

The Institute of Road Transport Engineers  
New Zealand

Fifth International Heavy Vehicle Conference

An International Perspective of  
Heavy Vehicle Safety

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## Passive Safety Measures

Safety cabs, Strength of the superstructure of large bus bodies, Rear underrun protection, Safety belts, and Anchorages, Door latches and retention components.

Recent world research has focused on a wide range of topics as demonstrated by the large number of papers which have been presented on the subject of 'SHE'. I have picked out a few interesting examples from the past few years from recent International Conferences on Experimental Safety Vehicles (ESV's) and Land Transportation Issues (see Annex I & II). The work embodied in these papers may be summarised into the following categories :

- (1) Improvements to brake performance based on Antilock Braking Systems (ABS).
- (2) Improvements in frontal collision between light vehicles (cars) and heavy vehicles (trucks and buses).
- (3) Detailed investigation and analysis of accidents in which heavy vehicles were involved.
- (4) Changes to regulations and enforcement media.

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During the Eleventh International Conference on Experimental Safety Vehicles Renault of France presented the results of global research in the form of their VE20. Many of the safety features invested in the design of this apparent world leader were quite remarkable as may be appreciated in the following list :

### Active Safety Features

- (1) Measures for Handling and Rollover.
- (2) Two hydraulic braking systems and retarder brakes.
- (3) Front wheel disk brakes with ABS.
- (4) Painted on reflective belt to improve night-time visibility for other road users to spot the vehicle.
- (5) Improved driver visibility by extended (to floor level) front and side windshields.
- (6) Improvements in driver positioning.
- (7) Splash and spray (road water) control.
- (8) Tyre pressure sensing.

### Passive Safety Features

- (1) Front underrun protection incorporated and made equivalent to the strength of a passenger car.
- (2) Body side and rear impact improved by designing the impact height as low as possible to prevent side and rear underrun.
- (3) Strengthening of cab to minimize occupant injury.

The collision of heavy vehicles into cars or collision of cars into heavy vehicles front, side or rear conjures-up some of the most severe of traffic accident scenarios in terms of physical injury where the crumple zones of cars become quite impotent as a passive safety feature. Bumper and crumple zone heights have still not been moderated across all vehicles (light and heavy) and many heavy vehicles with underrun devices have no absorption or crumple effect. However tests reported by Dr Klaus Langwieder and Stephan Gruttert and carried out in Germany showed very impressive benefits in the use of deep aluminium honeycomb blocks fitted to trucks to create the effect of a crumple zone to reduce the shock blow to a car during impact. These honeycomb blocks could be fitted to the front, rear or sides of trucks at a height which matched with cars (main chassis member) and hence provided a damper during impact as well as underrun prevention.

Similar studies done by M. Danner, K. Langwieder, H. Appel and V. Middelhaue again in Germany indicated via statistical analysis of accidents that the rate of serious injury and fatality was high in car to heavy vehicle accidents with the truck often sustaining relatively light damage. Advantages and disadvantages of underrun devices were listed as :

#### Advantages

- (1) Fatalities or severe injuries could be reduced by up to 20%.
- (2) When formed into an air dam fuel economy could be improved.
- (3) The appearance of the truck could also be improved.
- (4) In severe head-on collisions vital truck components would be afforded greater protection.

#### Disadvantages

- (1) Higher production cost.
- (2) Less bumper clearance (approach angle).
- (3) Significant weight increase in the order of 150kg to 200kg (330-440 lbs).

A paper also from Germany by Harald Eggelmann, Dr Peter Alber and Frank Wolf (Mercedes - Benz) reported on the findings of a statistical analysis of truck - involved accidents and recommended :

- (1) Strengthening of the cab to better secure the space for occupants, and
- (2) The use of seat belts by all occupants.

It was also pointed out that the standard for cab strength had not been established and that preventive measures against rear impact accidents must be adopted.

