Submission to National Highway Traffic Safety Administration

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Advance Notice Of Proposed Rulemaking, Docket No. NHTSA-2015-0070 / 2015-17973

A Proposed Rule by the National Highway Traffic Safety Administration

Re: **Rear Impact Protection, Lamps, Reflective Devices, and Associated Equipment, Single Unit Trucks**

https://www.federalregister.gov/articles/2015/07/23/2015-17973/rear-impact-protection-lamps-reflective-devices-and-associated-equipment-single-unit-trucks

Submitted via internet: http://www.regulations.gov/#!submitComment;D=NHTSA-2015-0070-0001

20th September 2015

TARS Research Centre, UNSW, Sydney Australia are pleased to provide National Highway Traffic Safety Administration (NHTSA) with our submission focussing on the *Rear Impact Protection for Single Unit Trucks*

We are prepared to assist in regards to our findings and any questions NHTSA may want to ask concerning Rear Impact Protection for heavy trucks. We have a long and strong research track record regarding Truck Underrun Barriers.

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Background

Rear underrun crashes involving heavy vehicles with rear overhangs represent the most extreme examples of incompatibility between heavy vehicles and passenger cars. This type of crash often causes severe or fatal injuries to car occupants including decapitation.

Considerable work has been carried out starting in the 1990's through to the early 2000's by the Authors (in particular Rechnitzer) investigating and mitigating such crashes.[1,2,3,4,5,6,7, 8,9,10] In particular, the Australian State Government Regulator 'VicRoads' and the former Federal Office of Road Safety (FORS and now known as the Australian Transport Safety Bureau (ATSB)) commissioned Adjunct Associate Professor Rechnitzer to carry out a series of crash tests on prototype rear underrun barriers and on a full scale heavy truck with an energy absorbing rear underrun barrier attached to it. An effective prototype was developed and was fixed to an Australia Post delivery truck.

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1 Rechnitzer G. and Foong Chee Wai. (1991), "Truck involved crash study: Fatal and Injury crashes of cars into the rear of trucks". Monash University, Accident Research Centre, Report 26. http://www.monash.edu.au/miri/research/reports/muarc026.pdf

2 Rechnitzer G, Scott G & Murray N W, (1993) "Design and Testing of Effective Rear Underrun Barriers for Heavy Vehicles". Dynamic Loading in Manufacturing and Service, Melbourne, 9-11 February 1993. The Institute of Engineers, Australia, pp 189-198 (National Conference Publication No. 93/1).

3 Rechnitzer, G., Scott G. & Murray, N.W., (1993). "The Reduction of Injuries to Car Occupants in Rear End Impacts with Heavy Vehicles"; 37th STAPP Car Crash Conference, 8-10 Nov. 1993, San Antonio, Texas. paper 933123, SAE Inter. http://papers.sae.org/933123/

4 Rechnitzer, G., (1993) "Improving the Design of Heavy Vehicles To Reduce the Injury Risk to Other Road Users in Crashes", 18th Australasian Transport Research Forum, Gold Coast Queensland; Sept. 1993. Graduate School of Management, University of Queensland., pp479-500. http://atrf.info/papers/1993/1993_Rechnitzer.pdf

5 Rechnitzer G., Powell C. and Seyer K. (May, 1996), "Development and testing of energy absorbing rear underrun barriers for heavy vehicles". 15th International Technical Conference on the Enhanced Safety of Vehicles, 13- 6 May; Paper No. 96-S4-O-10, World Congress Centre, Melbourne. http://trid.trb.org/view.aspx?id=477219

6 Rechnitzer, G., Zou, R. & Grzebieta, R. (1997) "MADYMO computer modelling of energy absorbing rear underrun barriers for heavy vehicles - a pilot study", Monash University Accident Research Centre, Report No. 112. http://monash.edu/miri/research/reports/muarc112.pdf

7 Zou R., Rechnitzer G. and Grzebieta R.H, "Simulation of Truck Rear Underrun Barrier Impact", Proc. 17th International Technical Conference on the Enhanced Safety of Vehicles, Amsterdam, Netherlands, June 2001.http://www-nrd.nhtsa.dot.gov/pdf/esv/esv17/Proceed/00225.pdf

