



AHEAD OF THE CURVE™

End Terminals

Presented by Phil Bigley



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Barriers are an important safety feature on our roads...



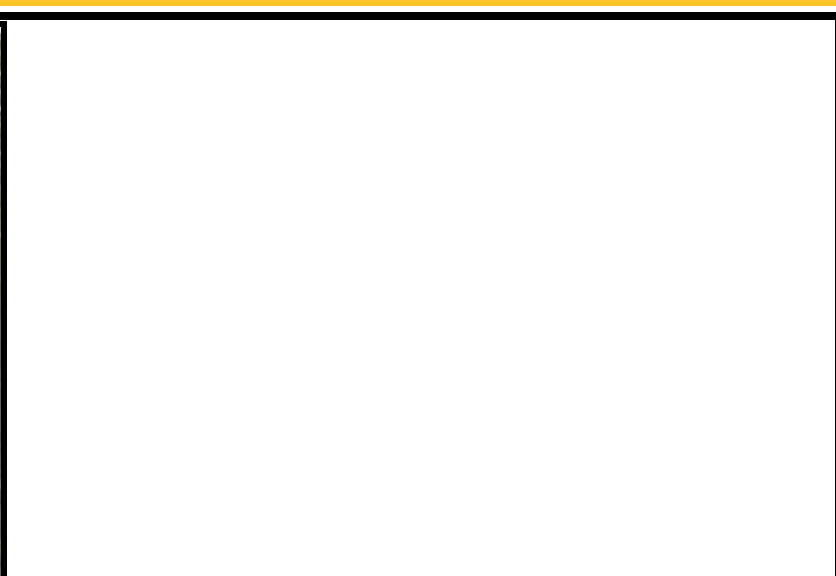


But one part of the barrier can still create a potentially lethal hazard:

the barrier end









100 km/h impact





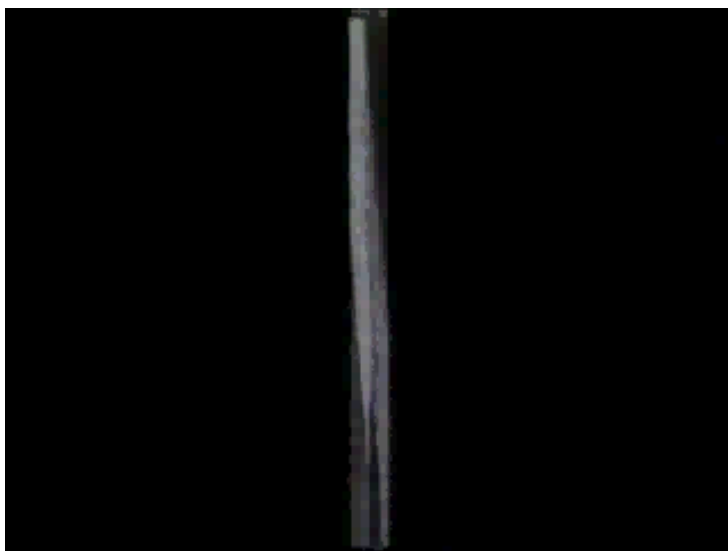
'TURNED DOWN ENDS'

This is one way to terminate a barrier and is still widely used because of the relatively low cost involved.

However, these can be very dangerous as they can act as a ramp for an impacting vehicle and restricted use of turned down ends is becoming more common within EU countries.