Another paper included here and again from Germany by Dietmar Otte and Harmann Appel analysed traffic accident data and proposed :

- (1) Prevention of underrun by lowering of the front bumper height.
- (2) Use of energy absorbing materials/surfaces within the cab to reduce severity of injury to occupants.
- (3) The injury suffered by motorcycle riders legs could be reduced by covering truck bumpers with rubber.
- (4) The installation of side underrun protection.
- (5) The need for legislation to enforce :
  - . the installation of an energy absorbing structure at the front of heavy vehicles;
  - . the covering of dash areas with soft material;
  - . the use of steering wheels with safety measures;
  - . the use of automatic 3-point seat belts.

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Moving now to Singapore a paper given by Mr NG Yook-koong at the Asia Pacific Conference (ASPACON) in 1993 giving an overview of the rules and regulations made the following interesting points :

- (1) Out of a total vehicular population of some 557,000 about 122,000 and 23,000 vehicles were goods vehicles and buses respectively (26% heavy vehicles).

(2) Road Safety and air quality were impressed via the regulations by :

- . setting roadworthiness standards;
- . education, inspections and enforcement;
- . the two main regulations pertaining to (i) construction and use and (ii) lighting;
- . with effect from January 1991 all DERV's must comply with UN/ECE 24.03 regarding emissions.

Mr. Ng focused on the protection for both vehicle occupants as well as other road users through better fields of vision, more prominent warning devices, stringent noise and exhaust emission standard's fitting of rear and side underrun bumpers (w.e.f. 1.9.1993), fitting of hazard warning lights (w.e.f. 1.9.1993) and Type Approval Tests which were conducted to check :

- . Exhaust emissions
- . Brake performance
- . Wheel alignment
- . Headlight intensity
- . Noise emission
- . Over and under carriage condition.

Teams of police officers backed-up by technicians were placed on daily patrols equiped with portable testers to look-out for badly maintained, overloaded or smoky vehicles.

Mr Joseph Lee of SAE Inspection Services, Singapore presented another interesting paper also at ASPACON '93' giving a description of each of the legally required tests regularly carried-out on vehicles in Singapore. In particular he provided the audience with statistics of the passing rates of vehicles by age (1986 to 1992). To indicate how rigorous the annual tests were. The highest test pass rate registered for any year was 55.8% (3,924 out of 7,026 goods vehicles tested). The pass rate dropped year by year as vehicles aged and the highest pass rates for 5 years old and 10 years old goods vehicles were 35.6% and 9.9% respectively in 1992 indicating that vehicles became less roadworthy/less able to meet latest 'SHE' standards as they aged. This had the benefit of reducing the average age of goods vehicles on the roads of Singapore.

One way of improving the productivity of goods vehicles has always been to increase their payload and this is something which history has proved to have been most effective. Mr Poon Ooi Theng went a few steps further in his paper to the ASPACON '93' by proposing the use of double stacked container trailers. As a result of his own calculations he considered it to be feasible to carry two 40-foot (2 x 30 tonne max.) containers on top of each other on specially designed trailers or four 20-foot (4 x 24 tonnes max.) containers at speeds up to a maximum of 25km/h (16mph) using a 6 x 4 prime mover. If this proposal ever came to fruition lets all hope that solid means of ensuring suitable stability and preventing speeding of such vehicles would be firmly in place.

### Global Environmental Concerns relating to Heavy Vehicle Operations

This subject has not been one which has normally come under the heading of safety. However the very future survival of all species of life existing on earth is affected by human activity not least the operation of heavy vehicles.

The Japan Automobile Research Institute originally established in 1969 as the Automobile High-Speed Proving Ground and reorganised in 1969 is devoted to serving the public and common interests of the automotive industry. Their research priorities into the 1990's include; Safety, Pollution Reduction, Fuels, New Technology Applications, Traffic Matters and International Interchanges and their budget in 1990 alone was some US\$32 millions.

Lets hope that this and similar such institutions around the world can all get together and produce ever improved solutions to our problems at the earliest stage.

Global competition has seriously hampered the development of much more sophisticated and safer trucks. Many developing countries, where the demand for trucks is highest, have preferred the cheapest and simplest product for the job. Also the countries which allow inferior trucks to operate due to a lack of stringent regulations and/or enforcement means effectively put the clock back in terms of progress to save the planet by use of more 'SHE' conscieous vehicles. Additionally some countries have less regard for human safety and life itself therefore progress would be extremely slow in changing their values.