8 Rechnitzer G, Seyer K & Powell G, "Performance Criteria, Design And Crash Testing Of Effective Rear Underride Guards", Proceedings of the 17th International Technical Conference On The Enhanced Safety Of Vehicles, Amsterdam 2001, 4-7 June 2001. http://www.georgerechnitzer.com.au/wp-content/uploads/2013/09/ESV-2001-Rear-Underrun-GR-2001.pdf

9 Lambert, J. M. & Rechnitzer, G. (2002) "Review of truck safety: stage 1: frontal, side and rear underrun protection", Monash University Accident Research Centre, Report No. 194. http://monash.edu/miri/research/reports/muarc194.pdf

10 Rechnitzer G. "The Improvement Of Heavy Vehicle Design To Reduce Injury Risk In Crashes With Other Road Users", PhD Thesis, Monash University, June 2003. https://www.filesanywhere.com/fs/v.aspx?v=8b6a69875e67767ca2a4

Rear underrun protection devices on trucks should be designed to engage the errant impacting car's safety systems and thus reduce the level of intrusion into the passenger compartment in such crashes.

It has now been well over 30 years since the first call for effective truck rear under-run barriers was made by research staff in the Department of Civil Engineering at Monash University together with Monash University's Accident Research (MUARC) staff (Grzebieta and Rechnitzer). Professor Noel Murray (passed away in 2000) again called for a review of the Australian Design Rules (ADRs) in 1994 in his book "*When it comes to the crunch*"[11]. Ten years later Dr. George Rechnitzer (Adjunct Associate Professor at TARS) again called for rear under-run protection.[12] Whilst there are force based design rules, e.g. in USA, Canada and Europe, it is apparent that these rules are inadequate. In our submission we strongly recommend crash test based performance requirements for under-run protection catering for both centred and off-set impact.

Around 10 people per year on average are killed in Australia in rear under-run crashes resulting in horrific injuries such as decapitation.[13] Yet the Regulation Impact Statement (RIS)[14] for Underrun Protection publish by the Vehicle Safety Standards Branch at the Department of Infrastructure, Transport, Regional Development and Local Government in July 2009 recommended that only front under-run protection be applied to all rigid and articulated trucks. Their conclusion was that the cost-benefit ratio for frontal under-run barriers was greater than one whereas for side and rear under-run the benefit was negative, and hence such protection should not be mandated in an Australian Design Rule. Yet despite these numerous calls for changes <u>over the past three decades</u>, we continue to consistently kill people in such crashes, ignoring the fact that practical low cost effective under-run barriers can be fitted. That is the real unforgivable tragedy.

The most recent call for changes to the ADRs posted by the NSW NRMA Motoring and Services association in 2010[15] we indeed continue to only find crocodile tears being shed by federal regulators. Whilst this submission welcomes the US National Highway Administration's revisiting the issue of rear under-run protection for trucks, yet again, it appears that NHTSA is embarking on a similar pathway of regulation based on a cos-benefit analysis as the Australian Regulators did in July 2009.

It needs to be pointed out that the US have committed to Towards Zero Deaths paradigm which is based on the Vision Zero and Safe System principles[16,17]. The US *Towards Zero Deaths: A*

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[11] Murray N.W., "When It Comes To The Crunch The Mechanics Of Car Collisions", World Scientific Publishing, Singapore, ISBN 981-02-2096-0, (1994).

[12] Rechnitzer, G. (2004), "Engineering Solutions: Crocodile Tears for Heavy Vehicle Safety", Year Book of the Australasian College of Road Safety. http://annaleahmary.com/wordpress/wp-content/uploads/2015/06/GR-Crocodile_Tears-for-Heavy-Vehicle-Safety-2004.pdf

[13] Haworth N. and Symmonds M., A Cost-Benefit Analysis of Heavy Vehicle Underrun Protection, Proc. Australasian Road Safety Research, Policing and Education Conference, 2003. http://acrs.org.au/files/arsrpe/RS030141.pdf

[14] Regulation Impact Statement for Underrun Protection, Jul-2009, Department of Infrastructure, Transport, Regional Development and Local Government, Australian Government.