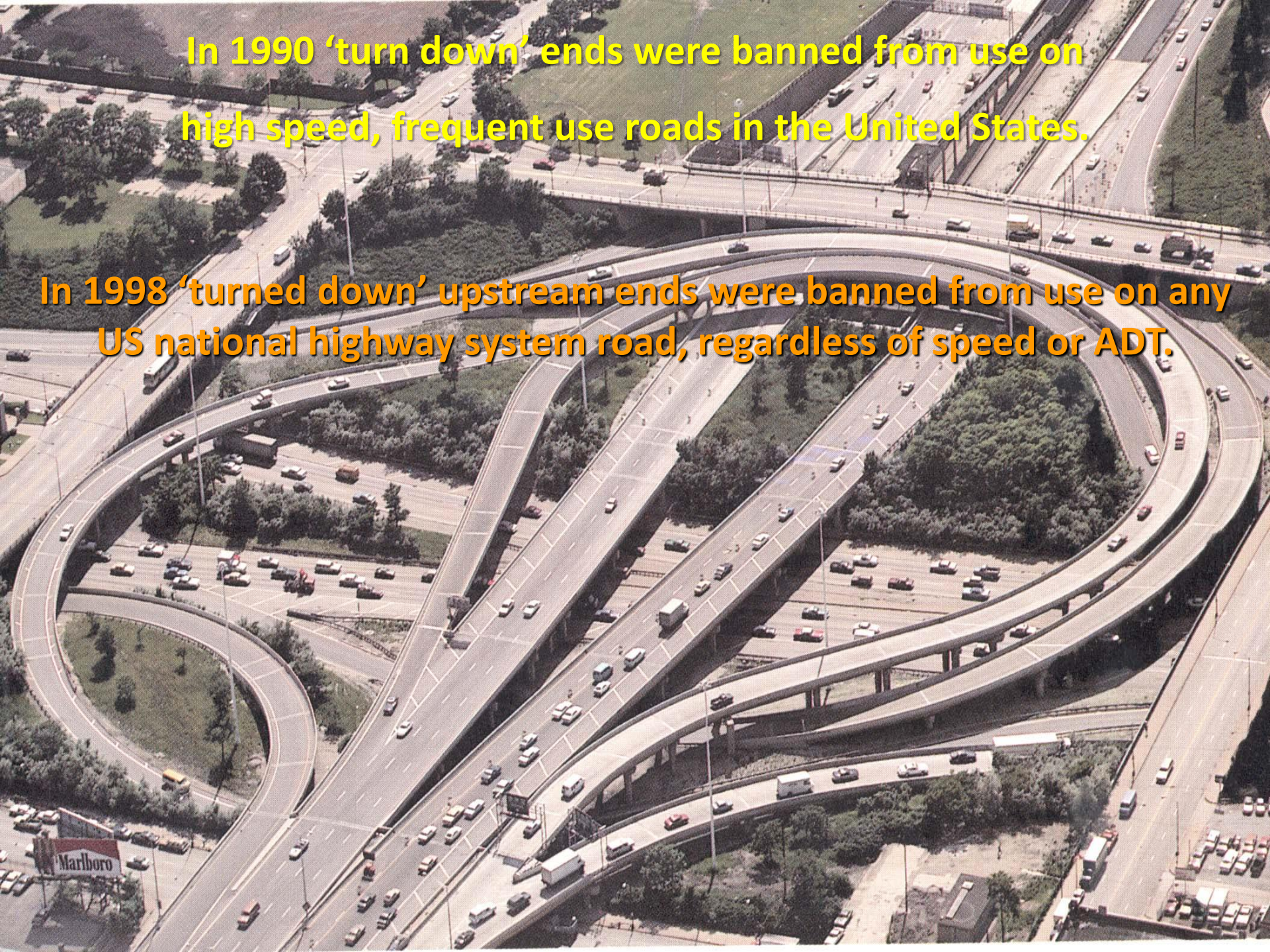




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In 1990 'turn down' ends were banned from use on high speed, frequent use roads in the United States.

In 1998 'turned down' upstream ends were banned from use on any US national highway system road, regardless of speed or ADT.



THE SAFEST SOLUTION?

Shield the end of the barrier with a crash-friendly terminal



UK legislation for Terminals IRRRS Chapter 8

8. CONTAINMENT PERFORMANCE CLASS REQUIREMENTS AND GUIDANCE ON TERMINALS AND TRANSITIONS BETWEEN DIFFERENT TYPES OF SAFETY BARRIER & VEHICLE PARAPETS

Terminals

8.1 All terminals must comply with the requirements of DD ENV 1317-4 "Road Restraint Systems – Performance Classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers" and the following specific requirements.

8.2 Terminals must be provided at the ends of safety barriers unless the Overseeing Organisation agrees to their omission. Terminals must be able to resist the forces that may be applied by the safety barriers to which they are connected.

On roads with a speed limit not greater than 50 mph

8.3 Terminals must have a minimum Performance Class of P1. The Impact Severity Level (ISL) must not exceed Class B in Table 5 of DD ENV 1317-4.

On roads with a speed limit greater than 50 mph

8.4 Terminals in the verge, and where possible in the central reserve, that face oncoming traffic must have a minimum Performance Class of P4. Terminals on the departure end of safety barriers on dual carriageway roads must have a minimum Performance Class of P1. The Impact Severity Level (ISL) must not exceed Class B in Table 5 of DD ENV 1317-4.

Permanent Lateral Displacement Zones

8.5 The Permanent Lateral Displacement Zone Class must be selected to ensure that there is adequate clearance to any obstruction or an area used by NMUs. In some situations this may preclude the use of certain terminals.

8.6 The performance or mode of operation of some types of terminal may make them unsuitable for use in the central reserve, where space is limited, or on the elevated approaches to bridges and other structures.

Safety Barriers

8.7 The safety barrier layout must be carefully planned to minimise the number of approach ends of barriers. In some cases, where space is severely limited, it may be necessary to use a lower class of end terminal than specified above; this must be agreed with the Overseeing Organisation and will require a Departure from Standard.

8.8 If possible, where there is a rigid end terminal, the approach end of the safety barrier and terminal should be flared away from the carriageway by setting back the terminal section.

Transitions

8.9 All transitions must comply with the requirements of DD ENV 1317-4 "Road Restraint Systems – Performance Classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers" and the following specific requirements.