It must be quite obvious to those living in developed countries that we all share the same wind and water around the globe and that if we cannot overcome the political, economic and cultural factors which stand in the way of the acquisition of the desperately needed global improvements in 'SHE' standards then we are all doomed!

Before concluding I must draw your attention to the heavy responsibility borne by the personnel involved in all aspects of land transportation from vehicle design to loading of vehicles to maintenance and also driving aspects. All accidents originate in human error therefore 'SHE' issues must be taken very seriously at all levels. Drivers of all kinds of vehicles must follow the various drivers' codes (Highway Code, Code of Driving etc.) which very adequately provide guidelines in the manner we should behave on the roads and all too often we see examples where these guidelines are ignored resulting in loss of life and injury. I believe thorough training and effective enforcement are the answers here!

### Conclusions

This can best be presented in the form of three shopping lists for 'SHE' improving measures relating to (i) Active Safety Measures, (ii) Passive Safety Measures and the other for health and environmental measures. (These are far from complete lists)

#### Active Safety Measures (not in order of importance)

- . The application of high quality personnel at all functional levels of the industry (Drivers, Traffic Controllers, Maintenance Technicians, Managers etc.).
- . Improved braking performance including ASB, failsafe/backup systems.
- . Payload sensing including axle overload and high Centre of Gravity sensors/inhibitors.
- . Improved yaw stability (braked and unbraked) especially for articulated vehicles.
- . Improved roll stability.
- . External electronic traffic control (speeds and routes).
- . External speed signalling.
- . Vehicle proximity sensing/inhibitors.
- . Tyre failure/pressure sensing mediums/inhibitors.
- . Vehicle replacement policies which maintain a modern fleet of vehicles.
- . Improvement to road surfaces, drainage, lighting, side wind protection, gradients, curvature, banking, signage etc.
- . Enhanced ergonomics within the vehicle.
- . Hazardous goods placarding with public education.

- . Hazard warning systems.
- . The full use of all feedback data from traffic accidents (global) to provide future corrective measures including the use of vehicle "black box" sensing of speed, acceleration, time etc.
- . External reflective markings to improve night time recognition.
- . Thorough regular maintenance and safety checks.
- . Improved driver visibility (all round).
- . Road water splash/spray reduction.

Passive Safety Measures (not in order of importance)

- . Installation of air bag technology.
- . Application of seat belts.
- . Strengthening of cabs for higher crush resistance.
- . More securely glazed windscreens.
- . All round energy absorbing underrun devices having 'all vehicle' height and crush zone compatibility.
- . Improved all-round vision for drivers.
- . Escape routes in case of roll-over, cab crushing or fire etc.
- . Fire fighting and first aid support systems.
- . Inter-vehicle and vehicle-base communication.
- . Smooth shaping of external body features.
- . Covering of bumper and other impact zones with rubber/soft material to reduce injury.
- . Installation of steering wheels having all safety features included in their design.
- . Installation of energy absorbing crumple zones and/or external air bag technology development.

Health and Environmental Measures

- . Vehicle and trailer weight reduction through the development and application of lightweight materials, body styling etc.
- . Reduced drag effect by reducing rolling resistance and air drag.



- . Improved engines with greater thermal efficiency, better mechanical efficiency etc.
- . More efficient drive train mechanisms.
- . Improved auxilliary systems.
- . Use of environmentally more acceptable fuel sources initially by the removal of sulphur from diesel fuel and improvements in quality and eventually alternative fuels. (Short term)
- . Eventual replacement of combustion dependant power units. (Long term)
- . Strict audit on the maximum load carrying utilisation of trucks.
- . Maximum use of reclamation and recycling of components and lubricants to save energy/resources.
- . Use of retarders to save energy and increase braking component life.
- . Use of devices (monitored) to provide the most fuel efficient speeds for given conditions.