[15] NRMA Motoring & Services, The Safety Needs Of Heavy Vehicles In Australia, March 2010, http://www.mynrma.com.au/media/Heavy_Vehicle_Safety_Report_March_2010.pdf

[16] http://www.towardzerodeaths.org/strategy/

National Strategy on Highway Safety states: "*The Toward Zero Deaths National Strategy was developed with input from numerous stakeholders, along with support from several agencies within the United States Department of Transportation, and is intended to represent a consensus-based document.*" The Vison Zero and Safe System approach adopted by most of the world now and on which Towards Zero Deaths is anchored, boldly moves away from the economic- rationalist 'cost-benefit' models (cited in this Docket as still being used by NHTSA), to a humanistic more rational model. The important aspect of a 'Vision Zero' principle is that it introduces 'ethical rules' to guide the system designers. In other words:

- *Life and health can never be exchanged for other benefits within the society*
- *Whenever someone is killed or seriously injured, necessary steps must be taken to avoid similar events.*

The Authors of this submission would further point out to those at NHTSA considering how the *Rear Impact Protection for Single Unit Trucks* should be revised; they should consider placing themselves in the position of the gentleman being asked in the following Australian Government advertisement: https://www.youtube.com/watch?v=bsyvrkEjoXI&feature=youtu.be. This advertisement was commissioned and paid for by the Victorian State Government in Australia. We would ask the NHTSA staff responsible for this NPRM which members of their family would they allocate to die that would be acceptable to them and would meet the NHTSA cost benefit ratios being considered?

To break the impasse between safety stakeholders and regulators, the Authors of this submission have proposed to incorporate into the revision of the ASNZS3845.2 Australian Road Safety Barrier Systems and Devices a crash test performance requirement for rear under-run barriers for heavy trucks, shortly to be released for public comment. In that standard test requirements for under-ride barriers, called Truck Under-run Barriers (TUBs), has been developed and now included. We hope that this standard will be approved by committee members (members include Australian State Government regulators) and hopefully will be published in early 2016. The tests requirements are in part based on the US Manual for Assessing Road Hardware (MASH) and are presented below.

We would strongly recommend that NHTSA consider such dynamic performance tests when they deliberate their development of the Federal Motor Vehicle Safety Standard for under-ride barriers.

[17] Mooren, L., Grzebieta, R., Job, S., 2011 Safe System – Comparisons of this Approach in Australia, Australasian College of Road Safety Conference – Safe System: Making it happen, Melbourne. http://papers.acrs.org.au/index.cfm?action=main.paper&id=359

TRUCK UNDERRUN BARRIERS (TUB'S)

Proposed Crash Test Performance Requirements To Be Incorporated Into The Australian Road Safety Barrier Systems and Devices (ASNZS3845.2)

GENERAL

The US Department of Transportation Federal Highway Administration Manual for Assessing Safety Hardware (MASH) with noted modifications shall be the basis of testing procedures for TUB's.

TUB's are designed to prevent a vehicle impacting the rear of a stationary truck under-riding the back of the truck in a manner where the truck structure intrudes into the impacting vehicle's occupant compartment. The TUB's main function is to protect the occupants in the impacting vehicle.

TUB's are usually permanently mounted to the rear of trucks or trailers towed by such trucks. They are used to act as a barrier against errant vehicles impacting the rear of a truck or trailer to prevent truck rear under-ride. TUB's usually do not protrude from the rear of the truck and mostly rely on the vehicle's crashworthiness for the ride down decelerations for the occupants although some of the impact kinetic energy can be dissipated by the TUB.

Current vehicle crashworthiness technology indicates that occupants will not suffer serious injury in an equivalent frontal impact speed (delta V or ΔV) of up to around 64 km/h into a deformable barrier if the car is a modern five star Australian New Car Assessment (ANCAP) vehicle. Moreover, the IIHS is now testing and rating cars for a narrow offset crash test where the vehicle is impacted into a rigid barrier at a speed of 64.4 km/h with a 25% offset. This could mean that TUB's that are a non-energy dissipating fixtures would be compliant with the requirements set out below, where the majority of the energy is required to be dissipated by the vehicle and the occupant restraint systems. If the car is designed to such ANCAP and IIHS test protocols with the maximum crashworthiness rating, it is likely that the occupants would not sustain serious injuries in a vehicle impacting such a TUB in the configurations shown in Figure 1.