8.10 A transition must be provided at all changes of type and/or Containment Performance Class of Vehicle Restraint Systems. The Working Width of the transition must not exceed the maximum Working Width of either system that it connects.

8.11 A transition must be provided at all changes in Containment Performance Class of Vehicle Restraint Systems so as to give:

- i) A progressive increase in strength and stiffness from the lower to the higher Containment Performance Class.
- ii) A lower Containment Performance Class that is not less than the weaker Vehicle Restraint System to which it is connected.

On roads with a speed limit greater than 50 mph

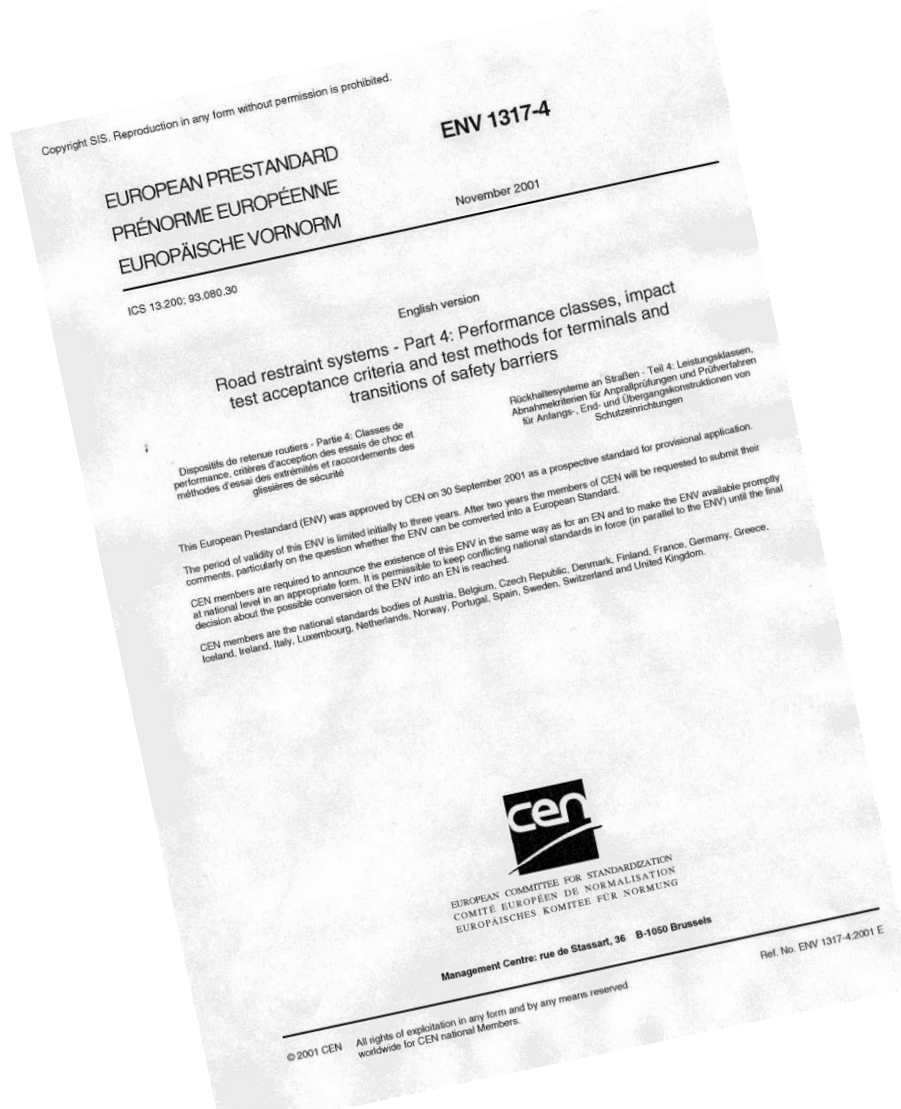
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Permanent Lateral Displacement Zones

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So what is a P4 terminal?