It must be said that in the view of the undersigned the great strides of advancement sought to secure a higher level of safety in the future, in relation to truck operations can only be realised through global legislation and enforcement to ensure all countries act equally positively and with a determined will to secure success. Before constructing new cities and towns or reconstructing old ones we must give consideration to the separation of pedestrians from moving vehicles and also the avoidance of having two way traffic movement thereby reducing head on collision scenarios. Many other traffic planning measures can help minimise traffic accident numbers.

As a final point, now that we've got used to the meaning of the abbreviation 'SHE' we must not forget 'HE'. In developed countries I have observed a high degree of equal rights (I'm not sure about New Zealand) and as a result the fairer sex ('SHE') has gained access to the highest levels of management, even in the transport industry. In developing countries and in particular Asia the men (HE) has remained the dominant one and women have played little or no part in management. On the basis of 'SHE' statistics it could be derived that where she is liberated high 'SHE' standards exist! Think about it!

Thank you, God Bless and Good Luck.

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 Motor Vehicle Engineering  
 Lee Wai Lee Technical Institute  
 Hong Kong

Acknowledgements

Eleventh International Technical Conference

1. [Heavy Truck Accident Exposure in the U.S.]  
H. Seiff (United States)
2. [Vehicle Factors in Accidents Involving Medium and Heavy Trucks]  
R. Clark, W. Leasure (United States)
3. [Improvement of Side Visibility for Safety While Turning]  
S. Saitoh, A. Hirose, N. Shirai (JAPAN)
4. [European Review of Heavy Goods Vehicles Safety]  
I. Neilson (United Kingdom)
5. [Priorities in Active and Passive Safety of Trucks]  
(Federal Republic of Germany)
6. [Typology of Traffic Accidents Concerning Cars Impacted by Trucks]  
M. Ramet, G. Vallet (France)
7. [Truck/Car Frontal Impacts - A Simulation of Underride Guards]  
A. Walton, M. Sadeghi (United Kingdom)
8. [Occupational Traffic Injuries to Truck Occupants]  
T. Jarl, J. Thorson, A. Ostman, H. Stenlund, L. Svensson (Sweden)
9. [Seat Belt Effectiveness for Heavy Truck Occupants During the Collision]  
M. Horii, K. Yamazaki, Y. Amamiya (Japan)
10. [Front Underrun Guards for Trucks]  
B. Riley, A. Farwell, T. Burgess (United Kingdom)
11. [The Benefits of Energy Absorbing Structures to Reduce the Aggressivity of Heavy Trucks]  
I. Jones (United States)

Twelfth International Technical Conference

1. [Braking Characteristics of 400 Heavy Trailer Combinations From Denmark, Finland, Norway and Sweden]  
L. Strandberg, L. Stadler, K. Karlsson (Road and Traffic Research Institute, Sweden)
2. [Heavy Vehicle Braking Philosophies : the U.S. VS. Europe]  
R. Radlinski, M. Flick (NHTSA, United States)
3. [Driving Behaviour of Different Coaches During Steering and Braking Maneuvers]  
D. Grunow (TUEV Rheinland, Federal Republic of Germany)
4. [Passive Frontal Crash Protection]  
S. Gruettert, V. Middelhaue, H. Appel (Technische Universitaet Berline, Federal Republic of Germany)
5. [Passive Safety Measures of Trucks - Effectiveness and Integrated Assessment of Priorities]  
M. Danner, K. Langwieder (HUK Verband, Federal Republic of Germany)
6. [Accident Tests with a View to Analysis of and Further Development in the Safety of Road Transport Tankers]  
J. Grandel, F.A. Berg (DEKRA Federal Republic of Germany)
7. [A Concept of Heavy Truck Safety - Its Realization and Markets]  
H. Eggelmann, P. Alber, F. Wolf (Daimler Benz Ag, Federal Republic of Germany)
8. [Truck Safety Aspects]  
L. Gardell (SAAB-Scania AB, Sweden)
9. [Safety Experience of Large Trucks in Canada]  
G. Sparks, A. Horosko (University of Saskatchewan, Canada)
10. [Safety Situation of Heavy Truck Occupants in Traffic Accidents]  
D. Otte, H. Appel (Medifuische Hochschule Hannover University, Federal Republic of Germany)
11. [Possibilities to Improve Bus Safety]  
N. Hackenberg, H.J. Krueger (TUEV Rheinland, Federal Republic of Germany)
12. [Improvements in the Frontal-Frontal Collision Between Personal Vehicles (PV) and Heavy Duty Vehicle (HDV)]  
P. Soret (Renault France)

