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**VOLUME 8    TRAFFIC SIGNS AND  
LIGHTING**  
**SECTION 4    TRAFFIC MANAGEMENT  
AT ROADWORKS**

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**PART 7**

**TD 49/07**

**REQUIREMENTS FOR LORRY  
MOUNTED CRASH CUSHIONS**

**SUMMARY**

This Standard describes the procedures to be followed by the various parties involved in the testing and performance evaluation of Lorry Mounted Crash Cushions.

**INSTRUCTIONS FOR USE**

1. Remove Contents pages from Volume 8 and insert new Contents pages for Volume 8 dated November 2007.
2. Remove the following documents from Volume 8 which are superseded by this Standard and archive as appropriate:  
  
TD 49/03, Volume 8, Section 4.
3. Insert TD 49/07 into Volume 8, Section 4, Part 7.
4. Please archive this sheet as appropriate.

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



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**THE DEPARTMENT FOR REGIONAL DEVELOPMENT  
NORTHERN IRELAND**

# Requirements for Lorry Mounted Crash Cushions

**Summary:** This Standard describes the procedures to be followed by the various parties involved in the testing and performance evaluation of Lorry Mounted Crash Cushions.

**REGISTRATION OF AMENDMENTS**

Amend No	Page No	Signature & Date of incorporation of amendments	Amend No	Page No	Signature & Date of incorporation of amendments

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# 1. INTRODUCTION

## Background

1.1 This Standard is a performance-based specification and provides the requirements for lorry-mounted crash cushions (LMCCs) for use in the UK, as referred to in the Traffic Signs Manual, Chapter 8: Section O5.4.1.

## Use of the Standard

1.2 This Standard has been prepared for use by appropriately qualified and experienced professional staff (as required by **HD 46** Quality Management Systems for Designers [**DMRB 5.2.1**]). It is not a statutory or regulatory document, nor a training manual; neither does it cover every point in exhaustive detail. The mandatory requirements given in the Standard must be adhered to for all Trunk Roads (and in Northern Ireland those roads designated by the Overseeing Organisation) with a mandatory speed limit of 50 mph or more, unless a Departure from Standard is approved.

## Scope

1.3 TD 49/07, together with the Traffic Signs Manual, Chapter 8, replaces TD 49/03.

## Mandatory Sections

1.4 Mandatory sections of this document are contained in boxes. Testing must comply with mandatory sections. The remainder of the document contains advice, explanation and guidance, which should be considered.

## General

1.5 All testing procedures must be as defined in the latest version of the NCHRP's Truck Mounted Attenuator (TMA) testing programme (currently NCHRP 350) unless alternative requirements are detailed within this Standard.

## Quality Management

1.6 Companies engaged in Mobile Lane Closure temporary traffic management operations are required to comply with a quality management system which meets the requirements of National Highways Sector Scheme documents; Scheme 12C listed in Appendix A of the Specification for Highway Works (SHW) relates to the Mobile Lane Closure technique.

1.7 In general National Highways Sector Scheme 12C defines the requirements for BS EN ISO 9001 but especially in respect of: (a) the training and competency qualifications of Mobile Lane Closure personnel; (b) quality planning requirements; and (c) the competency of UKAS accredited certification body assessors.

1.8 Not currently applicable in Northern Ireland.

## Mutual Recognition

1.9 The construction and maintenance of highways will normally be carried out under contracts incorporating the Overseeing Organisations' Specification for Highway Works (SHW) which are contained in the Manual of Contract Documents for Highway Works Volume 1 (MCHW 1). In such cases products conforming to equivalent standards and specification of other Member States (MS) of the European Economic Area (EEA) or a State which is party to a relevant agreement with the European Union and tests undertaken in other MS of the EEA or a State which is party to a relevant agreement with the European Union will be acceptable in accordance with the terms of Clauses 104 and 105 (MCHW 1.100). Any contract not containing these Clauses must contain suitable clauses of mutual recognition having the same effect, regarding which advice should be sought.

## Instructions for use

1.10 This Standard should be read in conjunction with the Traffic Signs Manual, Chapter 8, 'Traffic Safety Measures and Signs for Road Works and Temporary Situations'.

## Implementation

1.11 This Standard must be used forthwith for the testing and provision of LMCCs on the trunk road Network.

1.12 If the LMCC design is currently being used on the UK Highway, and is no longer being manufactured and/or promoted as a complete product, the LMCC requires no additional testing. This also applies to LMCCs tested to NCHRP 230.

1.13 If the LMCC design is currently being used on the UK Highway and is currently being manufactured and/or promoted as a complete product, an additional 1,500kg vehicle test must be successfully completed to the velocity class requirements of the LMCC. This testing must be conducted within twelve months of the date of publication of this Standard. No other retesting is required.