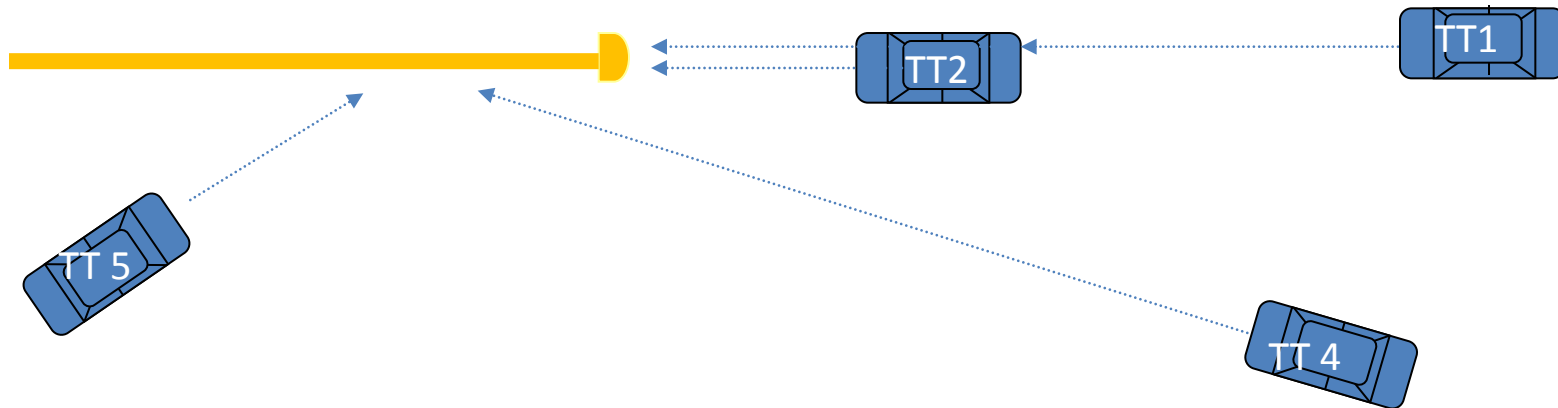
We need to take a look at the legislation to see how a terminal qualifies as a P4



Current European legislation for terminals:

ENV 1317-4

APPROACH – CODE NUMBERS FOR TESTS



- | | |
|-----|--|
| TT1 | Head-on centre |
| TT2 | Head-on $\frac{1}{4}$ vehicle width offset |
| TT4 | Side impact at 15° |
| TT5 | Side impact at 165° |

IMPACT SPEED – 3 OPTIONS

- 80 km/h
- 100 km/h
- 110 km/h

CODE NUMBERS FOR TEST VEHICLE MASS



(1) 900 kg vehicle



(2) 1300 kg vehicle



(3) 1500 kg vehicle

4 tests are required to meet the highest level (P4) ENV 1317- 4 criteria

Performance class	Location		Tests				
			Approach	Approach reference	Vehicle Mass (kg)	Velocity (km/h)	Test Code ¹⁾
P1	A		head-on nose 1/4 offset to roadside	2	900	80	TT 2.1.80
P2	A	U	head-on nose 1/4 offset to roadside	2	900	80	TT 2.1.80
			side, 15° 2/3 L	4	1 300	80	TT 4.2.80
		D	side, 165° 1/2 L	5	900	80	TT 5.1.80
P3	A	U	head-on nose 1/4 offset to roadside	2	900	100	TT 2.1.100
			head-on centre	1	1 300	100	TT 1.2.100
			side, 15° 2/3 L	4	1 300	100	TT 4.2.100
		D	side, 165° 1/2 L	5	900	100	TT 5.1.100
P4	A	U	head-on nose 1/4 offset to roadside	2	900	100	TT 2.1.100
			head-on centre	1	1 500	110	TT 1.3.110
			side, 15° 2/3 L	4	1 500	110	TT 4.3.110
		D	side, 165° 1/2 L	5	900	100	TT 5.1.100

Table 5 – Terminals: Vehicle Impact Severity Classes

Impact severity classes	Index values		
A	ASI ≤ 1,0	THIV < 44 km/h in tests 1 and 2 THIV < 33 km/h in tests 4 and 5	PHD ≤ 20 g
B	ASI ≤ 1,4	THIV < 44 km/h in tests 1 and 2 THIV < 33 km/h in tests 4 and 5	PHD ≤ 20 g
<p>NOTE 1 Impact severity class A affords a greater level of safety for the occupants of an errant vehicle than class B and is preferred when other considerations are the same.</p> <p>NOTE 2 The limit value for THIV is higher in tests 1 and 2 because experience has shown that higher values can be tolerated by occupants in frontal impacts (also because of better passive safety in this direction). Such a difference in human tolerance between frontal and lateral impacts is already considered in the ASI parameter, which therefore does not need to be changed.</p>			

Other factors measured and recorded in EN1317 testing are:

- Redirection zone class (Z rating from Z1 to Z4)

Measures the level of post-impact trajectory of the vehicle

- Displacement class (Class D1 to D4)

Measures the amount of permanent lateral displacement of the terminal, after impact