ESV Conference Reports by Contents and Countries

	<u>Number of Reports</u>	<u>Countries</u>
(a) ABS (Antilock Brake System) and cruising stability	4	Sweden ... 2 USA ... 1 Germany ... 1
(b) Passenger (of the passenger car) protection in a frontal to frontal collision between heavy duty vehicle and passenger car	3	Germany ... 2 France ... 1
(c) Statistical analysis of accidents in which heavy duty vehicles were involved	1	Germany ... 1
(d) Safety measures on bus and tank lorrys	1	Germany ... 2
(e) Occupant protection in heavy duty trucks	1	Germany ... 1
(f) Safety measures for heavy duty vehicles in Canada (contents unknown)	1	Canada ... 1

ASIA PACIFIC CONFERENCE (SINGAPORE) 1993

. Rules and Regulations of Motor Vehicles

Mr Ng Yook Koong, Head Engineering Division  
Registry of Vehicles, Singapore

. Experience and Some Fine Points on Customer Service

Mr Yin Hong Shuen, Divisional Manager, Training  
Caltex (Asia) Ltd., Singapore

. Progress in Environmental Control & Fuel Economy at Volkswagen & Audi Examples for Advanced Automobile Technology : Catalyst Diesel Engine, Eco Golf, Multi-Fuel Concept, Golf Hybrid and Electro Golf

Prof Dr Winfried Bernhardt, Director  
Powertrain Research, Volkswagen AG, Germany

. Skidding Risks on Wet Road Surfaces

Dr Chin Hoong Chor, Senior Lecturer  
National University of Singapore

. Air-conditioning of Buses - Secrets to Good Maintenance and Upkeep

Mr Lim Gim Hong, Senior Manager  
Singapore Bus Service (1978) Ltd., Singapore

. Shaping of Engine Torque Curve Using a Variable Manifold System

Dr Zhao Yong, Research Fellow  
Nanyang Technological University, Singapore

. Heavy-Vehicle Traffic in Singapore

Dr Fwa Tien Fang, Director, Centre for Transportation  
Studies, National University of Singapore, Singapore

. Exhaust Manifold Design for Wastegate Turbocharged Diesel Engine

Mr Jingbin Yang, Dept of Energy & Environmental Technology  
Glasgow Caledonian University, United Kingdom

. Opportunities to Maximise Companies' Success through a More Scientific Approach in the Selection and Management of People in the Motor Industry

Mr Roger Dennis, Director  
Lorry Logic, United Kingdom

- . The Restructuring Process and Economic Outlook of the European Automobile Industry

Mr H. Leuders, Director, Trade & Economics  
ACED, Belgium
- . How ITE Supports Employers in Technical Training

Mr Ng Ah Seng, Divisional Director  
Institute of Technical Education, Singapore
- . State of Development and Economic Implication of Regulatory Practice Governing Zero Exhaust Emission Automobile

Prof Gene E Smith, Asst Dean & Prof of Mechanical Engineering, University of Michigan, United States of America
- . Controlling Congestion in Singapore : A Review of Government Policies

Dr Winston Koh Teoh Hock, Senior Lecturer  
National University of Singapore, Singapore
- . Development of EAVI Technology using Microwave ID Tag System at Toyota

Dr Yoshihiro Nishimura et al  
Toyota Motor Corporation, Japan
- . Vehicle and Engine Performance Monitoring and Analysis System

Mr Sam de Maria, Lecturer, Director of Energy & Engines Research Group, University of Australia, Australia
- . The Impact of Aluminium on Automobile Technology & on Maintenance Repair

