of the terminal to be less than the combined width of the set back to the terminal, hard shoulder/ hard strip and first traffic lane adjacent to the safety barrier

Figure 2 - Za Value of Terminal for Single Carriageways

Dual Carriageway Roads

For dual carriageway roads, the available space in front of the line of the safety barrier before an errant vehicle rebounding off the terminal, in the event of a collision, will encroach beyond the hard strip of the opposite carriageway will always be greater than the maximum permitted Z_a value within Table 5.5 of DN-REQ-03034 i.e. Z_{a2} i.e. the total combined value of the setback, hard strip/hard shoulder, running lanes and central reserve will always be greater than 6m. In any case, central median barriers are mandatory for all National Road dual carriageways which should negate the risk of a vehicle crossing into the opposing carriageway. As such, the most appropriate Z_a value to specify for terminals on dual carriageways is “ Z_{a2} ”. The Z_a value specified by the designer is the minimum value acceptable at the location i.e. products with a declared Z_a value of Z_{a1} or Z_{a2} are permitted where Z_{a2} is specified.

Summary

In summary, Designers are now required to specify both the Z_a and Z_d class for safety barrier end terminals within Appendix 4/3 of Contract specific Works Requirements as per the June 2020 publication of CC-GSW-00400. The Z_a and Z_d values specified should be chosen to suit the available space at the specific location in line with the guidance within DN-REQ-03034 and this technical bulletin and should not default to specifying Z_{a1} and Z_{d1} for all scenarios. The exact Z_a and Z_d values for all terminals assessed as compliant under DN-REQ-03080 are available on the products Assessment Summary Sheet as linked from the TII [Compliant Terminal Systems List](#).

Table 1 presents example Z_a and Z_d values for different scenarios for guidance.

Table 1 - Sample Z_a and Z_d values for different scenarios

Scenario	Appropriate Z Class	Comment
New build dual carriageway with compliant safety barrier design.	Z_{a2}/ Z_{d3}	Terminals of class Z_{a1} , Z_{a2} / Z_{d1} , Z_{d2} , Z_{d3} are all permitted.
Type 1 single carriageway, full approach length provided.	Z_{a2}/ Z_{d3}^*	Terminals of class Z_{a1} , Z_{a2} / Z_{d1} , Z_{d2} , Z_{d3} are all permitted.
Online improvement project on a Type 3 single carriageway with 0.5m hard strip and set back to terminal 1.2m. Full approach length not achievable due to field access i.e. terminal forms part of length of need and is protecting the hazard.	Z_{a1}/ Z_{d1}^{**}	Departure from standards required for safety barrier design due to terminal forming part of the length of need.

* The Z_a value is based upon the total available space in front of the line of the connecting safety barrier before an errant vehicle will encroach beyond the first adjacent traffic lane i.e. combined value of the set back (0.6m), hard shoulder (2.5m) and first adjacent trafficked lane (3.5m) i.e. 6.6m available space which is greater than the Z_{a2} value of 6m.

**The Z_a value is based upon the total available space in front of the line of the connecting safety barrier before an errant vehicle will encroach beyond the first adjacent traffic lane i.e. combined value of the set back (1.2m), hard strip (0.5m) and first adjacent trafficked lane (3.5m) i.e. 5.2m available space which is less than the Z_{a2} value of 6m but greater than the Z_{a1} value of 4m hence Z_{a1} is appropriate. Z_{d1} value specified as terminal is protecting the hazard.

Guidance to Designers for Specifying T80 Safety Barrier End Terminals

As per DN-REQ-03034, all upstream terminals on National Roads shall comply with the requirements of I.S. ENV 1317-4 and prEN 1317-7. This includes T80 terminals which, under Table 5.1 of DN-REQ-03034, are permitted for use in various scenarios on National Roads where the design/ operational speed is <85km/h. Designers should be aware that at the date of publication of this technical bulletin, there are no T80 terminals included on the TII [Compliant Terminal Systems List](#). It is expected that T80 terminals will be added to the list in future but until such time as this is the case, Designers should specify T110 terminals in scenarios where they would have otherwise specified T80 terminals based on the speed of the road. Designers should periodically check the TII [Compliant Terminal Systems List](#) for the inclusion of T80 terminals that comply with the requirements of I.S. ENV 1317-4 and prEN 1317-7.

TII Authorisation and Contact Details

This document has been authorised by the Director of Professional Services, Transport Infrastructure Ireland. For any further guidance on the TII Publications system, please contact the following:

Contact: Standards and Research Section, Transport Infrastructure Ireland
Postal Address: Parkgate Business Centre, Parkgate Street, Dublin 8, D08 DK10
Telephone: +353 1 646 3600
Email: infoPUBS@tii.ie