Extract from UK Highways Agency List of EN1317 compliant terminals

Terminal Name	Performance Class	PLDZ Class	Exit Box Class/Vehicle Redirection Zone	Impact Severity Level	Name and Address of Promoter
Hill and Smith 'Safety Line' Wire Rope Safety Fence Terminal	P1	D.1.1	Z1	A	Hill and Smith Ltd. Springvale Avenue Bilston Wolverhampton WV 0QL Tel. 01902 499400 Fax: 01902 499419 email: steve@hill-smith.co.uk Web site: www.hill-smith.co.uk
Euro BXT Terminal	P4	D2.3	Z1	B	Hill and Smith Ltd. Springvale Avenue Bilston Wolverhampton WV14 0QL Tel. 01902 499400 Fax. 01902 499419 email: barrier@hill-smith.co.uk
TREND CEN End Terminal	P4	D.1.1	Z2	A	Hill and Smith Ltd. Springvale Avenue Bilston Wolverhampton WV14 0QL Tel. 01902 499400 Fax. 01902 499419 email: barrier@hill-smith.co.uk
TREND CEN DS Double Sided End Terminal	P4	D.1.1	Z2	B	Hill and Smith Ltd. Springvale Avenue Bilston Wolverhampton WV14 0QL Tel. 01902 499400 Fax. 01902 499419 email: barrier@hill-smith.co.uk
Sistema P4 Performance Terminal	P4	D1.2	Z1	B	Supplier: Jason Ferro FerroStrada (UK) Limited Hunters End Wattisfield Road Walsham-Le-Willows Bury St Edmunds Suffolk IP31 3BD Tel. 01359 258 806 Fax. 01359 258 181 email: admin@ferrostrada-uk.com

In Europe, countries that actively legislate and promote the use of P4 terminals include:

- **UK**
- **Sweden**
- **Norway**
- **Austria**
- **Italy**
- **Belgium**
- **Denmark**
- **Finland**
- **Estonia**



The benefits of taking a proactive approach to improving road safety is evident in the ERF European statistics

Trinity's Energy-absorbing terminals



TREND™ CEN



The TREND™ meets the most stringent of standards:

P4 (110 km/h)

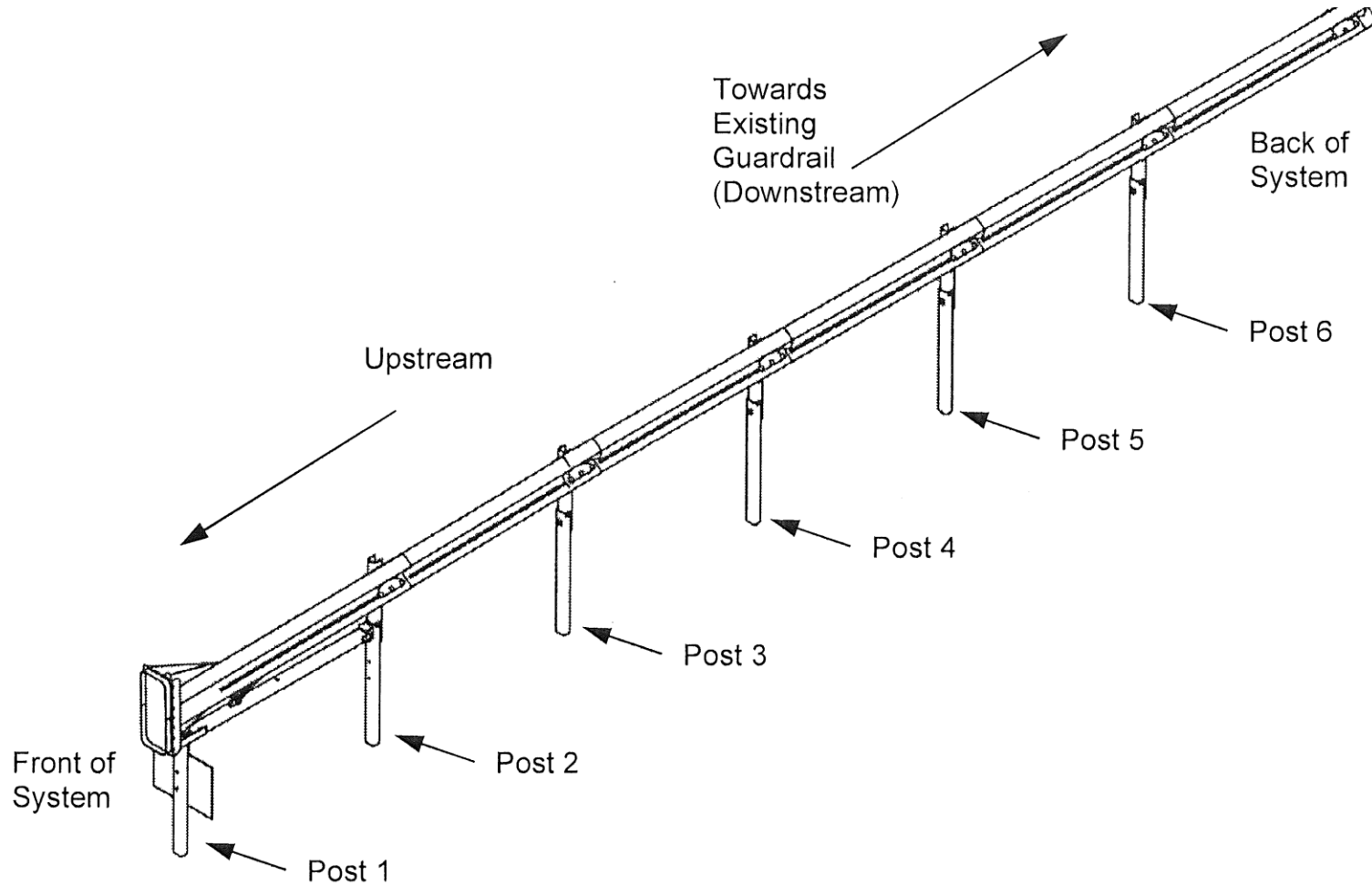
ASI: A

Displacement Class: D.1.1



TREND™ CEN

The TREND™ is a 6 post system (for 110 km/h)