Mr Henrich Timm, Director  
Audi AG Ingolstadt, Germany
- . A Novel Method of Engine Knock Control

Mr Russell Grant Britton, Lecturer  
Ngee Ann Polytechnic, Singapore
- . Inspection and Analysis of Failure Patterns of Heavy Vehicles in Singapore

Mr Joseph Lee, Manager  
SAE Inspection Services, Singapore

- . A Study of Benzene Pollution from Gasoline and Motor Exhaust  
Dr Foo Swee Ching, Safety First Council  
National University of Singapore, Singapore
- . Vehicle Exhaust Emission Control in Singapore  
Mr Lee Kheng Seng, Strategic Planning & Research Department  
Ministry of the Environment, Singapore
- . The Vibration Environment in Land Vehicles with Reference to  
the Human Occupant and Equipment  
Mr Joseph Toh Hang Lim  
Shama Technologies (S) Pte Ltd, Singapore
- . Design Considerations of Double-Stacked Trailers  
Mr Poon Ooi Theng, Senior Lecturer  
Ngee Ann Polytechnic, Singapore
- . Improving Workshop Operational Efficiency and Profit by the  
Use of Standard Repair Times  
Mr Roger Dennis, Director  
Lorry Logic, United Kingdom

## IAIN SEYMOUR-HART

### Speaker/Workshop Presenter

Iain is currently Head of the Department of Motor Vehicle Engineering at Lee Wai Lee Technical Institute of the Vocational Training Council, Hong Kong. He is also the Principal Lecturer for the 'Road Traffic Accident Reconstruction Course' for serving Senior Police Officers and is the Hong Kong Examiner for the City and Guilds of London Institutes regarding the aforementioned course.

Having spent some eight years training in both heavy and light vehicle repair from 1961 to 1969 Iain then entered the teaching profession to work his way through to his present position gaining valuable experience in a College of Further Education then a Technical College and, before coming to Hong Kong, in a College of Technology in Liverpool.

Whilst lecturing in Liverpool Iain became involved in teaching Road Patrol Police Officers various aspects of the technology related to Traffic Accident Reconstruction eventually becoming locally recognised as an authority regarding Vehicle Dynamics and Tyre Technology. It was during this ten year exciting "stint" in the home of The Beatles that Iain was first asked to analyse a few traffic accident cases and thereby made appearances in Courts of Law.

Soon after arriving in Hong Kong to set up the Motor Vehicle Engineering Department for the Vocational Training Council Iain liaised closely with the Royal Hong Kong Police Force and as a result two important new courses were born. The "Road Traffic (Construction and Maintenance of Vehicles) Regulations Requirements Course" for Enforcement and Control of safety on the roads of Hong Kong and the "Road Traffic Accident Reconstruction Course" these courses having trained about 120 and 15 participants' respectively each year for the past six or seven years.

On a consultancy basis Iain has analysed more than 300 traffic accident cases, many requiring attendance in Law Courts (Criminal and Civil) to give evidence. He has also established a group of able academic staff who have undertaken technical consultancy works of benefit to local industry which attract a much needed degree of realism into the academic arena.

Iain has also been active with the Hong Kong IMI/RTE Centre having been a committee member since 1984 and a recent past Centre Chairman. In addition he was invited to join the Marine, Mechanical & Chemical Divisional Committee of The Hong Kong Institution of Engineers in 1990 and is currently their Vice Chairman.



Academic/Professional Qualifications

Registered Professional Engineer and Full Member of the Hong Kong Institution of Engineers, Incorporated Engineer (I.Eng) and Full Member of the Institute of Road Transport Engineers, Full Member of the Institute of the Motor Industry, Honorary Member of the Hong Kong Institute of Advanced Motorists. Full Member of the Society of Automotive Engineers. Honorary Adviser to the Kowloon and Hong Kong Motor Repair Merchants' Association and Member of the Association of Motor Vehicle Teachers.

Bachelor of Education (Hons), City and Guilds of London Institutes. Full Technological Certificate in Automotive Engineering, Higher National Certificate in Mechanical Engineering, Transport Engineers Management Certificate, Teachers Certificate (TECH).

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