In regards to the development of effective energy absorbing TUBs, such a TUB would both reduce the serious injury to vehicle occupants and increase the effect frontal impact speed ΔV above the 70 km/h test speed compared with a rigid TUB. The manufacturers of such TUBs and operators of heavy vehicles are encouraged to explore the application of energy absorbing systems for TUBs including rear air bags mounted on the rear of trucks.

TEST REQUIREMENTS

Truck Underrun Barriers shall be required to comply with the following tests 2-51, 2-52, 2-54 and 2-55 as follows:

(a) Centred impact: the test requirements of Impact Tests 2-51 and 2-54 as set out in Table 1 and Figure 1(a). Test 51 is designed to test the structural integrity of the underrun barrier when struck by a larger mass vehicle such as an SUV. Test 54 is designed to evaluate the underrun potential of the TUB in regard to vehicle into truck impact compatibility when struck by a sedan vehicle. The vehicles used in Test 51 and Test 54 are typical of those driven on Australian public roads.

(b) Offset impact: the test requirements of Impact Tests 2-52 and 2-55 as set out in Table 1 and Figure 1(b) where the test vehicle is offset by

$$Y = \text{OFFSET} = \frac{A}{2} + 0.2W$$

as shown in Figure 1. A is the maximum width of the rear of the truck shown in Figure 4.4 and Figure 4.5 in Section 4.2 in MASH. In Figure 4.3 in MASH the dimension A = t.

TABLE 1

TEST MATRIX FOR TRUCK UNDERRUN BARRIERS

Test Level	Feature	Test designation	Impact conditions			Impact point	Evaluation Criteria (see Table 5.1 of MASH)[c]
			Vehicle	Nominal Speed[a] (km/h)	Nominal Angle[a] θ deg.		
2	Truck Underrun Barrier	2-51	2270P	70	0	(b)	C,D,F
		2-52	2270P	70	0	(b)	C,D,F
		2-54	1500A	70	0	(b)	C,D,F
		2-55	1500A	70	0	(b)	C,D,F

a - See Section 2.1.2 of MASH for tolerances on impact conditions.

b - See Figure 1 for impact point

c - For the evaluation criteria F in its cross reference to Section 5.3 in MASH in regards to the section specifying “deformation or intrusion” criteria the following criteria “Side front panel (forward of A-pillar) ≤ 12 in. (305 mm).” does not apply.

Tests 50, 51, 52 and 55 are to be conducted with either:

a) the maximum allowable truck weight. The support truck should be placed in second gear and the parking brake set.

b) or a rigidly blocked support truck for unlimited support weight. The support truck shall be placed in second gear and the parking brake set and shall be blocked to prevent forward or lateral motion.

c) or a surrogate structure that replicates the rear back portion of the truck type to which the TUB will be used when in service. The surrogate structure shall be fixed against a crash test block commonly used at vehicle crash test facilities that is replicating a rigidly blocked support truck for unlimited support weight.

The TUB shall be fixed to the rear of the truck in the same way as would be installed in service.

The maximum permitted rearward displacement of the TUB beyond the face of the rear of the truck shall not exceed 500 mm.

The TUB can deform under the impact loading but there shall be no joint failures or buckling of TUB’s key support structures or of the support truck structure.