1.14 If the LMCC design is not currently being used on the UK Highway, it must be tested in accordance with this standard.

## Terminology and Definitions

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

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

**Test inertial mass** – The mass of the test vehicle and all items (including ballast and test equipment) rigidly attached to the vehicle structure. The mass of dummies, irrespective of the degree of restraint, is not included in the test inertial mass.

**Total test mass** – The mass of the test vehicle and all items (including ballast, dummies and test equipment).

**Durability** – The ability of a product to maintain its required performance over time, under the influence of foreseeable actions. Subject to normal maintenance, a product should enable properly designed and executed works to fulfil specified requirements for an economically reasonable working life of the product.

**Working life** – The period of time during which the performance of a product will be maintained at a level that enables the product to fulfil the requirements of this document (i.e. the essential characteristics of a product meet or exceed minimum acceptable values, without incurring major costs for repair or replacement). The working life of a product depends upon its inherent durability and normal maintenance

Note: A clear distinction should be made between the assumed economically reasonable working life for a product, which underlies the assessment of durability in technical specifications, and the actual working life of a product in a works. The latter depends on many factors beyond the control of the producer, such as design, location of use (exposure), installation, use and maintenance. The assumed working life can thus not be interpreted as being a guarantee given by the producer.

1.16 For the definitions of the general highway terms used in this Standard such as ‘Highway Types’ (e.g. Trunk Roads, motorway and all-purpose roads) see BS 6100: Section 2.4.1.

### Abbreviations

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

ASI	Acceleration Severity Index
C	Car
LMCC	Lorry Mounted Crash Cushion
NCHRP	National Cooperative Highway Research Programme
OIV	Occupant Impact Velocity
ORA	Occupant Ridedown Acceleration
THIV	Theoretical Head Impact Velocity
TL	Test Level
TL2	American NCHRP test level 2
TL3	American NCHRP test level 3
TL2.UK	United Kingdom test level 2
TL3.UK	United Kingdom test level 3
TMA	Truck Mounted Attenuator

## 2. TEST PARAMETERS

### Test Article

- 2.1 For TL2.UK and TL3.UK tests, the supporting vehicle must **not** be placed against a rigid barrier.
- 2.2 For all tests, the supporting vehicle must be placed on a clean, dry, paved surface.

2.3 Asphaltic or concrete surfaces are recommended. Conditions such as a polished surface or a bleeding asphalt surface that could lower available tyre-pavement friction should be avoided.

### Test Vehicles

2.4 For TL2.UK and TL3.UK tests, the supporting vehicle must be in **neutral** with the parking brake **on**. The supporting vehicle's engine must be **off** and the front wheels must have **no steering angle**, that is, they must not be turned to the left or to the right. The supporting vehicle must also be fitted with an automatic brake activation system in accordance with the Traffic Signs Manual, Chapter 8: Appendix 4.2. This system must be **on** during the test. The supporting vehicle must also have a minimum test inertial mass of 10,000kg, i.e.

Supporting vehicle					
Test Inertial Mass	Engine Brake	Parking Braking System	Automatic	Transmission Angle	Steering
Minimum of 10,000kg	Off	On	On	Neutral	None

**Table 2-1: Condition of Supporting Vehicle – UK Tests**

2.5 The test inertial mass is defined as ‘the mass of the test vehicle and all items (including ballast and test equipment) rigidly attached to the vehicle structure. The mass of dummies, irrespective of the degree of restraint, is not included in the test inertial mass’.

2.6 All impact vehicles must meet the requirements of BS EN 1317-1&2. The 900kg vehicle must include a dummy in accordance with BS EN 1317-1&2.

### Test Matrices

2.7 LMCCs intended for deployment in the UK, must be tested to the UK Specification Test Level 2 or 3 (TL2.UK or TL3.UK) (refer to Tables 2-2 and 2-3)

2.8 Alternatively, those tested to the National Cooperative Highway Research Programme (NCHRP) Test Level 2 (TL2) or Test Level 3 (TL3) are deemed acceptable if an additional test with a 1,500kg car has also been successfully completed (refer to Tables 2-4 and 2-5).

2.9 It is anticipated that the next revision of NCHRP 350 will require a head-on impact with a 1,500kg vehicle as part of the mandatory test series. Such a test is deemed to satisfy the requirements of the 2-51.UK and 3-51.UK tests in Tables 2-4 and 2-5.