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TREND™ CEN

Head On

Small debris field, within 1 metre of system, 0° head-on

Tension bolt releases the upper post

Rail deformation & friction between rails dissipate energy



* Note how the posts stay connected and the rail does not protrude onto roadway as other products do.

TREND™ CEN

Leaves a small, neat debris field after impact,
(within 1 metre of system in 0° head-on test)

TREND™ CEN after head-on test



TREND™ CEN

Models

110 km/h (P4) system

- 6 Posts
- Length 12.4m



80 km/h (P2) system

- 2 Posts
- Length 4.4m



TREND CEN DS

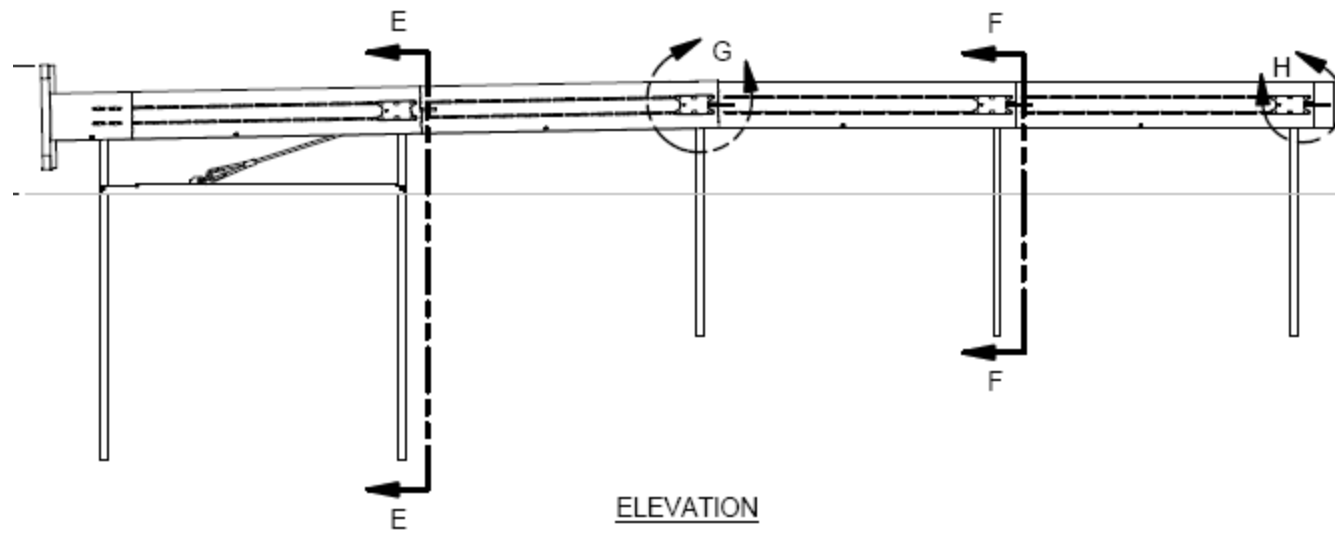
(double sided terminal)



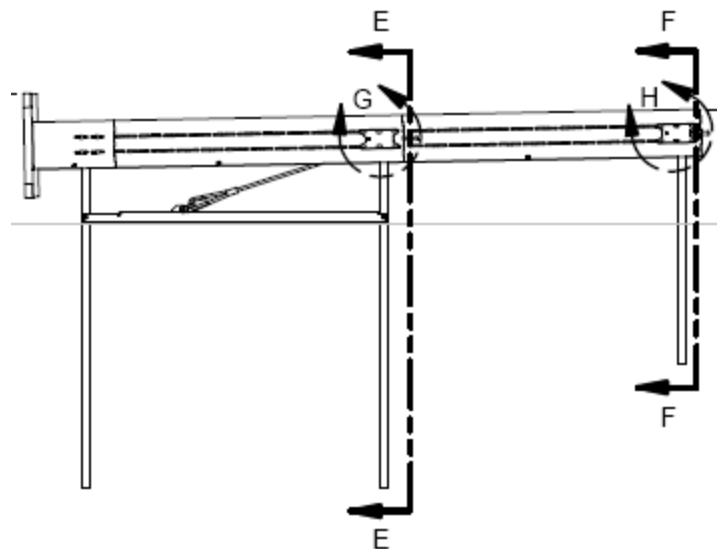
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110 km/h (P4) 5-post system
length 8.4m