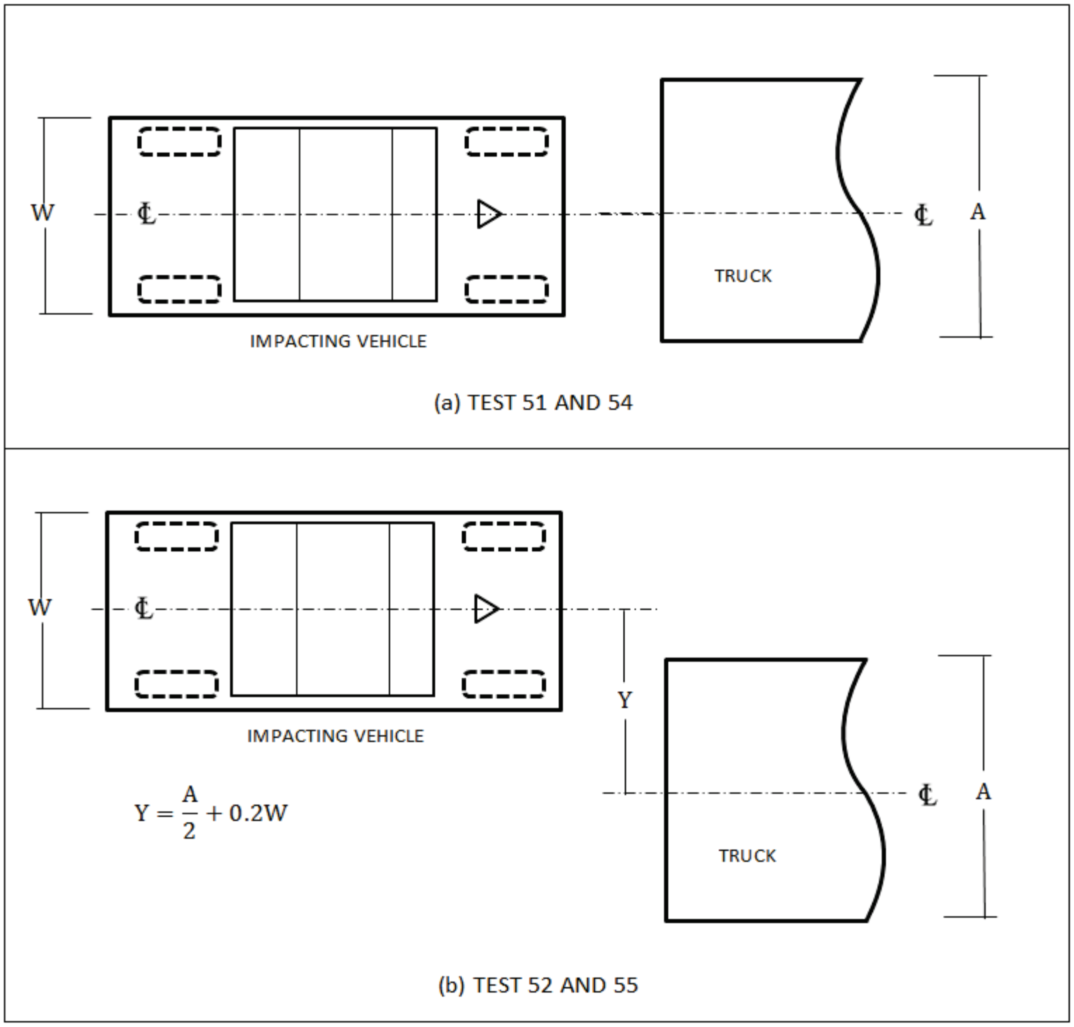

Figure 1

DOCUMENTATION

In addition to the normal documentation required for a road safety devices the following shall also be required:

(a) Support truck (or support truck and trailer) roll-ahead distances should be carefully documented for all four tests;

(b) The make, model and ballasting of the truck tested for the TUB;

(c) The make, model and any ballasting of the impacting vehicle;

(d) The deformation of the impacting vehicle and what crashworthy features (airbag, seat-belt pretensioners, etc.) were triggered that assisted in reducing ride down decelerations during impact;

(e) Range of truck masses the TUB can be attached to;

(f) Details of how the truck is braked (i.e., parking brakes set, engine in 2nd gear, etc.) or blocked against forward motion during operation when protecting a work zone;

(g) Geometric data including length, width, and height of TUB;

(h) Height of TUB with respect to the ground;

(i) Length of supporting truck;

(j) Mass of TUB and supporting hardware;

(k) Detailed drawings of mounting hardware;

(l) Descriptions of the test surface, including type (asphalt or concrete), finish, and state of wear.

(m) The type, location, and manner of securing the ballast;

(n) Ballast mass, test inertial mass, and the horizontal Center of Gravity location of the ballast;

(o) Condition and type of brakes or blocks used to reduce or prevent vehicle roll ahead.

INSTALLATION CRITERIA

The test condition documentation detailed above must be clearly documented for proper installation of the TUB. In addition, the following system requirements for the TUB's shall be met:

(a) The TUB barrier height clearance above the road shall be preferably 350 mm but shall not exceed 400 mm for an unloaded truck.

(b) The barrier width should be within 100 mm of the outer frame of the truck to ensure effective operation in offset impacts.