The testing requirements, which must be adhered to, are tabulated below:

UK Velocity Class	Test Designation		Car		
			Total Test Mass (kg)	Impact Speed (km/h)	Approach angle and location of impact point, see Figure 2-1
80	TL2.UK	2-50.UK	900C	80	head-on, centre
		2-51.UK	1,500C	80	
		2-52.UK	1,500C	80	head-on, 1/3 vehicle offset
		2-53.UK	1,500C	80	nose 1/4 offset, at 10°

Note: C = car

Table 2-2: Test Matrix – TL2.UK

UK Velocity Class	Test Designation		Car		
			Total Test Mass (kg)	Impact Speed (km/h)	Approach angle and location of impact point, see Figure 2-1
110	TL3.UK	3-50.UK	900C	100	head-on, centre
		3-51.UK	1,500C	110	
		3-52.UK	1,500C	110	head-on, 1/3 vehicle offset
		3-53.UK	1,500C	110	nose 1/4 offset, at 10°

Note: C = car

Table 2-3: Test Matrix – TL3.UK

UK Velocity Class	Test Designation		Car		
			Total Test Mass (kg)	Impact Speed (km/h)	Approach angle and location of impact point, see Figure 2-1
80	Additional Test	2-51.UK	1,500C	80	head-on, centre
	TL2		All tests in NCHRP's current TMA test matrix (contained within NCHRP 350) must be completed. This includes any optional tests for which the test vehicle is defined as a 'pick up'. If the current TMA test matrix includes a 1,500kg vehicle test, the additional 2-51.UK test stated above is no longer required.		

Note: C = car

Table 2-4: Test Matrix – TL2 NCHRP (USA)

UK Velocity Class	Test Designation		Car		
			Total Test Mass (kg)	Impact Speed (km/h)	Approach angle and location of impact point, see Figure 2-1
110	Additional Test	3-51.UK	1,500C	110	head-on, centre
	TL3		All tests in NCHRP's current TMA test matrix (contained within NCHRP 350) must be completed. This includes any optional tests for which the test vehicle is defined as a 'pick up'. If the current TMA test matrix includes a 1,500kg vehicle test, the additional 3-51.UK test stated above is no longer required.		