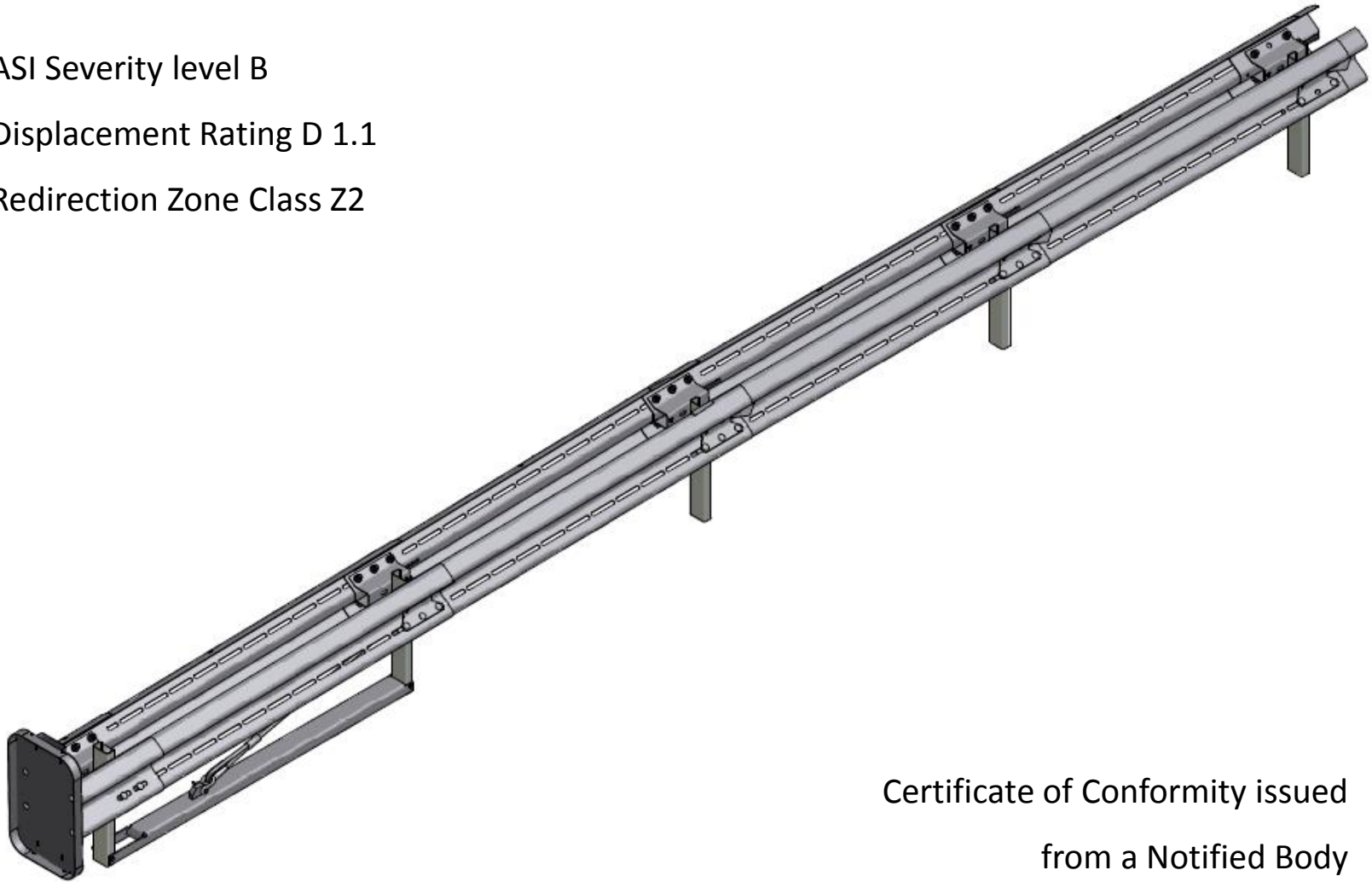


80 km/h (P2) 3-post system
length 4.4m

ASI Severity level B

Displacement Rating D 1.1

Redirection Zone Class Z2



Certificate of Conformity issued
from a Notified Body



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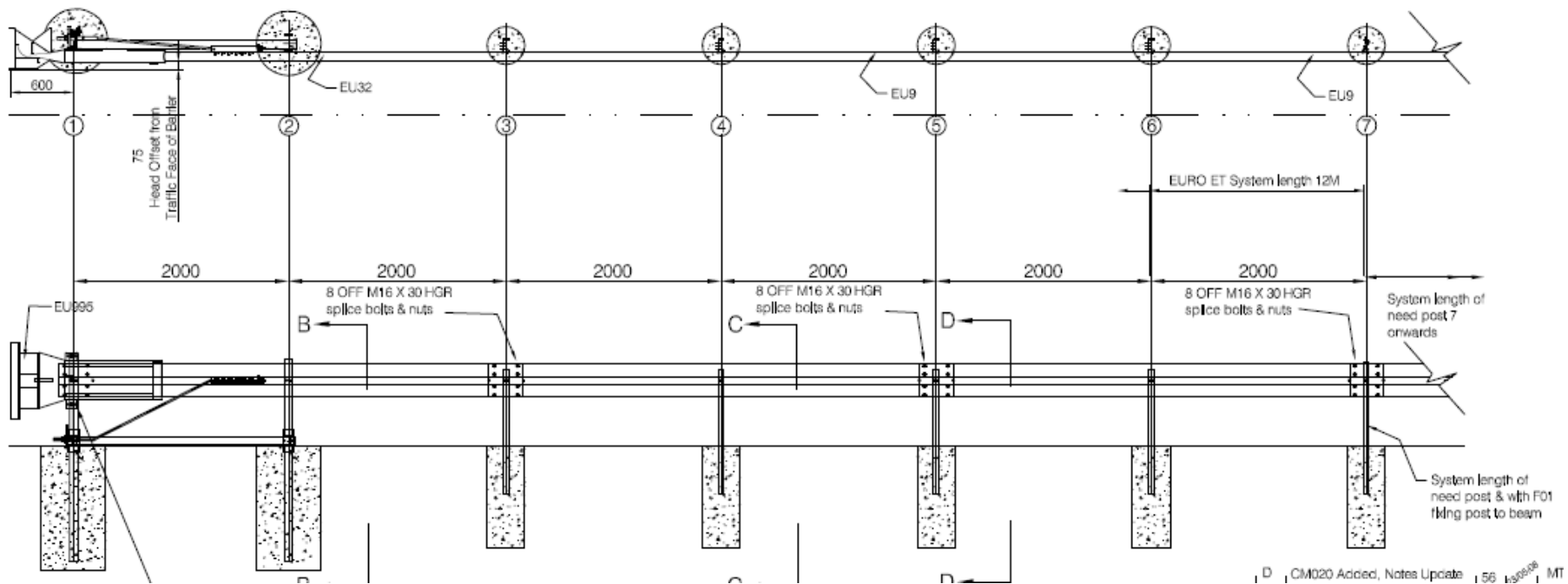
EURO-ET™ Guardrail End Treatment