Note: C = car

**Table 2-5: Test Matrix – TL3 NCHRP (USA)**

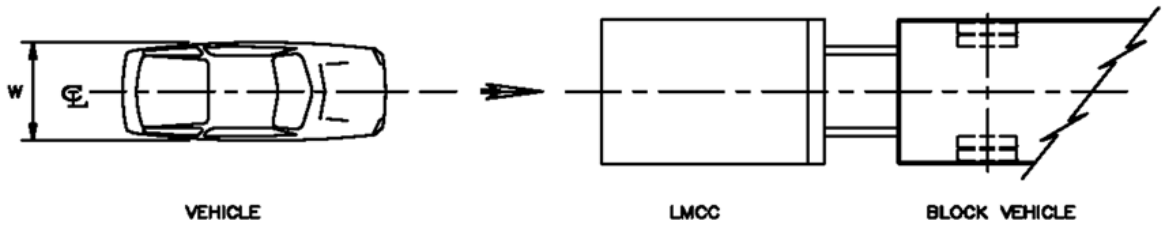


Figure 2-1(a). Head-on Centre Impact

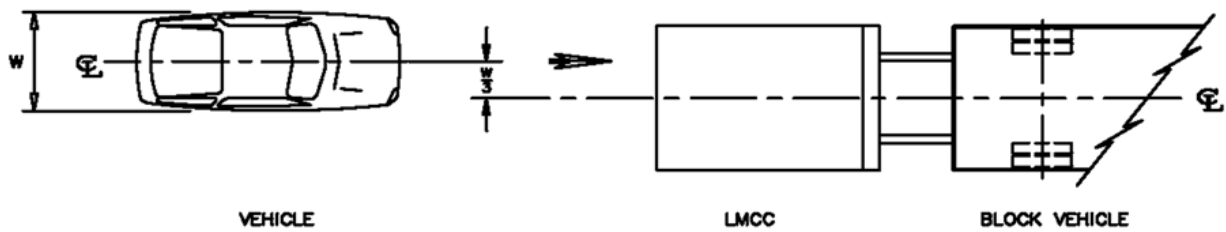


Figure 2-1(b). Head-on,  $\frac{1}{3}$  Vehicle Offset

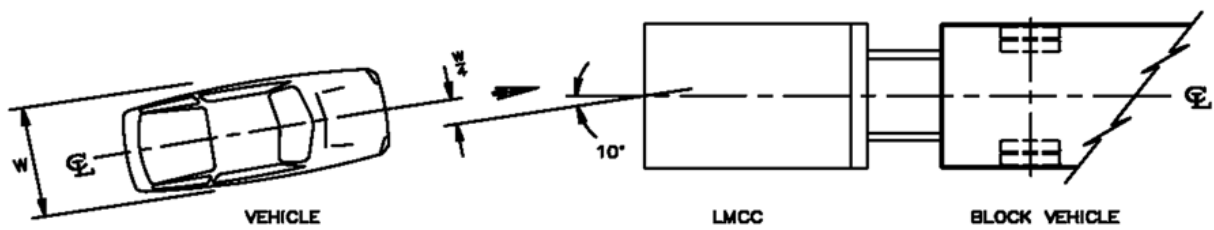


Figure 2-1(c). Nose  $\frac{1}{4}$  Offset, at  $10^\circ$

Figure 2-1: Vehicle Approach and Location of Impact

### 3. EVALUATION CRITERIA

3.1 LMCCs intended for deployment in the UK must meet the performance requirements described in Table 3-1, below.

Evaluation factors	Evaluation criteria
Structural adequacy	<p><b>1.</b> Acceptable LMCC performance may be by controlled penetration, or controlled stopping of the impact vehicle.</p>
Occupant risk	<p><b>2a.</b> Elements of the LMCC must not penetrate the passenger compartment of the impact vehicle.</p> <p><b>2b.</b> Deformations of, or intrusions into, the passenger compartment, that could cause serious injuries to the occupants, are not permitted.</p> <p><b>2c.</b> Elements of the LMCC having a solid mass greater than 2kg, must not become totally detached.</p> <p><b>2d.</b> The maximum width of the LMCC must be measured following the test and reported in the test report.</p> <p><b>2e.</b> Elements of the LMCC must not impede the path of adjacent traffic.</p> <p><b>3.</b> The impact vehicle must remain upright during and after collision. The maximum roll and pitch angles must not exceed 75 degrees.</p> <p><b>4. Severity Indices</b> Refer to Table 3-2 for further information and limiting values.</p>
Vehicle Trajectory	<p><b>5a.</b> After a head-on centre test, the vehicle’s trajectory must not intrude into adjacent traffic lanes.</p> <p><b>5b.</b> After a head-on 1/3 vehicle offset, or a nose 1/4 offset at 10° test, the final resting position of the vehicle must be reported, with reference to the departure side of the LMCC.</p>

**Table 3-1: Impact Test Performance Evaluation Criteria**

#### Severity indices

3.2 The Acceleration Severity Index (ASI), Theoretical Head Impact Velocity (THIV), Occupant Ridedown Acceleration (ORA) and Occupant Impact Velocity (OIV) must be determined for all tests with cars and compared with the maximum permitted values listed in Table 3-2.

3.3 The transducers, filters and recording channels must comply with a frequency class of CFC\_180 for acceleration and angular velocity channels. (Data filtered to CFC\_60 may be used for graphical plotting of acceleration data). They must also conform to ISO 6487.

3.4 The data must be sampled at a sampling interval rate of at least 2 kHz.

3.5 An additional 500 ms of data must be collected at the beginning and end of the data.

Impact Severity Index		Maximum Index Values	Requirement
ASI		≤1.9	TL2.UK, TL3.UK test series and 2-51.UK and 3-51.UK tests only
THIV		≤44kph	TL2.UK, TL3.UK test series and 2-51.UK and 3-51.UK tests only
ORA		≤20g	NCHRP tests only
OIV	Lateral and Longitudinal	≤12m/s (44kph)	NCHRP tests only

**Table 3-2: Impact Severity Values – Car Occupant**

3.6 For ‘head-on’ impacts, THIV is equivalent to OIV.

3.7 For further definition and/or information regarding the derivation of these severity criteria, refer to European Standard BS EN 1317-1.

### Durability

3.8 All LMCCs must be durable for an economically reasonable working life, for which a reviewable experience-based description and/or related measurements of durability shall be adequate.

3.9 The working life of an LMCC depends upon its inherent durability and the prevailing environmental conditions. A clear distinction must be made between the (declared) working life for a product, based on the assessment of durability in technical specifications, and the actual working life of a product. The latter depends on many factors beyond the control of the manufacturer, such as installation design, environmental location, handling, use, and maintenance.

3.10 The manufacturer must declare the materials and protective coatings used on the LMCC.

3.11 The manufacturer must declare an assessment of durability including the identification of technical characteristics of materials affecting durability, and the methods of evaluation (e.g. coating mass determination, adhesion testing).

## 4. REFERENCES

National Cooperative Highway Research Program (NCHRP) Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features (1993).

The Traffic Signs Manual, Chapter 8: 'Traffic Safety Measures and Signs for Road Works and Temporary Situations' (2006).

BS EN 1317-1 Road Restraint Systems – Part 1: Terminology and General Criteria for Test Methods.

BS EN 1317-2 Road Restraint Systems – Part 2: Performance classes, acceptance criteria & test methods for safety barriers.

ISO 6487 Road vehicles – Measurement techniques in impact tests – Instrumentation.

## 5. ENQUIRIES

All technical enquiries or comments on this Standard should be sent in writing as appropriate to:

Chief Highway Engineer  
The Highways Agency  
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