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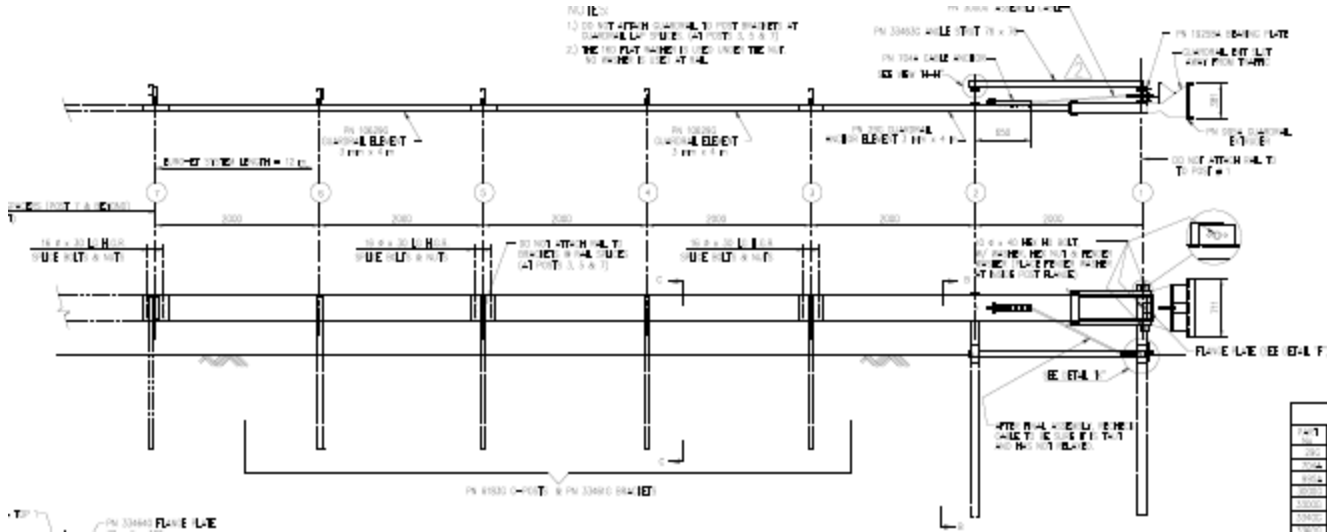






D CM20 Added, Notes Update, 56 12/2019 MT

- NOTES:
- DO NOT ATTEMPT TO REMOVE BEAM AT DRIVEWAY TO BE ERECTED IN PLACE
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NO.	DESCRIPTION
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Any questions?



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